Summit

to Create a Cyber-Community to Advance Deaf and Hard-of-Hearing Individuals in STEM

Bibliography on Remote Interpreting + Captioning 2008

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Research and Publication Request

Date: March 12th, 2008
Client: Bill Clymer, PEN International
Topic: research, publications and guidelines related to the use of technology to provide remote captioning or interpreting services for deaf students in post secondary settings

Search Terms: C.A.R.T. (Communication Access Real-time Translation), Real-time Captioning, Real-time Speech Transcription;

Contents:

Introduction and Websites

Communication Access Realtime Translation (CART) is the instant translation of the spoken word into English text using a stenotype machine, notebook computer and realtime software. The text appears on a computer monitor or other display. This technology is primarily used by people who are late-deafened, oral deaf, hard-of-hearing, or have cochlear implants. Culturally deaf individuals also make use of CART in certain situations. Please keep in mind that CART is also often referred to as realtime captioning.

Communication Access Information Center: http://www.cartinfo.org/

E-Michigan Deaf and Hard of Hearing People: http://www.michdhh.org/assistive_devices/cart.html

Articles - Research

Communication Access Real-time Translation (CART) Captionist from University of California, LA. (2003).
http://www.chr.ucla.edu/chr/comp/webdocs/ClassSpecAlpha_files/pdfclassspecs/captionist.pdf

Susanne Wagner (2005). Intralingual speech-to-text-conversion in real-time: Challenges and Opportunities. Challenges of Multidimensional Translation: Conference Proceedings.
http://www.translationconcepts.org/pdf/MuTra_2005_Proceedings.pdf#page=214

> Intralingual speech-to-text-conversion is a useful tool for integrating people with hearing impairments in oral communication settings, e. g. councelling interviews or conferences. However, the transfer of speech into written language in real time requires special techniques as it must be very fast and almost 100% correct to be understandable. The paper introduces and discusses different techniques for intralingual speech-to-text-conversion.

Anna C. Cavender (2008). Using Networked Multimedia to Improve Academic Access for Deaf and Hard of Hearing Students. Online document: http://dhhcybercommunity.cs.washington.edu/publications/annacc_generals_doc.pdf

> Deaf and hard of hearing students experience barriers that make access to mainstream universities a challenge. Educational technology has the potential to better include these students in the academic mainstream. This paper begins by outlining historical trends in education for deaf students because understanding the unique characteristics and experiences of members of the deaf community will be crucial for successful design. We then discuss current trends in educational technology in general, especially those that will ultimately be made accessible or compatible with the needs of deaf students. Finally, this paper describes the author's proposed thesis work: the development and evaluation of a classroom platform for deaf and hard of hearing students to access remote interpreters and captionists, avoid visual dispersion, and facilitate classroom interaction.

Kheir, Richard and Way, Thomas (2007). Inclusion of Deaf Students in Computer Science Classes using Real-time Speech Transcription: http://delivery.acm.org/10.1145/1270000/1268860/p261-kheir.pdf?key1=1268860&key2=7919364021&coll=GUIDE&dl=GUIDE&CFID=57738567&CFTOKEN=41315552.

> Computers increasingly are prevalent in the classroom, with student laptops becoming the norm, yet some beneficial uses of this widespread technology are being overlooked. Speech recognition software is maturing, and possesses the potential to provide real-time note taking assistance in the classroom, particularly for deaf and hard of hearing students. This paper reports on a practical, portable and readily deployed application that provides a cost-effective, automatic transcription system with the goal of making computer science lectures inclusive of deaf and hard of hearing students. The design of the system is described, some specific technology choices and implementation approaches are discussed, and results of two phases of an in-class evaluation of the system are analyzed. Ideas for student research projects that could extend and enhance the system also are proposed.

Elliot, L & Stinson,M. (2003). C-Print Update: Recent Research and New Technology. NTID Research Bulletin 8(2). https://ritdml.rit.edu/dspace/bitstream/1850/2701/1/NTIDNewsletterWinter2003.pdf

> C-Print refers to a family of computer-assisted, speech-to-print technologies. Here, we briefly describe the service and review recent findings and forthcoming enhancements to the system. Since 1990, approximately 1000 deaf and hard-of-hearing students have been supported in educational environments through use of C-Print and over 500 individuals from approximately 350 educational programs in at least 46 states and 4 foreign countries have completed the month-long training to become a C-Print captionist. C-Print has been widely disseminated beyond NTID and is now frequently requested by deaf and hard-of-hearing students around the world.

Smith, Duane. (2001). CART in the Classroom: How to Make Realtime Captioning Word for You. Instructional Technology and Education of the Deaf Supporting Learners, K – College: An International Symposium, Rochester, N.Y. http://www.rit.edu/~techsym/papers/2001/T10B.pdf

> Communication Access Realtime Translation (CART) reporting has gained increasing prominence as an assistive technology. CART provides a verbatim translation of the lecture, allowing students with a hearing loss to fully participate in class. Find out about the benefits of CART in the educational setting and experience a demonstration of this equalizing technology.

Fifield, M. Bryce; & Webster, JoLynn (2001). Realtime Remote Online Captioning: An Effective Accomodation for Rural Schools and Colleges . Instructional Technology and Education of the Deaf Supporting Learners, K – College: An International Symposium, Rochester, N.Y. http://www.rit.edu/~techsym/papers/2001/W11C.pdf

The Realtime Remote Online Captioning System (RROCS) developed by Fifield and his colleagues at the North Dakota Center for Persons with Disabilities (http://ndcpd.org) provides a tool for delivering captioning services to rural and isolated locations. Audio from the teacher and the classroom is captured via a lapel or handheld microphone and transmitted to a classroom computer running the RROCS software. The software digitizes the audio and transmits it via the Internet to an off- site captionist who is also running the RROCS software. The software plays the classroom audio for the captionist who transcribes it either directly into the RROCS or by using a commercial transcription program such as GlobalCat. The transcribed text is transmitted back to the classroom where it is displayed for the student. The transcript is also posted to a password protected web site for later retrieval or emailed to the teacher and/or student.

Veazey, Barbara & McInturff, Paul (2006). Establishing a Realtime Captioning Program: Designed to Meet the Needs of 28 Million Deaf and Hearing Impaired Americans. Community College Journal of Research & Practice 30(2) p157-158. http://web.ebscohost.com/ehost/pdf?vid=8&hid=4&sid=16991b28-f456-4209-ad56-6139b03245ee%40sessionmgr9

With the ability to provide open access at the local, regional, and statewide levels, community colleges are proving that they are truly the people's college. By revising existing programs in a short period of time to meet the needs of 28 million deaf and hearing impaired Americans, they are again proving that they can provide qualified graduates for new jobs demanded by the work force. This brief article describes a court reporting program at the West Kentucky Community and Technical College that has made the necessary revisions to take it to the level of being able to incorporate the Captioning and Communication Access Realtime Translation Program (CART) into their program.

Elliot, L; Stinsin, M.; McKee, Barbara; Everhart, Victoria; & Francis, Pamela (2001). College Students Perceptions of the C-Print Speech-to-Text Transcription System. Journal of Deaf Studies and Deaf Education 6:4. http://jdsde.oxfordjournals.org/cgi/reprint/6/4/285 .

With the ability to provide open access at the local, regional, and statewide levels, community colleges are proving that they are truly the people's college. By revising existing programs in a short period of time to meet the needs of 28 million deaf and hearing impaired Americans, they are again proving that they can provide qualified graduates for new jobs demanded by the work force. This brief article describes a court reporting program at the West Kentucky Community and Technical College that has made the necessary revisions to take it to the level of being able to incorporate the Captioning and Communication Access Realtime Translation Program (CART) into their program.

Foster, Susan; Long, Gary; & Snell, Karen (1999). Inclusive Instruction and Learning for Deaf Students in Postsecondary Education. Journal of Deaf Studies and Deaf Education 4(3). Oxford University Press, Cambridge. http://jdsde.oxfordjournals.org/cgi/reprint/4/3/225.pdf

This article explores how students who are deaf and their instructors experience mainstream college classes. Both quantitative and qualitative procedures were used to examine student access to information and their sense of belonging and engagement in learning. Instructors

were asked to discuss their approach to teaching and any viewed classroom communication and engagement in a similar manner as their hearing peers. Deaf students were more concerned about the pace of instruction and did not feel as much a part of the 'university family' as did their hearing peers. Faculty generally indicated that they made few if any modifications for deaf students and saw support service faculty as responsible for the success or failure of these students. We discuss results of these and additional findings with regard to barriers to equal access and strategies for overcoming these barriers.

Preminger, Jill E.; & Levitt, Harry (1997). Computer-assisted remote transcription (CART): A tool to aid people who are deaf or hard of hearing in the workplace. Volta Review 99(4), p218. http://web.ebscohost.com/ehost/detail?vid=4&hid=116&sid=e7f744c7-b9ff-418b-89c8-af7d58cc52dd%40sessionmgr103

New technologies are needed that will allow people who are deaf or hard of hearing to participate fully in meetings held in the workplace. Computer Assisted Remote Transcription (CART) is a procedure in which a stenographer transcribes a meeting from a remote location. This study investigated the feasibility of the CART system through an experiment and a case study. An experiment was conducted to learn whether a stenographer could transcribe a meeting of up to 10 speakers accurately from a remote location. In the case study, the CART system's usefulness and practicality were investigated in the workplace for a professional with a hearing impairment. The results indicated that, after a short familiarization period, a stenographer should be able to transcribe a meeting of up to 10 speakers with fairly good accuracy, but the results also revealed several problems with the practicality of the CART system in the workplace.

Class Specification – B.15
CART Captionist - 6681

Communication Access Real-time Translation (CART) Captionist

CLASS CONCEPT

CART Captionist

The Communication Access Real-time Translation (CART) Captionist provides a communication link between the hearing impaired or otherwise disabled student and the instructor by transmitting classroom lectures and/or other spoken materials in English into a concurrent display that has been put into a textural format. The captioning service is for the hearing impaired student's individual use and typically does include transcripts of the captioned transcription. The incumbent translates the transmission of what is being said in the student's immediate environment by using a stenography machine that connects to a laptop computer or a textural projection for the use of the student. The CART Captionist employs simultaneous delivery skills word-for-word between the instructor and the student to enable the hearing impaired student to participate in classroom discussions. The incumbent is available for captioning the student's appointments with faculty and may assist faculty and staff members in communicating with the hearing impaired student. The incumbent may be required to caption technical and scientific information, necessitating understanding of related words and phrases that require technical training for comprehension. As called upon, the CART Captionist may provide additional captioning, and may perform other related duties as assigned.

DISTINGUISHING CHARACTERISTICS:

The CART Captionist position is distinguished from the Interpreter/Translator for the Deaf position (Title Code 6680) in that the CART Captionist utilizes specialized equipment to transcribe auditory input; the Interpreter for the Deaf uses sign language to translate the same information. The positions are also distinguished from one another in that they serve different student needs. The positions are similar in that both provide services to enable the student with a hearing impairment to participate in the educational process.

MINIMUM QUALIFICATIONS

CART Captionist

Graduation from high school or a General Education Diploma; comprehensive knowledge of English, proven proficiency in using captioning equipment; or an equivalent combination of education and experience and knowledge and abilities essential to the successful performance of the duties assigned to the position. Requirements for this position typically include proficiency with a dictionary of 26,000 entries and captioning speed up to 180 words per minute. Some positions may require certification by recognized CART Captionist associations and the provision and use of own captioning equipment and software.

Susanne Wagner (Halle)

Intralingual speech-to-text-conversion in real-time: Challenges and Opportunities

Contents

Abstract

Intralingual speech-to-text-conversion is a useful tool for integrating people with hearing impairments in oral communication settings, e. g. councelling interviews or conferences. However, the transfer of speech into written language in real time requires special techniques as it must be very fast and almost 100% correct to be understandable. The paper introduces and discusses different techniques for intralingual speech-to-text-conversion.

1 The need for real-time speech-to-text conversion

Language is a very fast and effective way of communicating. To use language means to express an unlimited amount of ideas, thoughts and practical information by combining a limited amount of words with the help of a limited amount of grammatical rules. The result of language production processes are series of words and structure. Series of words are produced – i.e. spoken or signed – in a very rapid and effective way. Any person can follow such language production processes and understand what the person wants to express if two preconditions are fulfilled the recipients must:

1. know the words and grammatical rules the speaker uses and
2. be able to receive and process the physical signal.

Most people use oral language for everyday communication, i.e. they speak to other people and hear what other people say. People who are deaf or hard-of-hearing do not have equal access to spoken language, for them, precondition 2 is not fulfilled, their ability to receive speech is impaired.

If people who are severely impaired in their hearing abilities want to take part in oral communication, they need a way to compensate their physical impairment[1]. Hearing aids are sufficient for many hearing impairment people. However, if hearing aids are insufficient,

[1] To provide access to oral communication situations for hearing impaired people is an issue of fairness which, in recent years, is increasingly reflected by national governments. In some countries laws stipulate that at least authorities and official institutions provide information in a form which is also accessible for people with an impairment. Consequently, auditory information has to be provided in a way which can also be detected visually or haptically by people with a hearing impairment (cf. S. Wagner et al., 2004).

spoken language has to be transferred into a modality which is accessible without hearing, e.g. into the visual domain.

There are two main methods to transfer auditory information into a visible format. The translation into sign language is one method and it is best for people who use sign language as a preferred language, as e.g. many Deaf people do. However, for people with a hearing disability who do not know sign language, sign language interpreting is not an option — as for many Hard of Hearing people and people who became hearing impaired later in their life or elderly people with various degrees of hearing loss. They prefer their native oral language given in a visible modality. For them, a transfer of spoken words into written text is the method of choice, in other words: they need an intralingual speech-to-text-conversion.

Speech-to-text-translation (audiovisual translation) of spoken language into written text is an upcoming field since movies on DVDs are usually sold with subtitles in various languages. While the original language is given auditorily, subtitles provide a translated version in another language at the same time visually. The audiovisual transfer from the spoken original language into other languages which are presented in the subtitles can be called an interlingual audiovisual translation. Interlingual translation aims at transferring messages from one language into another language. This translation process combines classical interpreting with a transfer from spoken language patterns into written text patterns. Auditory events which are realized as noises or speech melodies would often not be transferred because normally hearing people can interpret them by themselves. Interlingual translation primarily addresses the lack of knowledge of the original language, i.e. the first precondition for understanding language.

The intralingual audiovisual transfer differs in many aspects from the interlingual audiovisual translation between two languages.

First of all, intralingual audiovisual transfer for people with hearing impairments addresses primarily precondition 2, i.e. the physical ability to perceive the speech signals. The aim of an intralingual audiovisual transfer is to provide all auditory information which is important for the understanding of an event or action. Words as well as non-language sounds like noises or hidden messages which are part of the intonation of the spoken words (e.g. irony or sarcasm) need to be transmitted into the visual (or haptic) channel. How this can be achieved best, is a question of present and future research and development (cf. Neves, in this book). Moreover, people with hearing impairment may insist on a word-by-word-transfer of spoken into written language because they do not want a third person to decide which parts of a message are important (and will therefore be transferred) and which parts are not. As a result, intralingual audiovisual transfer for people with hearing impairment might mean that every spoken word of a speech has to be written down and that all relevant auditory events from outside of the speech have to be described, too (interruptions, noises). In the latter case, the intralingual audiovisual transfer would exclusively satisfy the physical ability to perceive the speech signal (precondition 2).

The classical way to realize an intralingual speech-to-text transfer is to stenotype a protocol or to record the event and to transfer it into a readable text subsequently. This post-event transfer process is time-consuming and often difficult, since auditory events easily become ambiguous outside of the actual context. Moreover, the time shift involved in the transfer into a readable text means a delayed access to the spoken words, i.e. it does not help people with hearing impairments in the actual communication situation. However, for counselling interviews, at the doctor's or at conferences, access to spoken information must be given in real-time. For these purposes, the classical methods do not work.

2 The challenges of speech-to-text-conversion in real-time

Real-time speech-to-text-conversion aims at transferring spoken language into written text (almost) simultaneously. This gives people with a hearing impairment, access to the contents of spoken language in a way that they e.g. become able to take part in a conversation within the normal time frame of conversational turn taking. Another scenario for real-time speech-to-text-transfer is a live broadcast of a football match where the spoken comments of the reporter are so rapidly transferred into subtitles that they still correspond to the scene the reporter comments on. An example from the hearing world would be a parliamentary debate which ends with the electronic delivery of the exact word protocol presented to the journalists immediately after the end of the debate. (cf. Eugeni, forthcoming)

This list could be easily continued. However, most people with a hearing disability do not receive real-time speech-to-text services at counselling interviews, conferences or when watching a sports event live on TV. Most parliamentary protocols are tape recorded or written stenotyped and subsequently transferred into readable text. What are the challenges of real-time speech-to-text conversion that make its use so rare?

2.1 Time

A good secretary can type about 300 key strokes (letters) per minute. Since the average speaking rate is about 150 words per minute (with some variance between the speakers and the languages), even the professional typing rate is certainly not high enough to transfer a stream of spoken words into a readable form in real-time. As a consequence, the speed of typing has to be increased for a sufficient real-time speech-to-text transfer. Three different techniques will be discussed in the following section "methods".

2.2 Message Transfer

The main aim of speech-to-text transfer is to give people access to spoken words and auditory events almost simultaneously with the realization of the original sound event. However, for people with limited access to spoken language at a young age, 1:1 transfer of spoken words into written text may sometimes not be very helpful. If children are not sufficiently exposed to spoken language, their oral language system may develop more slowly and less effectively compared with their peers. As a result, many people with an early hearing impairment are less used to the grammatical rules applied in oral language as adults and have a less elaborated mental lexicon compared with normal hearing people (Schlenker-Schulte, 1991; see also Perfetti et al. 2000 with respect to reading skills among deaf readers)[2].

If words are unknown or if sentences are too complex, the written form does not help their understanding. The consequence for intralingual speech-to-text conversion is that precondition 1, the language proficiency of the audience, also has to be addressed, i.e. the written transcript has to be adapted to the language abilities of the audience - while the speech goes on.

Speech-to-text service providers not only need to know their audience, they also have to know which words and phrases can be exchanged by equivalents which are easier to

[2] Apart from people who were born with a more severe hearing impairment, language proficiency might differ also for people with cultural backgrounds different from a majority group, people with other mother tongues or people with learning difficulties.

understand, and how grammatical complexity can be reduced. They need to know techniques of how to make the language in itself more accessible while the information transferred is preserved. Aspects of how language can be made more accessible will be discussed in the following section "text adaptation".

2.3 Real-time presentation of the written text

Reading usually means that words are already written down. Presented with a written text, people will read at their individual reading speed. This, however, is not possible in real-time speech-to-text conversion. Here, the text is written and read almost simultaneously, and the control of the reading speed shifts at least partly over to the speaker and the speech-to-text provider. The text is not fixed in advance, instead new words are produced continuously and readers must follow this word production process very closely if they wants to use the real-time abilities of speech-to-text transfer. Because of this interaction of writing and reading, the presentation of the written text must be optimally adapted to the reading needs of the audience. This issue will be discussed at the end of the paper in section "presentation format".

The challenges of real-time speech-to-text conversion can now be summarized as follows:

1. to be fast enough in producing written language that
2. it becomes possible to meet the expectations of the audience with respect to the characteristics of a written text. Word-by-word transfer enhanced by a description of auditory events from the surroundings as well as adaptations of the original wording into easier forms of language must be possible. Moreover,
3. a successful real-time presentation must match the reading abilities of the audience, i.e. the written words must be presented in a way that is optimally recognizable and understandable for the readers.

3 Methods of real-time speech-to text conversion

There are three methods that are feasible when realizing (almost) real-time speech-to-text transfer: speech recognition, computer assisted note taking (CAN) and communication access (or computer aided) real-time translation (CART). The methods differ

1. in their ability to generate exact real-time transcripts.
2. with respect to the conditions under which these methods can be properly applied and
3. with respect to the amount of training which is needed to become a good speech-to-text service provider.

3.1 Speech recognition

Automatic speech recognition (ASR) technologies today can correctly recognize and write down more than 90% percent of a long series of spoken words for many languages. However, even this high percentage is not sufficient for speech-to-text services, since 96+x% correctness is needed to provide a sufficient message transfer (Stinson et al. 1999: accuracy). Moreover, even the 90+x% accuracy in automatic speech recognition does not occur by itself. In order to be recognized, the speaker has to train the speech recognition system in advance with her/is voice and speaking characteristics. Some regional speaking characteristics (dialects) are generally only poorly recognized, even after extensive training. Physical changes in voice quality (e.g. from a flu) can result in poorer recognition results. The reason for this is that the speech recognition process is based on a match of physical parameters of the actual speech signal with a representation which was generated on the basis of a general

phonetic model of language and the phonetic and voice data from the individual training sessions. If the individual physical parameters differ from those of the training sessions, recognition is less successful. Moreover, if background noise decreases the signal-to-noise-ratio, accuracy might go down to below 80 percent.

However, speech recognition systems can meet challenge number 1 (writing speed) under good circumstances. In this case, the recognition rate of ASR would in principle be high enough to transfer every spoken word into written text in real-time. But there are limitations which have to be taken into account. The most restrictive factor is that automatic speech recognition systems are not (yet) capable of recognizing phrase- and sentence boundaries (but see Leitch et al. 2002). Therefore, the output from an automatic speech recognition system is a stream of words without any comma or full stop. Moreover, the words would not be assigned to the different speakers. An example from Stuckless (1999) might illustrate how difficult it is to understand such a stream of words:

> "why do you think we might look at the history of the family history tends to dictate the future okay so there is some connection you're saying what else evolution evolution you're on the right track which changes faster technology or social systems technology." (Stuckless 1999)

Automatic speech recognition today fails as far as challenge 3 is concerned.: Although the single words are readable, the output of automatic speech recognition systems is almost not understandable for any reader.

The short-term solution for this problem is that a person, who has trained her/is speech recognition system extensively with his/her speaking characteristics, has to re-speak the speech of the speaker with explicit punctuation commands and speaker identification. With re-speaking, speech recognition is an option especially for live subtitling and conferences where the speech-to-text conversion can be made in a studio or sound shielded room. With respect to the need of an excellent signal-to-noise-ratio, it is certainly not an option for noisy surroundings.

Re-speaking has advantages though. It makes it possible to adapt the spoken language for an audience with limited oral language proficiency. This would not be possible with automatic speech recognition.

Real-time speech-to-text conversion with speech recognition systems does not require special technical knowledge or training except for the fact that the SR- system has to be trained. For the user it is sufficient to speak correctly. However, linguistic knowledge and a kind of "thinking with punctuation" is necessary to dictate with punctuation marks.

Summary of speech recognition

Automatic speech recognition is not yet an option for speech-to-text transfer since phrase- and sentence boundaries are not recognized. However, speech recognition can be used for real-time speech-to-text conversion if a person re-speaks the original words. Re-speaking is primarily necessary for including punctuation and speaker identification but also for adapting the language to the language proficiency of the audience. Apart from an intensive and permanent training of the speech recognition engine, no special training is required. A sound-shielded environment is useful. The use of a speech recognition systems does not require any special training. Linguistic knowledge, however, is necessary for the chunking of the words and for adaptations of the wording.

3.2 Computer-assisted note taking (CAN)

With computer-assisted note taking (CAN), a person writes into an ordinary computer what a speaker says. However, as was discussed earlier, even professional writing speed is not sufficient to write down every word of a speech. To enhance writing speed, abbreviation systems are used in computer-assisted note taking which minimize the amount of key strokes per word. The note taking person types abbreviations or a mixture of abbreviations and long forms. An abbreviation-to-long-form dictionary translates the abbreviations immediately into the corresponding long form. On the screen, every word appears in its long form.

Realizations of CAN systems are widespread. On the one hand, small systems are incorporated in almost every word processing software. The so called "auto correction" translates given or self defined abbreviations into the corresponding long forms. On the other hand, there are very elaborated and well developed systems like e.g. C-Print which has been developed at the National Technical Institute for the DEAF at Rochester Institute of Technology (RIT 2005). This system uses phonetic rules to minimize the key strokes for every word. After a period of training with the system, the captionist is able to write with a higher speed. This allows for a high quality message transfer. However, the writing speed is still limited so that word-for-word transcripts are rather unusual, even with C-Print. With CAN-systems like C-Print, a message-to-message rather than a word-for-word transfer is produced.

The efficiency of CAN systems is mainly determined by the quality of the dictionary which translates the short forms into the corresponding long forms. The better the dictionary, the higher the typing speed potential.

Individually made dictionaries are mostly a collection of abbreviations like 'hv' for 'have' and 'hvt' for 'have to' etc. However, this kind of dictionary is limited insofar as the user has to know every abbreviation. Consequently, the amount of time which is needed for people to learn and to prevent them from forgetting the abbreviations once learned increases with the increase in the size of the dictionary.

Elaborated systems like C-Print use rule-based short-to-long translations. Here, the captionist has to learn the rules of transcription. One rule could be that only consonants but not vowels are written down. The resulting ambiguities (e.g. 'hs' for 'house' and 'his') have to be resolved by a second rule. However, orthographic transcription rules turned out to be rather complicated – at least in English. Therefore, systems like C-Print are often based on a set of rules which are in turn based on a phonetic transcription of the spoken words. On the basis of a set of shortening rules, the note taking person does not write certain graphemes but phonemes of the spoken words.

Summary of CAN-systems:

CAN-systems can be used for real-time speech-to-text conversion if a message-to-message transfer is sufficient. For word-for-word transfers, the typing speed of CAN-systems is not high enough.
The quality and speed of the transfer depends on the kind and quality of the dictionary which translates abbreviations or shortened words into the corresponding readable long forms. To use a CAN-system, the note taking person needs to learn either the abbreviations of the short-to-long dictionary or the rules of short-phoneme/grapheme-to-long-grapheme conversion the dictionary is based on.

Linguistic knowledge is necessary for adaptations of the wording.

3.3 Communication access real-time translation (CART)

Communication access real-time translation (CART) uses stenography in combination with a computer based dictionary. The phonemes of a word are typed on a steno keyboard which allows the coding of more than one phoneme at a time. It is thus possible to code e.g. one syllable by a simultaneous key press with up to all 10 fingers: The left keys on the keyboard are used to code the initial sound of the syllable, the down keys code the middle sound and the right keys of the keyboard code the final sound of the syllable. For high frequency words or phrases, prefixes and suffixes, abbreviations are used.

The phonetic code of the words or the respective abbreviation is immediately translated into the corresponding long form by a sophisticated dictionary. An example (taken from www.stenocom.de, cf. Seyring 2005) can illustrate the advantage with respect to typing speed:

a) typing on a normal keyboard: 88 strokes
Ladies and Gentlemen! The people want to have calculability and stability.

b) Same words in machine steno code: 12 strokes
(The code between two spaces is 1 stroke, typed with up to 10 fingers.)
*HRAEUPLBG STPH T PAOEPL WAPBT TO*F KAL KUL BLT APBD STABLT FPLT*

The parallel typing with CART systems results in a high typing speed which is sufficient for word-for-word transcripts in real-time. The phonetic transcription reduces ambiguities between words and allows real-time accuracy levels of more than 95%. Moreover, if the audience is not interested in word-for-word conversion, CART systems can also be used for message-to-message transfers since they allow adaptations of the wording in real-time.

CART-systems can be used in silent or noisy surroundings, their efficiency mainly relies on the education of the person who does the writing. However, the education of the speech-to-text provider is one of the most limiting factors of CART systems. 3-4 years of intensive education with a lot of practicing are the minimum for a person to become a CART speech-to-text provider who produces text in sufficient quality (less then 4% of errors) and speed (ca. 150 words per minute). The second limitation of CART is the costs for the steno system of around 10.000 Euro.

Summary of CART-systems:

CART systems are highly flexible tools for real-time speech-to-text conversion. They can be used in noisy or silent surroundings for word-for-word as well as for message-to-message transfer. The limitations of CART are located outside of the system, i.e.

- the long period of training which is needed to become a good CART provider
- the costs of the steno system

3.4 Comparison of Speech Recognition, CAN- and CART-systems

	Speech Recognition with re-speaking	**Computer-Assisted Note-taking**	**Communication Access Real-time Translation**
Exact word protocols	Yes	almost, but needs a lot of training and a sophisticated dictionary	Yes
Language adaptations	Possible with re-speaking	Yes	Yes
Education to use the method	Some hours for initial training of SR-system	some weeks- months	3-4 years
Special conditions	Minimum background noise	None	None
Cost of equipment[1]	100-200 € SR-system 50-100 € good microphone (opt.) 1.000 Euro notebook	1.000 € notebook (+ licence for the dictionary)	~ 10.000 € steno machine 1.000 € notebook (+ licence for the steno-longhand dictionary)

Table 1: Speech recognition, computer-assisted note-taking and communication access real-time translation in comparison.

4 Text adaptation

Spoken and written forms of language rely on different mechanisms to transfer messages. Speech for instance is less grammatical and less chunked than text. A real-time speech-to-text conversion - even if it is a word-for-word service - has to chunk the continuous stream of spoken words into sentences and phrases with respect to punctuation and paragraphs in order for the text to be comprehensible. A correction of grammatical slips might be necessary, too, for word-for-word conversions and even more corrections my be necessary for an audience with less language proficiency. While intonation may alleviate incongruencies in spoken language, congruency errors easily cause misinterpretation in reading.

The transfer from spoken into written language patterns is only one method of text adaptation. As discussed earlier, the speech-to-text provider might also be asked to adapt the written text to the language proficiency of the audience. Here, the challenge of word-for-word transfer shifts to the challenge of message transfer with a reduced set of language material. A less skilled audience might be overstrained especially with complex syntactical structures and low frequent words and phrases. The speech-to-text provider therefore needs to know whether a word or phrase can be well understood or should better be exchanged with some more frequent equivalents. S/he also has to know how to split long and complex sentences into simpler structures to make them easier to understand.

The know how of text adaptation with respect to the needs of the audience is highly language- and field-specific. People who become C-Print captionists learn to use text condensing strategies which is mainly aimed at reducing key strokes (RIT 2005) but might also reduce grammatical complexity and lexical problems. However, a recent study on the effects of summarizing texts for subtitling revealed that "summarizing affects coherence relations, making them less explicit and altering the implied meaning" (Schilperoord et al. 2005, p.1). Further research has to show whether and how spoken language can be condensed in real-time without affecting semantic and pragmatic information.

For German, it has already been shown that test questions can (offline) be adapted linguistically without affecting the content of the question. That is, many words and structures can be replaced by equivalents that are easier to understand (cf. Cremer 1996; Schulte 1993; Wagner et al. 2004). Further research will have to show whether this kind of text adaptation on word-, sentence- and text level (in German called "Textoptimierung") can also be realized in real-time.

5 Presentation format

The last challenge of real-time speech-to-text transfer is the presentation of the text on the screen in a way that reading is optimally supported. The need to think about the presentation format is given as the text on the screen is moving which is a problem for the reading process. We usually read a fixed text, and our eyes are trained to move in saccades (rapid eye movements) on the basis of a kind of preview calculation with respect to the next words (cf. Sereno et al. 1998). But in real-time speech-to-text systems, the text appears consecutively on the screen and new text replaces older text when the screen is filled. A word-by-word presentation as a consequence of word-for-word transcription could result in less precise saccades which subsequently decreases the reading speed. Reading might be less hampered by a presentation line-by-line, as it is e.g. used in C-Print (cf. the online presentation at http://www.rit.edu/~techsym/detail.html#T11C). However, for slower readers, also line-by-line presentation might be problematic since the whole "old" text is moving upwards whenever a new line is presented. As a consequence, the word which was actually fixated by the eyes moves out of the fovea and becomes unreadable. The eyes have to look for the word and restart reading it.

The optimal presentation of real-time text for as many potential readers as possible is an issue which is worth further research, not only from the perspective of real-time transcription but also for subtitling purposes.

6 Perspectives

Real-time speech-to-text transfer is already a powerful tool which provides people with a hearing impairment access to oral communication. However, elaborated dictionaries as they are needed for efficient CAN- or CART-systems are not yet developed for many languages. Without those dictionaries, the systems can not be used.

Linguistic research has to find easy but efficient strategies for the real-time adaptation of the wording in order to make a message understandable also for an audience with limited language proficiency.

Finally, the optimal presentation of moving text to an audience with diverging reading abilities is a fascinating research field not only for real-time speech-to-text services but with respect to the presentation of movable text in general.

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Using Networked Multimedia to Improve Academic Access for Deaf and Hard of Hearing Students

Anna C. Cavender
General Exam Document
University of Washington
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Abstract

Deaf and hard of hearing students experience barriers that make access to mainstream universities a challenge. Educational technology has the potential to better include these students in the academic mainstream. This paper begins by outlining historical trends in education for deaf students because understanding the unique characteristics and experiences of members of the deaf community will be crucial for successful design. We then discuss current trends in educational technology in general, especially those that will ultimately be made accessible or compatible with the needs of deaf students. Finally, this paper describes the author's proposed thesis work: the development and evaluation of a classroom platform for deaf and hard of hearing students to access remote interpreters and captionists, avoid visual dispersion, and facilitate classroom interaction.

1. Introduction

Entering mainstream universities involves extra challenges for people who are deaf and hard of hearing: skilled sign language interpreters and captioners with advanced domain knowledge can be difficult to find; multiple visual channels of information in the classroom can be difficult to juggle; and collaboration inside and outside the classroom is often strained due to language barriers [28].

Classroom technology research aims to improve educational experiences for all students and this creates opportunities to better include deaf and hard of hearing students. Wireless networks, data projectors, and portable computing devices can be used to bring in remote interpreters, support the sharing and capture of instructional materials, and provide additional communication channels for everyone. A more digital academic environment creates an opportunity for customization to better suit the needs of individual students.

2. Goals and Contribution

This research will investigate and develop technology to help manage the many academic tasks required of the estimated 20,000 deaf and hard of hearing students at mainstream universities in the U.S. [38]. Development will parallel other educational technologies so that technology for deaf students will be similar to those used by all students. The DHH Cyber Community project at the University of Washington will be a catalyst bringing together video remote interpreter services, remote captionists, skilled interpreters, and knowledgeable people within the deaf

community. The proposed work will utilize this web of resources and services and the high-bandwidth connections between them to promote the best educational environment and lower barriers to participation in university-level academics for deaf and hard of hearing students regardless of classroom type, instructor accommodation, or locally available resources.

3. Background

When designing for deaf and hard of hearing people, it is important to understand that as a group, they have extremely varied backgrounds and educational experiences. A person's self-identification as either deaf, hard of hearing, or hearing impaired is often primarily a personal choice and not a function of the degree and onset of hearing loss. Deaf people tend to prefer sign language, often choose not use their voice, and are likely to be involved in the signing Deaf Community (note the capital "D" indicating a sense of pride in the uniqueness of sign language and culture). Hard of hearing people tend to speak and lip-read and may rely on residual hearing, hearing aids, or cochlear implants when communicating with hearing people. They may also know sign language and participate in the Deaf Community. These groups are by no means distinct and both people and preferences can shift across group lines. Alternately, elderly people who have lost hearing later in life may better fit into a third group as they are unlikely to know sign language, do not identify with Deaf Culture, and may prefer the term hearing impaired (which is a term typically rejected by members of the Deaf Community as it is thought to negatively emphasize a deficiency).

The degree of a person's hearing loss is only a small aspect of their disability and does not necessarily determine the best classroom accessibility solution or accommodation. For some people, the ability to adjust the audio volume may be sufficient. For others, translation to a signed language may be more appropriate. For others still, access to text alternatives may be the best solution. For those who were raised in environments promoting speech training, good access to the face of the speaker may be sufficient. These different preferences are in large part due to varied backgrounds and personal experiences and no type of accommodation is perfect. Understanding the diversity of experiences from early childhood on is an important aspect of designing with and for deaf and hard of hearing students.

3.1. Issues Affecting Deaf and Hard of Hearing Students

From a strictly audiological point of view there are several ways to quantify hearing loss. The most common metric is the degree of loss in decibels (dB) from mild loss (25 to 40 dB) to profound loss (90 dB or greater). But, as the next sections will illustrate, hearing loss itself is only one of many factors affecting language acquisition and education of deaf students.

3.1.1. From Infancy to Early Childhood

There is a distinction between pre- and post-lingual deafness, meaning that deafness occurred before spoken language acquisition or after, respectively. Oral training (learning to speak and read lips) is much easier for post-lingually deaf children and much more difficult and often unsuccessful for pre-lingually deaf children. In either case, excellence at lip reading is not common.

Language acquisition depends much more strongly on early exposure to language, whether spoken or signed; relying on lip reading alone very much restricts the child's language exposure. In fact, deaf children born to deaf parents (much like hearing children born to hearing parents) experience almost effortless natural language acquisition simply through exposure to the language of their parents. However, ninety percent of deaf and hard of hearing children are born to hearing parents who do not know sign language. Many of these children are not exposed to any language in a natural way during those early critical years of language acquisition. Oral training is not a substitute for the almost effortless language acquisition that occurs naturally. This lack of early exposure to any language may be the reason that many deaf people struggle with the written form of spoken languages, for example English. In fact, for the lucky ten percent, early exposure to sign language and strong signing skills seem to act as a linguistic bridge to more easily acquiring English as a second language [31]. The effects of language acquisition during the early childhood years trickle through grade school, on to high school, and ultimately affect access to college and career.

3.1.2. From Early Childhood through Grade School

The type of schooling environment that a deaf student experiences growing up will also affect their preferred accommodation and access to the college classroom. Education for deaf children in the U.S. has undergone policy changes that have resulted in even more diversity within the deaf and hard of hearing group.

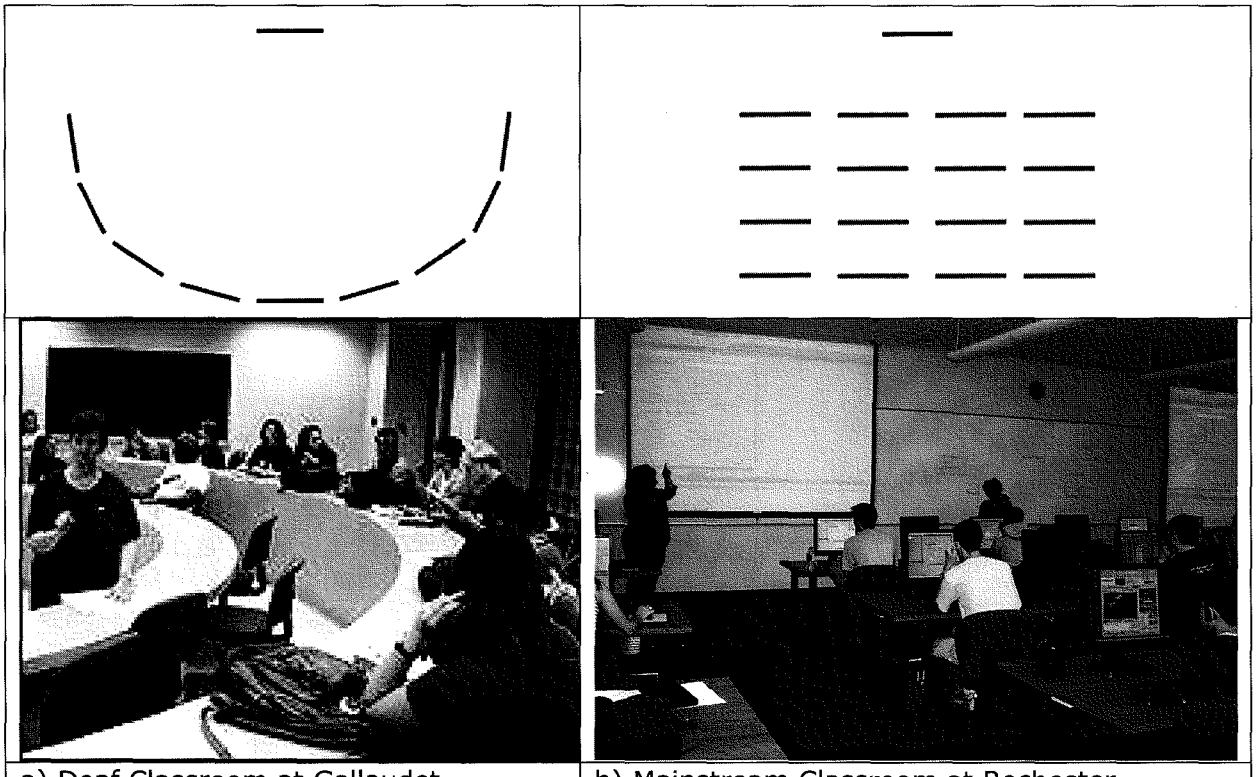
Until 1975, education of deaf children and adults in the United States was very centralized. Residential schools for the deaf were introduced in most states during the 1800s and Gallaudet University (an all-deaf liberal arts university) was founded in 1864. Centralization is based on the concept that deaf students need a specialized education because of their disability. In 1975 there was a fundamental change in public policy concerning the education of deaf people and others with disabilities with the passage of Public Law 94-142 now called the Individuals with Disabilities Education ACT (IDEA). The law mandated that all children with disabilities are assured a free appropriate public education. This "full inclusion movement" has not been without controversy [22]; some assert that a mainstream classroom may not be an ideal learning environment as it isolates students and reduces exposure to the deaf community and deaf role models. Since then, the percentage of deaf students attending residential schools has declined steadily to about 15% [45], with the majority attending mainstream schools.

3.1.3. From High School to College and Beyond

Although a large segment of deaf and hard of hearing students attend the three major universities serving primarily deaf students (Gallaudet, National Technical Institute for the Deaf (NTID), California State University Northridge (CSUN)), the vast majority of deaf students attend mainstream colleges and universities. According to the National Center for Education Statistics (NCES), over 20,000 deaf and hard of hearing students are enrolled in post-secondary educational institutions in the U.S., approximately 93% at the undergraduate level. This is likely an underestimate as the survey was conducted more than a decade ago, it did not include primarily deaf universities like Gallaudet, NTID, and CSUN, and not all

students identify themselves to the university as deaf or hard of hearing. Over 50% of 2- and 4-year post-secondary institutes in the U.S. have identified as serving 1 or more deaf or hard of hearing student, nearly 95% for larger colleges and universities [38]. This illustrates how deaf and hard of hearing students are spread thinly at universities across the country, a point we will come back to later.

There are striking differences between classrooms geared toward all-deaf classes versus typical mainstream classrooms. All-deaf classrooms tend to be aligned in a semicircle so that all students can easily see the instructor, presentation, and all other students. Mainstream classrooms may have a number of different configurations, but the most frequent is rows of students all facing the front of the class (see Figure 1). Clearly, mainstream classrooms were not designed with the deaf student in mind.



a) Deaf Classroom at Gallaudet University (www.npr.org "At Gallaudet, a Turn Inward Opens New Worlds")

b) Mainstream Classroom at Rochester Institute of Technology 9/2007 (interpreter far left, instructor front and center)

Figure 1: Deaf Classrooms as in a) focus on visual accessibility. Mainstream Classrooms as in b) are often arranged in rows.

Recent years have seen an increase in deaf and hard of hearing students attending mainstream universities, which is likely a result of the "full inclusion" movement, IDEA act, the Americans with Disabilities Act of 1990 that prohibits discrimination based on disability.

3.2. Existing Accommodations

This increase in deaf and hard of hearing students in the academic mainstream has resulted in an array of accommodations in academic settings including: interpreters, real-time captioners, hearing aids, FM systems, and note takers.

3.2.1. Interpreters

As more deaf students enter mainstream universities, there is a growing need for skilled sign language interpreters that have specialized, university-level knowledge and signing skills. Because deaf students are spread thinly across U.S. universities, matching a student interested in a given domain with an appropriate interpreter who has knowledge of that domain can be a challenge, especially for advanced courses and for universities serving only a small number of deaf students.

Video remote interpreting (VRI) has been used in the classroom to help increase resource opportunities for this matching problem. VRI uses an intermediary interpreter, not in the same room, who signs what is voiced and voices what is signed for deaf and hearing people from the within same room. Video relay services (VRS) have similar services and are very popular, but these services are restricted to telephone conversations between parties not physically co-located.

3.2.2. Real-time captioners

Communication Access Real-time Translation (CART) is the system used by court stenographers and closed captioners in both academic and non-academic settings to manually convert speech to text using a keyboard or stenographic machine.

Much like interpreters, real-time captioners can only effectively convey classroom content if they understand that content themselves. Thus, matching students with appropriate and knowledgeable captionists can also be a challenge. Remote CART can also be used where the operator receives the voice through a telephone or computer connection and the text is sent back over a data connection. Some CART systems allow the student to highlight and add their own comments to the real-time text as it scrolls across the computer monitor [41]. C-Print is a type of CART developed at the National Technical Institute for the Deaf that enables operators who are trained in academic situations to consolidate and better organize the text with the goal of creating an end result more like class notes and more conducive to study [17].

Several researchers are working on speech recognition for automatically displaying spoken language in text [5]. Error rates are slowly improving, but these systems have a long way to go until they are usable. Very low errors would be required as even the smallest error (imagine recognizing a "ought" when the speaker actually said "not") can completely change the meaning of the text. Using textbooks to train the system on relevant course content [27] can improve error rates. When these systems are used in the classroom, a human operator typically corrects the errors on-the-fly [49] and formats the text to show pauses to indicate speaker changes and to better facilitate later study. At this stage, the operator can not be eliminated altogether.

3.2.3. Note-takers

Because deaf students rely so heavily on visual communication, looking down to take notes causes them to miss the information that is being signed or captioned. Therefore, deaf students often receive notes from hearing students who volunteer (or sometime are employed by the university) to share their notes. Instructors may also copy class notes, slides, or transparencies for deaf students. While this helps ease visual burdens during class, the student may miss out on the value of taking and studying personal notes.

3.2.4. Accommodation of Choice

A student's choice of accommodation depends in large part on their experience and educational background: strength in sign language, comfort with English, and previous experience with a given accommodation. Studies that have compared different types of services (sign language instruction, sign language interpretation, CART, and C-Print) show mixed results, probably due to the diversity of student needs [32].

Additionally, the same student may choose different accommodations for different types of courses. As one student pointed out, real time text may be better than sign language interpretation for courses involving many new vocabulary terms: "C-Print works best in lecture-based courses and courses that rely more on words as opposed to formulas or graphics." [17]. Sign language may be better for courses such as geometry containing lots of spatial and relative information or for courses focused on discussion or debate if the student's preferred mode of communication is sign language.

Can too much accommodation be a bad thing? Mayer *et al.* showed that both real time text captioning and in-person sign language interpretation together resulted in greater loss of information than either one alone, perhaps due to visual overload [34]. In contrast, Marschark *et al.* found that having both sources of accommodation (but shown on the same computer screen) was beneficial [32]. Furthermore, students learned more from sign language during class but got more out of real time text notes for studying. This could indicate that more channels of information are in fact beneficial, but only if they are arranged in a way that reduces visual overload, a point we will come back to in Section 3.3.1.

3.3. Accessibility Goals and Design Criteria

In spite of the plethora of possible accommodations, attrition of deaf students at the university level is high. This is partly due to missed classroom information and underdeveloped study habits such as note taking, but it is also related to difficulty with social and cultural connections with other students [28]. Our work will address both missed information through visual dispersion and translation as well as issues with collaboration with other students.

3.3.1. Reducing Visual Dispersion

> "The ear tends to be lazy, craves the familiar, and is shocked by the unexpected; the eye, on the other hand, tends to be impatient, craves the novel and is bored by repetition." ~ W. H. Auden

Problem:
Unfortunately, there are several ways that a deaf student can miss classroom information. Because deaf students receive nearly all classroom information visually, they must juggle their visual attention between instructor, slides, interpreter and/or captioner, and personal notes or handouts. Due to this juggling, information can easily be missed. Even when best practices for classroom setup are followed such as reducing visual obstacles (having the student sit up front) and utilizing techniques to include deaf students, the visual juggling act still results in missed information [25].

Even if explicit information is carefully provided, inadequate access to subtler, implicit information may put students at a disadvantage. For example, both conscious and sub-conscious gestures used by instructors often contain task-relevant information that has been shown to be helpful to the learner in problem solving activities [19]. If deaf students' visual attention is focused on the interpreter or the captions, they may be missing out on this alternative mode of information. Having better visual access to the teacher and the ability to replay both the instructor's actions and the interpreter and/or captions later may further reduce missed content.

Visual distribution problems often found in the classroom are summarized nicely by the experiences of one profoundly deaf and profoundly influential researcher while enrolled in a workshop to learn a new statistical software package (from [31]):

> Superficially, the learning context seemed ideal: The lecturer was a sensitive individual who went to great lengths to ensure full access by deaf individuals participating in the workshop. He had a projection of his own computer display on a large screen behind him, and each participant had their own computer for hands-on activities. The sign language interpreters were the best that could be found: all experienced in interpreting under such conditions. The two deaf participants had strong backgrounds in the use of computers, research, and statistics. Yet, both quickly became lost, viewing the two days as a waste of time. What went wrong?
>
> Primarily the problem was one of multiple, visual tasks placing too many demands on the processing of information in the learning situation. While the hearing participants were able to look at their screens and listen to the presenter, the deaf participants had to look away from the interpreter to see the instructor's screen or to try a procedure on their own computer. Missing one sentence of the instructions was enough to slow down or even derail learning. Watching the interpreter made it difficult to catch each action of the presenter or the projected screen.

Key Challenges:
Consolidating visual content into one device may prevent missed information and reduce the visual juggling act. Laptops, tablets, webcams, and high bandwidth connections can all be used to consolidate and conglomerate the visually important

aspects of the classroom, making them easier to access. Regardless of the student's choice of accommodation and the source of that choice (whether the interpreter or captioner is physically present or remote) presenting it in one device along with the instructor, the presentation materials, personal annotations, and potentially other classmates will allow the student to make better use of their visual modality.

Consolidation will likely help since studies have shown that items located closer to a person's current visual task are more easily and accurately found than items located farther away in the periphery (the eccentricity effect). Wolfe *et al.* offer proof that visual attention is affected by eccentricity by showing that people are more likely to notice and quicker to locate nearer items. Also, the effects of eccentricity are reduced when there are fewer distractions on the screen [51]. We may be able to further reduce clutter by giving the user control over their interface to emphasize what is most important and cut out what is not, as in WinCuts [47].

A frequent question when talking about visual interfaces for deaf learners is if deafness has an effect on visual perception. While the visual modality is clearly important for deaf students, there is no evidence that deaf people are able to make better use of vision than hearing people [31]. However, in at least one study Corina *et al.* have shown that deaf students are better able to redirect attention from one spatial location to another and better able to detect important motion in their periphery [13]. This is especially impressive considering that deaf people watching sign language focus on the face of the signer over 95% of the time [10].

Empowering students to design their own layout and formatting on-the-fly will be important for supporting a diverse user group with diverse needs, but it may also offer insights into future user interface design for this group.

3.3.2. Broadening Opportunities for the Best Services

> "Teachers are the most important classroom 'technology' and students are the least utilized classroom 'resource.'"
> ~ Harold Johnson, Kent State University

Problem:
Deaf students can also miss information in the classroom if that information is not properly or accurately conveyed to them. Section 3.2.1 described the importance of matching students with interpreters and/or captioners who understand and can accurately interpret for advanced, university-level content. Because students are spread so thinly, finding appropriate interpreters and captionists can be a problem.

Key Challenges:
Using high-bandwidth connections and remote interpreters and captionists would increase the pool of available accommodation for a student to choose from. Several universities and companies including Viable Technologies [48] and HandsOn VRS [21] are already pooling their resources and offering services for this type of remote assistance in the classroom. This has been especially important in the recent past for remote schools and colleges that otherwise would not have the resources to offer this type of assistance [18]. Also, the Media Access Group at

WGBH provides real-time captions for live Web events and Web conferencing [35], which could be used for online courses. Remote accommodation has also been shown to be adequate for both real-time captioning and sign language interpreting as video-based interpreting appears to be just as effective as in-person interpreting [33]. Because the system will be flexible with students' choice of accommodation, they could potential choose an automatic speech recognition system, assuming error rates were tolerable and alternate accommodation was not available [40].

Better collaboration through the existing high-bandwidth connections between universities would allow better access to skilled interpreters familiar with specialized, university-level topics. The DHH Cyber Community project is already pooling together these types of resources. This approach will also allow different types of students to receive differing accommodations based on preference. For example, one student may prefer a remote sign language interpreter while another student prefers real-time captioning.

Relying on high-bandwidth connections may not always be an option and anytime a technology can use less bandwidth, it will be available more of the time. Our MobileASL group has developed compression techniques specific to sign language that may help reduce bandwidth usage [11]. Finally, the digital nature of videos will also have the benefit of being recorded, archived and perhaps distributed.

3.3.3. Reducing Barriers to Classroom Participation

"Tell me and I will forget;
show me and I may remember;
involve me and I will understand."
~ Chinese proverb

Problem:
Communication, and thus participation, in the classroom can be strained for deaf and hard of hearing students due to language barriers. Plus, events outside the classroom (project group meetings and impromptu study groups) where there is no scheduled interpreter can inadvertently exclude deaf or hard of hearing students.

By the time students reach college, they are a diverse group with diverse backgrounds, knowledge, and communication/accommodation preferences. Mainstreamed students who may not have sign language skills and/or knowledge of deaf culture can feel excluded from other deaf students and sometimes stereotyped by hearing students [26]. This may further increase barriers to participation, which is crucial to academic success. A study of multimedia learning environments found that nothing affected learning more than student participation [14]. The study tested text only, text and content movies, text and sign movies, text and discussion questions, and all of these together. The only conditions to significantly affect learning were the ones involving discussion questions. Clearly, students do not learn nearly as much if they do not participate and interact in their own learning.

Key Challenges:
Deaf students may benefit from technological environments that put more students on equal footing. In fact, Richardson *et al.* found that the effects of hearing loss on

participation in distance learning courses was slight, perhaps because the asynchronous textual modalities of communication lowered the barrier to participation [43]. New "digital" classroom environments may have a similar effect, opening up new possibilities for promoting equality *within* the classroom.

3.3.4. Enabling Instructor Participation (buy-in):

"Teachers open the door, but you must enter by yourself."
~ Chinese Proverb

Problem:
Instructors do not like to trouble shoot during class-time so the platform should work seamlessly with or without other technologies being used.

Key Challenges:
While the proposed technology will likely be beneficial for a wide range of classroom, meeting, study group, and other academic situations, we are primarily focusing on lecture-style classrooms for a number of reasons. First, enabling access to the most common type of pedagogy found in large university courses will make the biggest impact for deaf and hard of hearing students pursuing degrees at mainstream universities. Second, we feel that if we were to require a different type of pedagogy, use of the system would be reduced. Instructors should be able to teach in a way that is most effective for them and deaf students should be able to take any class they like, regardless of the teaching style or compliance of the instructor. Minimizing the burden on the instructor and placing more of the power and choice with the student will not only increase adoption of the technology, but will empower and increase opportunities for the student.

To summarize, people with hearing loss form a disability group very different from other disability groups. Accommodation needs can range from sign language interpretation to visual access to the speaker to text captions to FM systems and hearing aids. Clearly, a one-size-fits-all approach has a good chance of failure as different solutions will work for different students (perhaps even for different classes or situations) and flexibility and user choice will be key to adoption.

4. Related Work

Work related to the proposed technology can be divided into technology designed for typical mainstream audiences and technology designed specifically for deaf audiences, whether in the mainstream or deaf classroom.

4.1. Educational Technology (in general)

Classroom technology research aims to enhance educational experiences for all students by using technology to better engage and involve students in the classroom through active learning. Insights from this field will be incorporated into our project to better include deaf and hard of hearing students.

Electronic classroom response systems (CRSs) allow instructors to solicit feedback and results from student activities, and receive them electronically to then summarize or discuss as a class. These systems have been shown to have positive

effects on classroom participation, active learning, and conceptual understanding [23]. They also tend to encourage shy or less outspoken students to contribute more and reduce the impact of students who tend to dominate classroom interaction [39]. "Clicker" systems are a subset of CRSs that allow students to submit short responses to the instructor (such as answers to multiple choice questions or numeric answers) so that the instructor can display summaries of class responses and opinions of students [12][16][20][44] or groups of students [15]. The summaries can serve as feedback on class understanding for the instructor and can spark conversation about a given topic, but they limit students in the type of their submissions and don't allow for anonymous, independent questions.

Systems that allow text and digital ink to be submitted to the instructor are less restrictive and better at promoting self-initiated dialog between students and instructor. The University of Washington's Classroom Presenter uses networked Tablet PCs to allow students to electronically submit work, questions, and/or comments to the instructor who can then choose to display submissions and digital ink on lecture slides [2][30]. Ubiquitous Presenter [50] and DyKnow [6] offer similar functionality, but with a web-based interface that requires no tablet (a laptop will do). In addition to submitting questions anonymously during class, ActiveClass allows students to rate the questions of other students to bring them to the attention of the instructor [42]. Because cost barriers exist to providing all students with similar technology, Classroom Presenter also offers a version using mobile phones, a device more and more students tend to already have [29].

The digital classroom has incredible potential to better accommodate the needs of students with disabilities in mainstream university classrooms. For example, LiveNotes uses digital ink over lecture slides to encourage group conversations and cooperative note-taking during lectures [24]. This type of interaction may allow deaf students to become more involved in the note-taking process without being solely responsible for their own notes.

As academic environments become more digital, capture and retrieval introduce interesting areas to improve content accessibility. Synchronization of video feeds, digital ink, and presentation materials could result in better preservation and easier post-class access, much like eClass [8] and other classroom capture techniques [37]. One might think that classroom capture would encourage students to skip class but studies suggest that it does not. In fact, in one instance students were more likely to attend if the class was being captured. Students tend to recognize the value of interactions that occur in an in-person group class [8], which helps to relieve the worry of missing class. As deaf students juggle their visual attention during class time, the ability to re-watch parts of the class that were missed may level the playing field and ease information retention.

4.2. Educational Technology for Deaf and Hard of Hearing

Both educational technology for deaf and hard of hearing students and educational technology for a general audience are developed to encourage participation and active learning. The focus of the former is typically more on translation of speech, new interaction techniques, and eliminating visual overload.

Networking within the classroom is also utilized in educational technology for deaf and hard of hearing classrooms. Linda Burik at NTID has shown active learning benefits from using wireless laptops and a SMART board in the classroom [9]. In her system, the teacher can show the students' work on the big class display for discussion, somewhat like Classroom Presenter but the instructor can "grab" student screens rather than receiving students "submissions." Students keep both their own digital work and digital copies of the instructor's notes so that participation in class and note-taking activities are one in the same.

Researchers such as Donald Beil have recognized the potential of using tablets in class to enable deaf students to take notes on top of, instead of away from, other classroom content [4]. Digital pen-based environments create further opportunities for deaf students in terms of self-notetaking as was proposed by Miller *et al.* using transparent video and overlaid digital ink to reduce the visual distance from the interpreter (video) and the student's notes (digital ink) [31].

In online distance learning settings, high-bandwidth connections and streaming video are already being used to better include deaf and hard of hearing students [7]. While this use of the technology works well for distance learning, we predict that the same benefits of inclusion will occur in the physical classroom as well.

To facilitate communication between deaf and hearing students in his classes, Jonathan Schull proposed a system that he successfully uses at RIT/NTID for students to join a common, on-the-fly chat room and display text concurrently to best augment a face-to-face conversation.

4.3. Enabling Technology (a comparison)

ConferenceXP [3] and Adobe Connect [1] are two conferencing technologies that have potential for use in our work. Both enable video/audio conferencing and remote sharing of presentation slides, application windows, and even entire desktops. We will leverage their existence and stability as a foundation for our own work.

ConferenceXP, developed at Microsoft Research, provides the infrastructure for networking the Tablet PCs used in Classroom Presenter and is also used for audio and video distance learning and classroom capture. Classroom Presenter is currently used by at least 70 instructors at universities nationwide and this number is likely to grow in the future, so compatibility would ensure that the technology used by deaf and hard of hearing students will work well in conjunction with the classroom technology used by all students.

Adobe's Connect also offers video and presentation conferencing technology that could serve as a backbone for remote connections with interpreters and captioners and sharing of in-class resources [1]. In fact, Adobe currently has an alliance with Caption Colorado (www.CaptionColorado.com) and WGBH (www.wgbh.org) to provide captions for meetings. Several universities in the U.S. are currently using Connect for remote, online distance learning. Its use as a distance-learning tool ensures that several of the components needed for in-class involvement and participation will be available.

Both ConferenceXP and Connect have released open source versions of their systems that would allow us to make the necessary enhancements needed by deaf and hard of hearing students, discussed in Section 5.

We will also leverage the high-bandwidth, reliable internet connections that exist between universities enabled through Internet2 and Cyber-infrastructure communities to provide the best quality video/audio and stable transmission.

Describing our planned use of these systems is best illustrated with a scenario. The following three scenarios are intended to convey different types of students, accommodation needs, class structures, and enabling technologies.

4.3.1. Scenario A (Connect, Remote Interpreter)

Sally is a deaf student at the University of Io. She is fourth-generation deaf and prefers to converse in American Sign Language. She is majoring in Psychology and taking Child Psychology 101. The class is discussion-based; the instructor tends to show slides and videos and then expects students to discuss their opinions about them. For this class, Sally is using Adobe Connect to bring in a remote interpreter from a different university who happens to hold a degree in Child Psychology.

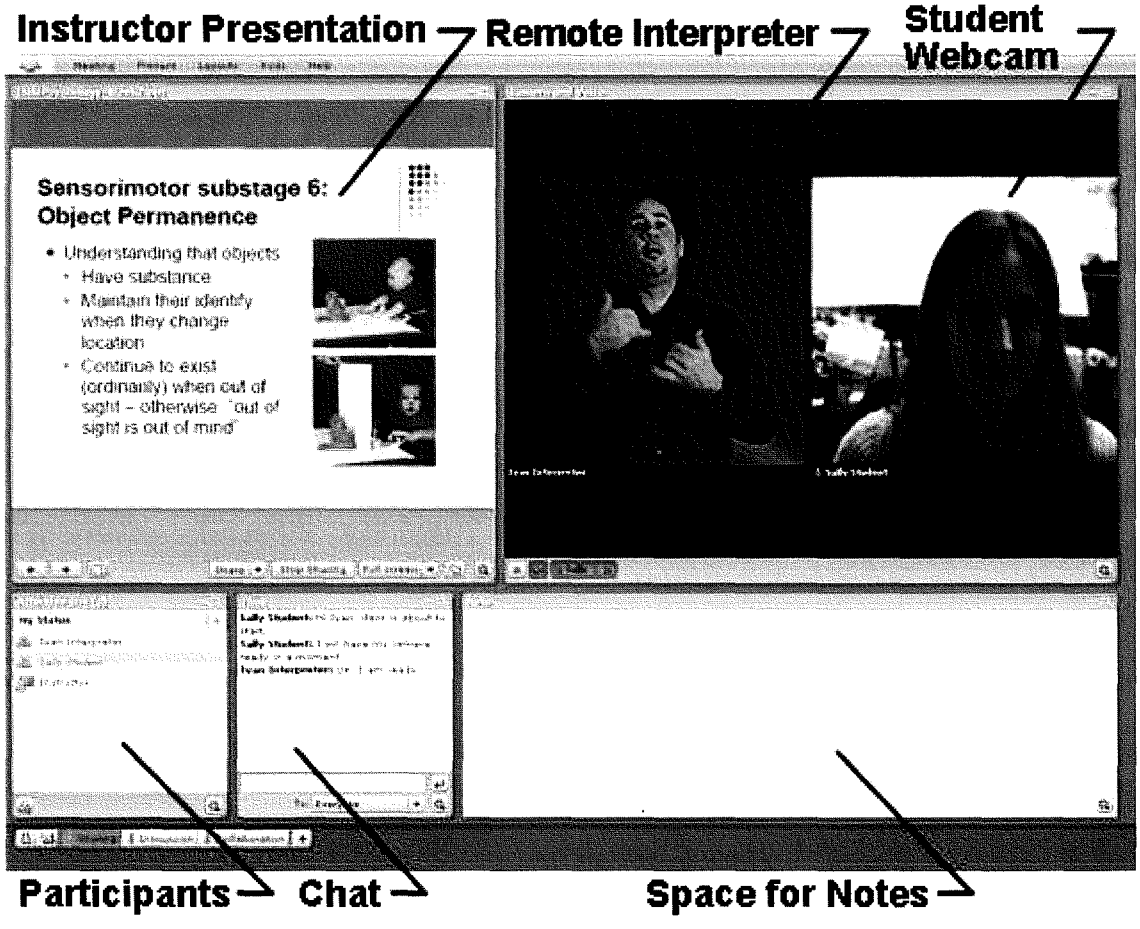


Figure 2: Using Adobe's Connect in Scenario A. Sally's computer screen show's the instructor's presentation, her remote sign language interpreter,

her own webcam, and the ability to chat and take notes.
The instructor has agreed to upload his slides and videos before classes start and to use the system during class. Because he only uses the power-point feature to show slides and videos, it is nearly the same process he would have used to teach (in fact he is even using the same materials as last quarter). The only noticeable different in class is that he now wears a microphone and earpiece to transmit voice between him and the interpreter. The students pass a microphone around during discussion and the instructor appreciates this added structure and enforced turn-taking.

Figure 2 shows Sally's screen on her laptop at the beginning of class. She has access to the instructor's slides and videos which are synchronized with his presentation. She can see both her interpreter and herself. She can chat with the interpreter and the instructor (if he checks the chat log) for example, incase the video stops working. And she has space to take typed notes. If she has a question or takes a turn in discussion, she signs to the interpreter who then voices for her. For this class, she chooses to turn the volume up on her laptop because the class is small and everyone can hear the interpreter. For larger classes, she would have the instructor repeat what he or she hears in their earpiece.

4.3.2. Scenario B (Classroom Presenter, Remote Captionist)

Bobby is a hard of hearing student at the University of Ganymede. He is majoring in Computer Science and currently taking Data Structures. He has only recently learned sign language (since he started college), so he does not yet feel comfortable with an interpreter. He prefers to use his voice to communicate and uses real-time captions during class because there are so many different vocabulary terms and acronyms in Computer Science courses and seeing the words helps him to find the topics later. He uses a note-taker because, in addition to the captions, he must watch the instructor who often writes code on the screen. Bobby has chosen ConferenceXP as a way to connect with his favorite captionist who is also a computer geek and so understands the content and is occasionally creative with ASCII art.

Luckily, his Data Structures instructor this quarter is using Classroom Presenter, so it will be easy for him to link the ConferenceXP connection he needs. All the students in class have TablePCs and submit in-class activities with digital ink. He too can create submissions and this puts him on the same level as other students. The use of tablets also gives him direct access to the notes of his note-taker. This enables him to add to the notes if he wants, but it mainly helps him refer back to the notes later because he sees them as they are created. The appearance of his screen can be seen in Figure 3.

From the instructor's perspective, her teaching process is exactly the same. She simply wears a microphone for the captionist and tells Bobby which session to connect to so that his tablet is on the same network as all the other tablets. Bobby then gives this information to his captionist, so that he too can see the slides. Instead of walking around the room with a microphone, the instructor prefers to repeat questions asked by hearing students as she feels this is a good practice to make sure all the other students heard the question.

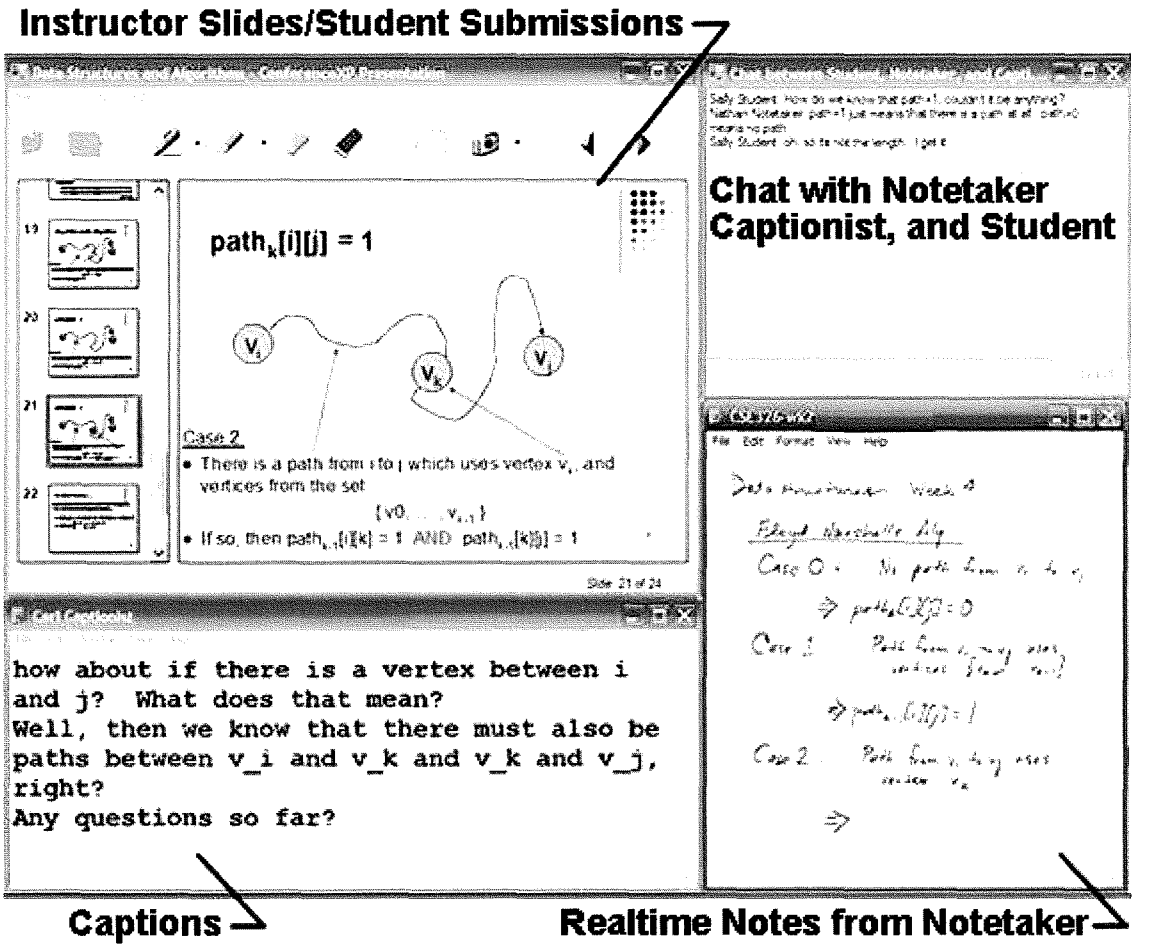


Figure 3: Using ConferenceXP in Scenario B. Bobby has the same level of involvement as all other students as they all submit activities with digital ink. He has access to a remote captioner and the digital notes created by his note-taker in class. He can chat with both his captioner and note-taker.

4.3.3. Scenario C (Interpreter in Class, Either Technology)

Tom is a deaf student at the University of Callisto and has attended mainstream schools from Kindergarten through high school. He prefers sign language interpreters and is accustomed to using them in class. This quarter, he is taking Intro to Biology in a huge, stadium-seating classroom. Even if he sits at the front of the class, the projected presentation is so large that he feels as though he is watching a tennis match between the screen, the instructor, and his interpreter. Instead, he sits a few rows back and uses a webcam to capture the entire front of the class. Then, he cuts out the important pieces: the instructor, presentation, and interpreter. He arranges these components on his screen so that he still has room for a chat window with a friend in class and a section for his own notes. Because the interpreter is present in the class with him, he can easily raise his hand, ask questions and interact.

5. Thesis Proposal

Existing technology has potential to alleviate some of barriers to and encourage participation in mainstream university-level academics for deaf and hard of hearing students. Designing, implementing, and evaluating technological solutions that bring many different technical and human resources into the classroom in an accessible and unobtrusive way is a challenging research problem. Technology has been shown to enhance education in the classroom and these "digital" environments open up new possibilities for leveling the academic playing field for deaf and hard of hearing students.

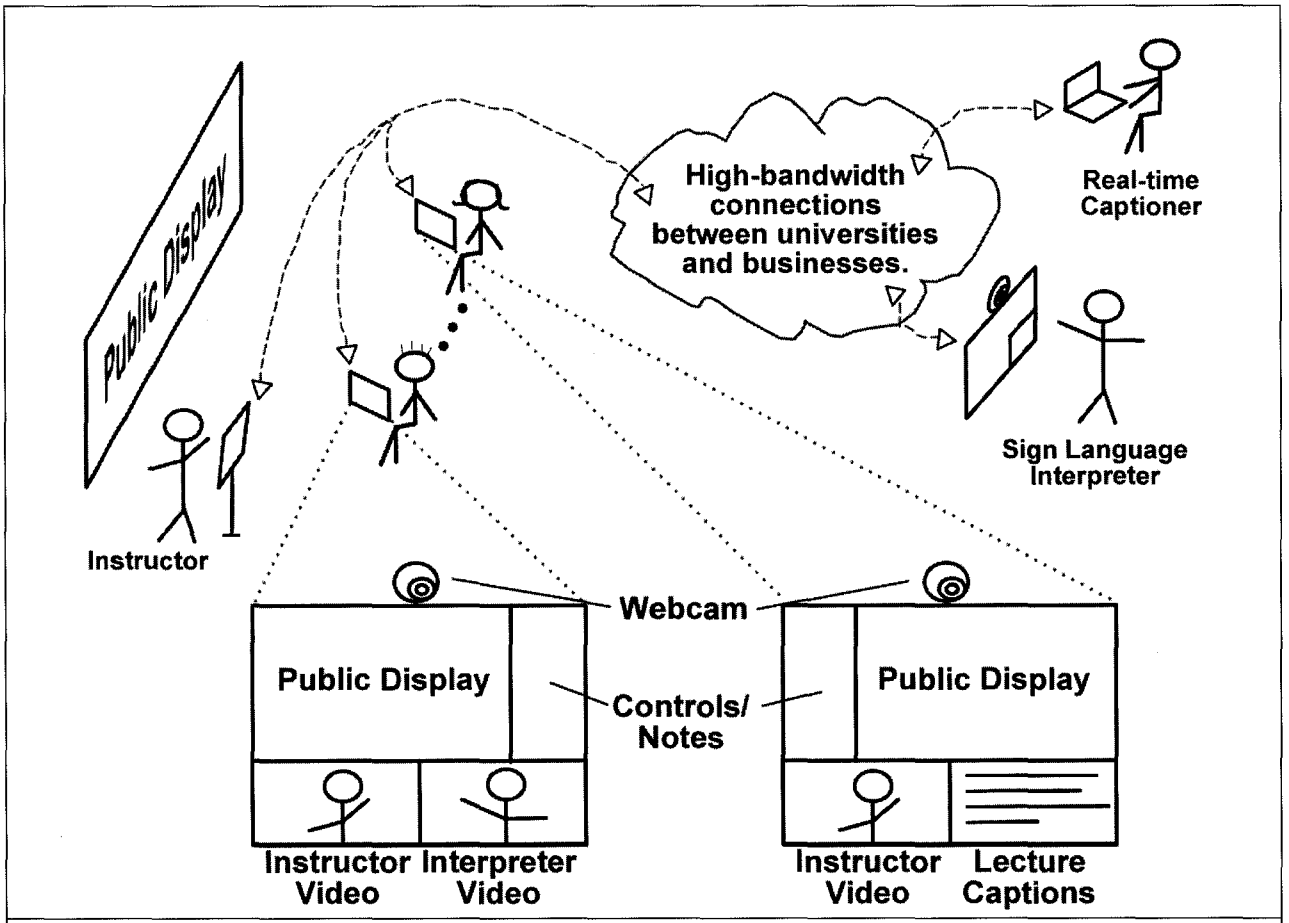


Figure 4: Networked multimedia brings remote interpreters and captioners into the classroom. Students have access to presentation, instructor, accommodation of choice, and their own notes. The instructor uses a microphone and earpiece and to relays audio, video, and presentation materials to the remote interpreter. Students' webcams relay questions and discussions through the interpreter to the rest of the class.

We will investigate effective ways for leveraging collaboration technologies for enhancing the participation of deaf and hard of hearing students in academic settings. The University of Washington's Classroom Presenter [2], Conference XP [3], and Adobe's Connect [1] will serve as a backbone so that technology for deaf students will be similar to and compatible with future classroom technology for all students. This technology will also be used to bridge the cultural and language gap

between hearing and deaf students and encourage group work using text and digital ink. Given the scenario where all students are equipped with a networked Tablet PC, an additional opportunity exists for student collaboration. Finally, capture and retrieval introduce interesting areas to improve content accessibility. Synchronization of video feeds, digital ink, and presentation materials could result in better preservation and easier post-class access.

5.1. Enabling User Control of the Interface

Different accommodations will be required for different students, different classroom situations, and various aspects of the classroom will be more or less visually important for different students at different times. Flexibility in the interface will be crucial for success. We will modify existing video conferencing and classroom technology to enable students to choose the size and visual importance of each interface component. Using techniques like those found in WinCuts [47] and Facetop Tablet [36], our interface will allow students to crop, zoom, show, hide, and arrange independently, all while maintaining compatibility with technology used by other students and the instructor. To help reduce clutter on the screen, students may choose levels of transparency for videos feeds and other desktop components so that overlap can occur when appropriate. Imagine an interpreter standing to the left of a public display. She occasionally references specific items from the display as the instructor is talking about them. The student may want to reduce his video feed of the interpreter to show only her signing box (upper body from waist to the top of her head) and it will be important that her video feed appears to the left of the video feed showing the public display. No interface could be expected to predict these types of scenarios and students preferences. The best solution will be to engage the student in the creation of their own academic environment in a way that adds minimal complexity to the interface.

5.2. Enabling Collaboration and Group Work

Communication, participation, and active learning in the classroom have all been shown to promote learning in positive ways. These types of activities can be difficult for deaf students due to language barrier and interpreter/captioner delay. Compatibility with other classroom technologies, such as Classroom Presenter, will assist with this. The ability to anonymously submit questions and answers to the instructor is likely to play a role in reducing barriers to participation.

Additionally, we will develop mechanisms to create or access alternate channels of communication if they are available. If students in the classroom have digital-ink-based devices, students will be able to share notes much like LiveNotes [24]. Students will be able to connect to synchronous text chat channels for discussion much like in the classrooms of Schull [46]. If the deaf student has arranged to have a note-taker, the two could combine efforts by having access to the digital ink or text notes being created on-the-fly.

5.3. Enabling Capture and Later Retrieval

Because deaf students have a multitude of priorities that divide their visual attention during class, having access to a captured version of that class for review may help them to fill in missed content and parse class notes.

We will create an online repository for classroom capture if the student chooses this option. Mechanisms for both student and instructor security will be explored. We will borrow some of the tried and true techniques from eClass [8] for implementing segmentation of the recordings. For example, slide changes are a natural way to segment the video and allow students to easily access the interval of the class they are interested in. We will also explore techniques for allowing students to mark their own points of interest for later retrieval during class.

5.4. Evaluation Techniques

Evaluation of the proposed classroom technology will be an integral aspect of the project from day one. Involvement from the deaf and hard of hearing community is key to adoption, so evaluation will take the form of focus groups, participatory design techniques, and iterative design where feedback from students is incorporated into the design at every iteration.

However, implementing traditional HCI techniques of evaluation will be difficult due to a limited number of diverse users, inconsistencies in instructors' teaching style, and technology and classroom setup. Doing studies with sustained use over several courses and several students will be impractical. For example, it would be difficult to teach the same course with and without the proposed technology because comparisons may not easily be made across a small handful of students.

Some of the most successful and influential work in the field of educational technology has studied the effects of learning, scores, participation, and student responses to questionnaires and interviews across hundreds of students and tens of years [8][24]. Interestingly, none of the studies were able to find significant results from the collections of attendance and grades (two data points that would be difficult for us to use reliably). Even 33 years of research on electronic response systems yields inconclusive results on effects of academic success, citing pedagogical practices of the instructor among other things as dominating factors [23]. The most significant and meaningful results from these studies were obtained through student questionnaires, surveys, and observations of student behavior.

Student surveys, focus groups, student and instructor artifacts, observational interviews with both instructors and students that focus on student perceived benefits seem to be the norm [6][15][20][30]. Learning improvements, test scores, and grades may not be reliable measures because evaluations "in the wild" in actual classrooms will have too many confounding factors, including variability of students, instructor's teaching style and level of engagement, participation of other students in the class, time of day, and lecture topic. Cost/*benefit* analyses may be more practical than cost/*effective* analyses and may even result in better indicators of quality of learning and interaction with instructors and peers. Thus, we will measure impacts on classroom environment, participation rates, and subjective measures based on student perceptions.

Evaluations for the project will test the following hypotheses.
Potential Hypotheses:

1. Students will feel that using the technology in class makes lectures more engaging.
2. Students will feel they have learned more as a result of using the technology.
3. Students will participate more in classrooms when using the technology.
4. Students will feel they participate more as a result of using the technology in the classroom.
5. Students will feel that the quality of their interaction in the classrooms is improved when using the technology.
6. Some students will alter their seating behavior as they are no longer forced to sit at the front of the class.
7. Students will view the technology as a useful study tool.
8. A majority of students will voluntarily continue to use the technology after participating in the study.

In addition to these hypotheses, we will also include evaluations for some of the adverse effects that we hope to avoid or outweigh with our technology, including 1) a learning curve for the technology that distracts from learning course content, 2) in-class distractions caused by the technology, 3) increased potential for off-topic behavior. Although we should decide carefully if any effects from point 3) are in fact adverse. In light of research that suggests that attrition of deaf students is partly due to isolation, increases in communication, even if off-topic, may have more of a positive than a negative effect.

During evaluations, we will collect the following types of data. We will collect quantitative data from recording student interactions and observing student and instructor behaviors. We will also collect qualitative data from focus groups, student survey, interviews, and voluntary student feedback.

Quantitative data:

- Attendance and/or classroom participation
- Effects on note-taking behavior.
- Effects on seating behavior.
- Increased or continued use (even without study requirements) would likely imply that students see the technology as valuable.

Qualitative data:

- Students' self-reflections on access to classroom content, note-taking behavior, participation, performance, learning experience and feeling of inclusion.
- Effects of classroom engagement.
- Students' perception of the technology as a useful in-class tool.
- Students' perception of the technology as a useful study tool.

We are currently collaborating with Rochester Institute of Technology (RIT), home of the National Technical Institute for the Deaf (NTID) supporting over 400 deaf students in the academic mainstream, over 120 sign language interpreters, and over 50 captioners. Evaluation of the technology will take place in mainstream classrooms at the University of Washington using both technical and human resources at RIT.

Another excellent opportunity for evaluation and feedback is the Summer Academy for Deaf and Hard of Hearing Students hosted each summer at the University of Washington. The top ten deaf college freshmen or sophomore applicants join the program to take college courses focused on introductory Java programming, computer science, and related fields. Because the academy involves mainstream courses, it presents an ideal testbed situation. Students who are interested in participating will be asked to use the technology, including a remote sign language interpreter or captioner, during class time and rate its usefulness through a series of questionnaires. Weekly one-on-one interviews will be conducted to discuss problems, suggestions, and other feedback.

5.5. Timeline

Spring 2008

- Prepare a working prototype of the classroom technology for the DHH Cyber Community Summit gathering in June 2008.

Summer 2008

- Implement and evaluate an initial version of the classroom technology locally at the University of Washington.
    i. This version will be fully functional, but may not include all of the desired features, such as capture.
- Conduct evaluations with students from the Summer Academy for Deaf and Hard of Hearing.

Fall 2008

- Use feedback from the summer release to improve the design of the system.
- Create an online repository for capture and retrieval.
- Implement and evaluate the classroom technology with interpreters and captioners at RIT and students at UW.
- Execute a formal user study to determine the best digital educational environment using the classroom technology.

Winter 2009

- Iterate improvements to the system based on the results from the formal user study.

Spring 2009

- Continue to improve and develop.
- Begin longitudinal studies with UW students to investigate long term use and results of any novelty factors.

Summer 2009

- Release and evaluate at Summer Academy for Deaf and Hard of Hearing and compare results to previous summer academy.

Fall 2010

- Finish remaining analysis and research.
- Prepare dissertation and defend.

6. Conclusion

Our primary research goal is to find ways to increase involvement of deaf and hard of hearing students in university academics. With this goal in mind, we will strive to broaden the accommodation resources for students through high-bandwidth remote interpreting, reduce the visual dispersion of important in-class components

through on-screen consolidation, and encourage in-class inclusion through new channels of communication and interaction. Solutions will be viable for traditional classroom environments as well as for lab sessions, study groups, and project meetings. And because our work will parallel that of other educational technology, we will follow universal design guidelines so that the technology used by deaf and hard of hearing students is compatible and seamlessly coexists with educational technology designed for a general, mainstream audience. By utilizing networked resources and flexible design that empowers students, we hope to create a more inclusive, easily accessible classroom environment.

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Inclusion of Deaf Students in Computer Science Classes using Real-time Speech Transcription

Richard Kheir and Thomas Way
Applied Computing Technology Laboratory
Department of Computing Sciences
Villanova University
Villanova, PA 19085
richard.kheir@villanova.edu
thomas.way@villanova.edu

ABSTRACT

Computers increasingly are prevalent in the classroom, with student laptops becoming the norm, yet some beneficial uses of this widespread technology are being overlooked. Speech recognition software is maturing, and possesses the potential to provide real-time note taking assistance in the classroom, particularly for deaf and hard of hearing students. This paper reports on a practical, portable and readily deployed application that provides a cost-effective, automatic transcription system with the goal of making computer science lectures inclusive of deaf and hard of hearing students. The design of the system is described, some specific technology choices and implementation approaches are discussed, and results of two phases of an in-class evaluation of the system are analyzed. Ideas for student research projects that could extend and enhance the system also are proposed.

Categories and Subject Descriptors

K.4.2 **[Computers and Society]**: Social Issues – *Assistive technologies for persons with disabilities.* H.5.2 **[Information Interfaces and Presentation]**: User Interfaces – *Voice I/O.*

General Terms

Design, Experimentation, Human Factors.

Keywords

Speech recognition, computer science education, inclusion, accessibility, deaf students, hard of hearing students, assistive technology.

1. INTRODUCTION

Advances in affordable portable computing technology have led to wider availability, making it possible to deploy automatic speech recognition (ASR) in the classroom, although challenges remain [3]. The ability of ASR systems to transcribe continuous speech faster than a note taker can write, with reasonable accuracy and minimal training, make them a viable option to assist deaf and hard of hearing students with note taking [5]. Computer science continues to be a popular choice of college major for high school students with hearing disabilities [1], although these students can find traditional accommodations such as sign language interpreters or lip-reading insufficient [10]. Technology such as speech recognition can provide a viable solution, but awareness of accessibility issues continues to be the most significant hurdle to inclusion [4].

Obstacles to relying on ASR for note taking include recognizing multiple or random speakers [5], synchronizing and incorporating visual cues [9], balancing real-time automated speech text against the potential for distraction [6], insufficient accuracy in recognizing domain-specific jargon [5], configuring, training and deploying the ASR system for classroom use [2], and achieving acceptable accuracy through microphone selection, improved software and additional training of the ASR system [11].

Active research in ASR for college classrooms is being done by the Liberated Learning Project (LLP), among others [5,6,2,11]. The LLP has the goal of enabling students with various disabilities, including hearing impairment, to maximize the benefits of the college lecture experience [8]. Significantly, the LLP has collaborated with IBM to develop the ViaScribe software that is specifically designed for real-time captioning, including ASR, of natural, extemporaneous speech. ViaScribe improves readability by detecting pauses in speech and inserting sentence and paragraph breaks, provides phonetic spellings when the recognizer is uncertain, and even has a less-accurate speaker-independent mode to accommodate multiple speakers [3].

Accuracy of reasonably well-trained ASR systems typically is better than 75-85% in classroom lecture settings, with rates over 90% for particularly consistent and clear lecturers [5,11], a rate that a significant majority of students find acceptable and useful [6]. A centralized ASR system producing real-time captioning on a projection screen with post-lecture access to a transcription has been used successfully in the classroom [11], although a more individualized approach often may be preferable [3,6,11].

This paper presents the design and evaluation of the Villanova University Speech Transcriber (VUST) system that increases accessibility of computer science lectures for deaf and hard of hearing students using real-time speech recognition software. This study was conducted at the Applied Computing Technology Laboratory at Villanova University (actlab.csc.villanova.edu), and

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evaluates the impact of the VUST system paired with our Dictionary Building Software utility (DiBS) [7] on the effectiveness of a portable, centralized, affordable, laptop-based ASR system designed to augment note taking by deaf and hard of hearing students in the college classroom. Although the original motivation for development of the system was to improve accessibility of computer science lectures specifically, the system holds potential for much wider applicability.

2. SYSTEM DESIGN

The VUST system consists of three major components: the speech recognition software, a dictionary enhancement tool, and a transcription distribution application. Figure 1 illustrates the VUST architecture, showing these major components and other elements of the system.

The dotted line in Figure 1 indicates the physical computer on which the speech recognition engine, VUST server application, wireless microphone receiver and other elements are located. One or more client applications can connect to the server, and a wireless headset microphone transmits speech to the server for processing.

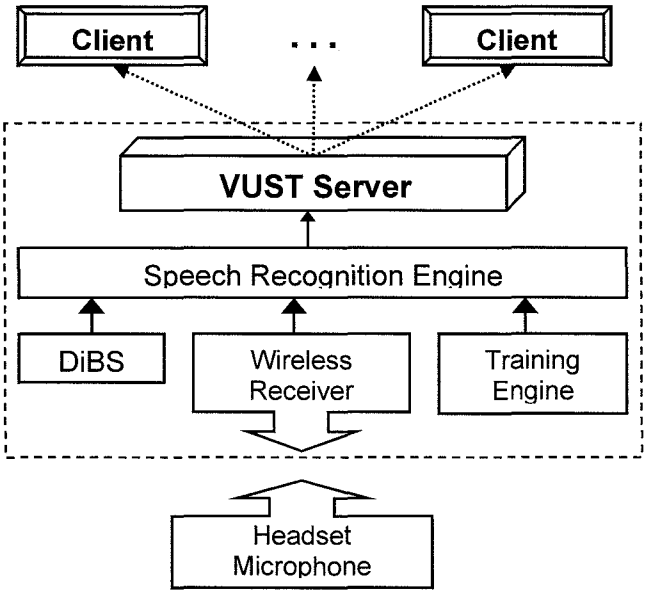

Figure 1. VUST System Design.

2.1 Speech Recognition System

The speech recognition system uses an ASR system designed to be affordable, accurate and easy to set up and use. The Microsoft Speech Recognition Engine (MSRE) was selected due to the wide availability in academic institutions of the Microsoft XP platform, which includes the MSRE, effectively providing the ASR engine for our system at no additional cost.

The Nady Systems UHF-3 wireless unidirectional headset microphone was selected as a cost-effective solution ($120-$140), with unrestricted movement, high directionality and good tolerance of interference being key considerations when selecting a microphone for ASR [7].

The MSRE is trained by an instructor via a control panel included with the engine. The instructor reads from a selection of available text scripts into a microphone, enabling the recognition engine to learn to recognize the specific words as spoken by the specific instructor. The maximum level of training that was tested in our evaluation required less than one hour, with 30 minutes of script-based training, 5 minutes to run the dictionary tool, and 10 minutes of additional training to record pronunciations of domain-specific words.

Setting up and running the system involves ensuring the instructor's computer is appropriately networked, connecting the wireless microphone receiver and putting on the wireless headset, activating the MSRE via the Windows Speech control panel, and starting the server application. Once the system is running, students can connect via a simple web page containing the client application. The instructor controls the location and content of this web page.

2.2 Dictionary Tool

The Dictionary Building Software tool (Figure 2) analyzes textual input, scanning for domain-specific terminology to add to the speech recognition system custom dictionary (i.e., "custom.dic"). DiBS parses an input file into words, filtering words below a minimum length threshold, that appear in a standard system dictionary, and that already appear in the custom dictionary. The minimum length threshold of six characters limits the words considered to those with a higher likelihood of being domain-specific, which tend to be longer in length.

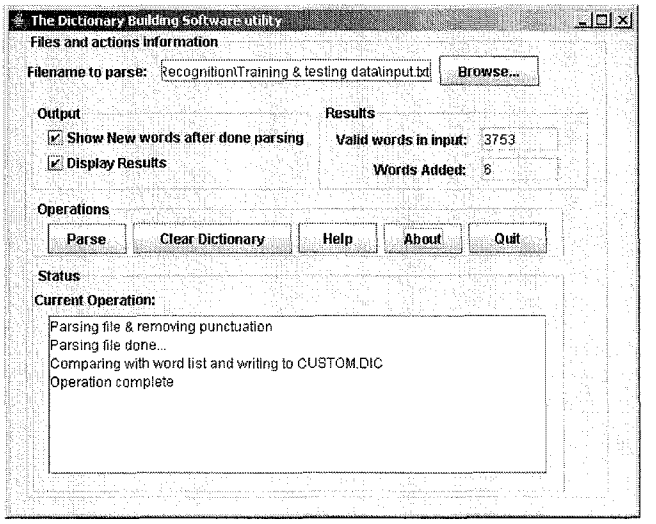

Figure 2. Dictionary Building Software (DiBS) utility.

The key innovation of the DiBS tool is the ability for the user easily to add domain-specific terminology to the MSRE custom dictionary in one, simple step. Prior to DiBS, the method for customizing the dictionary and improving recognizer accuracy was well hidden in obscure documentation, and involved a number of non-intuitive steps. The DiBS tool streamlines the process so that minimal time and no technical expertise is required in order to customize the dictionary, thereby improving

the accuracy of the recognition engine, and therefore likelihood that the speech recognition system will be used.

The speech recognition engine relies on a static system dictionary for its basic recognition, with syntax rules built into the recognizer that phonetically match utterances with corresponding words. Secondly, the recognizer uses words in the custom dictionary in a similar way. DiBS improves recognition accuracy by adding terminology to this custom dictionary.

If a user notes that some terminology is still not being recognized, which can happen if the word uses exceptions to typical rules of pronunciation or is particularly complicated, word-specific training can be performed by the user. This training is part of the underlying Windows XP speech recognition system, and is done using a training interface linked to the custom dictionary.

2.3 Transcription Distributor

The VUST consists of a text distribution server application and corresponding client application, both implemented in Java. The server and client are based on common chat server architecture, modified to accept input from the speech recognition engine and with client chat-back disabled. The design of VUST was kept minimal and straightforward to support a design goal of ease of use. Capture and acquisition of a lecture transcription had to be easy so that any instructor could deploy and use the system, and any student would find it easy to read and save the result. Java was selected as the implementation language to ensure portability across platforms, including Macs, PCs and Linux machines.

The VUST server receives the textual output of the recognition engine, and immediately forwards it to any client applications that are connected. The client application is a Java applet (Figure 3), embedded on a simple web page provided by the instructor, and automatically connects to the VUST server when the page is accessed. If the client fails to connect to the server, a message appears on the client indicating this failure.

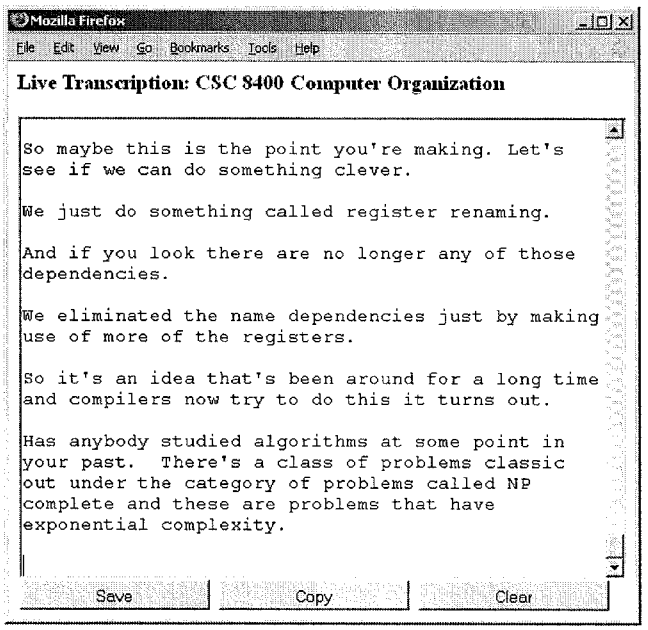

Figure 3. VUST Transcription Client applet.

In the sample of captured text in Figure 3, when brief pauses are detected, a period is inserted in the text, while longer pauses lead to the insertion of a paragraph break. In the last block of recognized text, even though the last sentence obviously contains some errors, it still maintains the intended meaning of the spoken sentence. This is typical of an acceptable form of recognition error.

In addition to presenting the live transcription of the lecture, the client also allows the student to export the transcription to a text file, copy and past it to another program, or clear the current transcription from the screen. A pop-up dialog prevents the student from accidentally clearing a transcription in progress without first confirming the desire to do so.

3. Evaluation

The VUST system was evaluated as a standalone, centralized speech transcription system for recognition accuracy, perceived accessibility and deployability. The system was tested in a controlled environment in an empty classroom using prepared lecture notes, and in a real classroom setting. An initial study was performed to measure the effectiveness of the DiBS tool on improving recognition accuracy. A follow-up study making use of the full VUST system was conducted to determine how the system would perform in an authentic lecture setting.

3.1 Improving Accuracy

The initial study measured the effectiveness of the DiBS utility to improve the recognition accuracy of the Microsoft Speech Recognition Engine (MSRE). The engine was prepared and tested using five training scenarios: untrained, minimally trained, moderately trained, moderately trained with a customized dictionary, and moderately trained with a customized dictionary and selected customized pronunciations.

The DiBS utility analyzed a number of text files containing the content of technical papers and lecture notes related to the subject matter of selected computer science lectures. Custom pronunciations were recorded using the MSRE training interface for approximately 10 domain-specific words that the MSRE had difficulty recognizing.

Tests were performed using spoken lectures containing terminology-rich material from undergraduate and graduate courses in computer architecture, totaling approximately 3,700 words or 30 minutes of continuous speech. The lectures were conducted in a classroom by a computer science professor wearing a wireless headset microphone, using a very clear and consistent speaking style, and were digitally captured to WAV files. To enable valid comparison, these digitized lectures were then replayed to the MSRE running on a university-issued laptop, under five training scenarios, with the transcription output captured into a Microsoft Word file. Objective measures of accuracy were made using a free text file comparison tool called DiffDoc (softinterface.com) by comparing the output of the speech recognizer with a human transcription of the original lecture. Results of the file comparison tool were analyzed manually for verification.

Table 1 shows the results of evaluation of the recognition engine for accuracy and accessibility under the five training scenarios. Accuracy improved with additional training, with marked

improvements when going from an untrained to a minimally trained system (from 75% to 88% accurate) and with the addition of a customized dictionary and pronunciations to a moderately trained system (from 91% to 94%). The recognition accuracy varied greatly (plus or minus 5-10%) depending on the prevalence of terminology that was not found in the default ASR dictionary. Adding terminology from the domain of the lecture helped, and additional recording of pronunciations of specific terminology that the recognizer still misrecognized helped more.

Table 1. Comparison of recognition accuracy, range of accuracy, and accessibility.

Description	Accuracy	Range	Accessibility
Untrained	75%	64-83%	poor to fair
Minimal training (default script, 10 minutes total)	88%	78-93%	sufficient
Moderate training (3 additional scripts, 30 minutes total)	90%	81-96%	good
Moderate training, customized dictionary	91%	83-96%	good
Moderate training, customized dictionary, customized pronunciations	94%	86-98%	very good

Accessibility of the resulting transcription was measured by reading the transcript and in effect grading it as if it were a student report summarizing the content of the lecture. This more subjective accessibility of each transcript was judged broadly to be: poor, fair, sufficient, good, very good, excellent. Even with minimal training, the results were passable (sufficient), although they required careful reading and some editing to make them usable as notes. With moderate training, transcripts were usable (good) as class notes with only minor editing, such as inserting paragraph breaks.

Although very good accessibility was achieved with the addition of some customized pronunciations, excellent accessibility was not achieved in any of the scenarios, reinforcing the need for continued research in speech recognition technology [1]. It is important to note that, although recognition at times reached well above 90% accuracy, a very good result, these results may be artificially optimistic due to the constrained nature of the quiet test environment, consistent speech and chosen material. The second phase of evaluation was designed to measure recognition in a more realistic classroom setting.

3.2 Measuring Deployability

To determine whether speech recognition could be a beneficial classroom technology for increasing accessibility of computer science lectures for deaf and hard of hearing students, the VUST system was deployed in a real lecture setting. For this experiment, the full system was used by the instructor in a regular computer architecture class meeting which included a hard of hearing student.

An entire 90 minute lecture consisting of nearly 10,000 words was transcribed using the VUST system, and the transcription output was saved to a text file and also transcribed manually for comparison. The instructor then analyzed the transcript and identified all misrecognitions, within reasonable constraints (e.g., singular vs. plural and homonym misses were allowed when the meaning was intact, while obviously incorrect recognition or anything that hurt the meaning was marked as incorrect). The automatic and manual transcriptions were then compared for accuracy. Sections of the transcript were classified based on their speech content, as: roll-call (list of names or otherwise discontinuous speech), planning (assignments, dates, general classroom business), discussion (interaction including student discussion), and lecture (continuous instructor speech).

Not surprisingly, the best recognition accuracy was achieved with prepared lecture, resulting from the MSRE preference for continuous speech. Note that the DiBS utility was not used in this phase of experiments to enable clear distinction among classifications of speech and effectiveness of the client-server approach. Overall accuracy was 85%. Planning, lecture and discussion were all consistent with this average, with roll-call scoring the lowest (61%). Table 2 summarizes the results obtained using the VUST.

Table 2. Comparison of VUST recognition accuracy with four classifications of speech content.

Classification	Words Correct	Total Words	Percent Recognized
Planning	628	758	83%
Lecture	5930	6925	86%
Roll-call	155	254	61%
Discussion	1556	1846	84%
TOTAL	**8269**	**9783**	**85%**

The low recognition accuracy (61%) of roll-call speech was not unexpected. A student name can be a form of domain-specific terminology all to itself, and are not likely to be found in the static system dictionary. Planning speech scored next lowest (83%), due to its disjoint, bullet-item nature, also lacking the continuous flow that the MSRE prefers. Discussion and lecture speech were both recognized at relatively acceptable rates, deemed very usable by the instructor and student who participated.

Student reaction to the VUST system was striking. The experience of real-time transcription was described as a "totally new experience" and of enormous benefit. The hearing-impaired student found himself raising his hand to contribute to a classroom discussion for the first time, having followed along with the help of the VUST transcript. Other (hearing) students who had access to the transcript following the class found it to be

a useful supplement to their notes, and they remarked at how closely the transcript matched what occurred in class.

4. CONCLUSIONS AND FUTURE WORK

The VUST system shows significant promise as an affordable and beneficial assistive system to make the computer science classroom more inclusive for deaf and hard of hearing students. Although the benefits of a sign language interpreter or prepared lecture note handouts is recognized, both require additional and regular cost or preparation. By enabling the use of a automated, real-time transcription, cost and preparation overhead is reduced and accessibility is increased.

Providing easy to use software that can improve recognition accuracy and make distribution of a real-time lecture transcription contribute to making VUST very usable by instructors and students. Customizing the dictionary of speech recognition system with domain-specific terminology is effective at improving accuracy. The DiBS tool provides an efficient means to automatically cull such uncommon jargon from large amounts of text and customize the recognition engine, in this case the MSRE. Although DiBS only considers new terms that are six characters or greater in length as an optimization, shorter domain-specific terms can be added manually by an instructor.

An alternative use of VUST could be in stand-alone mode, running on a student laptop. In this configuration, a student would provide a wireless microphone to the instructor and capture the lecture transcription directly on the student computer. However, effective use of ASR in this way requires the student laptop to contain a speech profile trained by the instructor. Using the Speech Recognition Profile Manager Tool (microsoft.com), a speech profile can be imported or exported, making possible distribution of the profile, along with custom dictionaries for specific topics, via a central repository such as a university or department web site. In this way, a student can install such a speech profile of a particular instructor and immediately improve recognition accuracy.

It is important to note that although VUST generates a transcription that can improve accessibility, it is not a replacement for attendance and the very real benefits of being physically present and interactive in a lecture setting. Recognition technology has advanced considerably in recent years, yet accuracy is still far from producing lecture notes on par with what an instructor would prepare by hand. The VUST transcript is best used to assist and augment note taking, much as a student uses a spoken lecture to add detail and clarification to material gleaned from slides or board work.

Because VUST and DiBS are implemented using Java, and the system consists of distinct software components, there are many opportunities for student research and development projects. One project could involve improving the DiBS tool to harvest more domain-specific terminology from a variety of sources. DiBS currently only accepts text input, but available Java add-ons could make it possible to parse PDF and MS Word documents, further improving the usability of the system.

Another potential project is the development of a corpus of domain-specific terminology, ready-made for computer science that could be used as customization input to the DiBS tool. This collection could be extended to other terminology rich subjects, such as biology, engineering, philosophy, and others, further increasing accessibility to real-time lecture transcription.

Future work includes plans to produce a commercial-quality version of the VUST and DiBS software, design of a centralized repository system for domain specific terminologies and speech profiles, and evaluation of other cost-effective speech engines.

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Lisa Elliot is a research associate in the Department of Research at NTID.

Michael Stinson is a professor in the Department of Research at NTID.

C-Print Update: Recent Research and New Technology

by Lisa B. Elliot and Michael S. Stinson

C-Print™ refers to a family of computer-assisted, speech-to-print technologies. Here, we briefly describe the service and review recent findings and forthcoming enhancements to the system. Since 1990, approximately 1000 deaf and hard-of-hearing students have been supported in educational environments through use of C-Print and over 500 individuals from approximately 350 educational programs in at least 46 states and 4 foreign countries have completed the month-long training to become a C-Print captionist. C-Print has been widely disseminated beyond NTID and is now frequently requested by deaf and hard-of-hearing students around the world. For a background in the C-Print system, see articles in the *NTID Research Bulletin*, *1*(3), Fall 1996, and *5*(2), Spring 2000.

Background

C-Print includes both automatic speech recognition (ASR) and computerized word-abbreviation approaches to transcribe speech into text. New software developed by the project provides communication between computers and provides displays for the captionists and students. C-Print does not produce verbatim text but uses summary techniques to capture as much of the meaning as possible. It was developed after many years of research at NTID with another speech-to-text system, called Communication Access Real-time Translation (CART), that uses stenographic equipment to produce verbatim text. Students were happy with the CART text, but researchers realized that for many school districts, the expenses associated with the system were much too great.

Research with College Students: 1993-1996

The first large-scale study using C-Print ran from 1993-1996 on the campus of RIT (Elliot, Stinson, McKee, Everhart, & Francis, 2001). Over this three-year period, 36 deaf and hard-of-hearing students who were mainstreamed into 32 business and liberal arts classes, and who also were supported by interpreting and notetaking, used the C-Print support service. These students participated in questionnaire and interview studies in which they provided feedback about the support service. Twenty-two of the 36 students were also interviewed.

Questionnaire items included student ratings of lecture comprehension. These ratings indicated good comprehension with C-Print, and the mean rating was significantly higher than that for understanding of the interpreter. Students also rated the hard copy printout provided by C-Print as helpful, and they reported that they used these notes more frequently than the handwritten notes from a paid student notetaker. Interview results were consistent with those for the questionnaire.

Questionnaire and interview responses regarding use of C-Print as the only support service indicated that this arrangement would be acceptable to many students, but not to others. Data from school records were also correlated with students' questionnaire responses, and communication characteristics were related to responses to the questionnaire. Students who were relatively

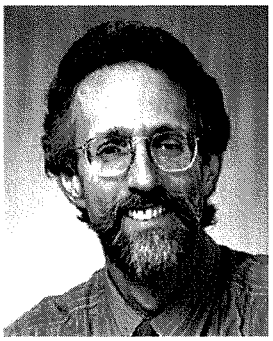
C-Print Update continued on page 3

Notes of Note

On January 24, 2003, **Susan Fischer** presented a colloquium related to her cross-linguistic sign language research to the linguistics department of the University of Toronto. For more information she can be contacted at *SDFNCR@RIT.EDU.*

Oxford University Press has just published the *Oxford Handbook of Deaf Studies, Language, and Education*, edited by **Marc Marschark** and **Patricia Spencer** (Gallaudet University). In describing the volume, RIT Vice President for NTID, Robert Davila said, "In my opinion, over the course of the past 40 years, no other deaf studies publication offers a more comprehensive and authoritative perspective of the social, psychological, linguistic, and pragmatic aspects of deafness." The 672-page handbook contains 36 chapters, including chapters by **John Albertini** and **Sara Schley**, **Harry Lang**, **Michael**

Notes of Note continued on page 3



Accommodation and Access

"Will I have an interpreter for this class?"
"Will the boss be accommodating?"

Such questions run through the minds of deaf and hard-of-hearing students and employees daily. Sign language interpreters, note takers, and newer support services, such as C-Print captionists, are accommodations that provide students and employees access to lecture, presentation, and discussion. At school and in the workplace, it is often up to the deaf or hard-of-hearing person to request accommodation or changes that will improve access to information and communication. According to the *Oxford English Dictionary (Third Edition)*, to accommodate means to reconcile persons who differ and to bring persons who differ to harmony or agreement. Where differences become barriers, reconciliation will open the way to communication and information.

Though serious disagreements continue over what constitutes "reasonable accommodation" and how to achieve it, we are certain of two things. We know that new speech-to-print technologies can improve students' access to classroom discourse and that legislation (for example, the Americans with Disabilities Act, 1990) can only promise due process. Accommodating peoples' differences and providing equivalent access to all learners and employees are complex processes, and we are fortunate to have two research reports in this issue of the *NTID Research Bulletin* that shed light on them.

The first report by Lisa Elliot and Michael Stinson (NTID Department of Research) brings us up-to-date on the use of new speech-to-print technologies in mainstream high school and college classrooms. The C-Print program of research has spawned software and hardware development, training, and prototype evaluation. The goal of the program has always been to develop sound new technologies that will improve access and enhance learning in the classroom. For balance and focus on the workplace, we invited our colleague David Baldridge (College of Business, RIT) to summarize what he found to be the key personal and contextual variables leading an employee to request or not to request changes in the workplace. Twelve years after the Americans with Disabilities Act was signed into law, employees still hesitate to request accommodation.

Future issues of the Bulletin will report on other studies of access and accommodation, a main focus of activity in the Department of Research at NTID. As always we hope you find these reports thought-provoking and helpful and that you will send us your comments and suggestions via the NTID Research Advisory Group's website at *http://www.rit.edu/490www/RAG*. Also, please check out the Department of Research's new website at *http://www.rit.edu/ntidresearch*.

John A Albertini

John Albertini
Chair, Department of Research

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John Albertini, Chair, Department of Research
Gail Hyde, Editor

Lisa Elliot is a research associate in the Department of Research at NTID. Since 1996, she has been involved with the research and development of speech-to-text captioning systems at NTID. Currently, her other research interests include student study skills and applications of universal design in teacher education. For more information, she can be reached at LBENRD@RIT.EDU.

C-Print Update continued from page 1

proficient in reading and writing English, and in speechreading, responded more favorably to C-Print.

Research with High School and College Students: 1996-1999

With support from the U.S. Dept of Education, we were able to expand our research to three college and university settings in the Rochester, NY, area, and to public high schools in greater metropolitan Rochester, and in Irvine and San Diego, CA. Two additional interview (and questionnaire) studies and a controlled experiment have been conducted.

Successful implementation of assistive technology can satisfy both the needs of the student and the values of the educator when everyone's needs and values are taken into account.

Interview studies. Interviews were conducted with 75 participants (25 high school students, 14 college students, 14 high school classroom teachers, 10 high school teachers of the deaf, and 12 college professors) about their experiences with the C-Print system.

One study focused on students' and teachers' use of C-Print notes (Elliot, Foster, & Stinson, 2002). Consistent with research on normally hearing students, high school students in this study typically would read the notes only, while college students used multiple study strategies with the notes. Teachers tended not to know how their students used their notes for studying and they were sometimes reluctant to teach students about effective note usage. This study supports the idea that both students and teachers could benefit from further instruction on note usage and study skills.

In another study, we analyzed teachers' acceptance of C-Print as a support service in their classrooms. Previous research has found that student success using an assistive technology may be, in part, attributed to educators' acceptance of the technology. Using Rogers (1995) model of "diffusion of innovations," we found that educators accepted C-Print due to its relative advantage over other notetaking services, that is, the perceived simplicity of the system and its perceived potential for students. However, some educators, who prefer eye contact with their students as an indication that students are participating in class, were resistant to C-Print because the technology requires students to focus their attention on a computer. We also learned that educators who were more accepting of the service had different perceptions of their initial introduction to the service; they recalled being asked to participate in trials of C-Print in their classrooms, whereas less accepting teachers perceived that they were "told" a student would be trying C-Print. Successful implementation of assistive technology can satisfy both the needs of the student and the values of the educator when everyone's needs and values are taken into account.

Experiments. Data are currently being analyzed for two controlled experiments. In one experiment, participants were 48 deaf and hard-of-hearing high school students, mostly from San Diego. Students were randomly assigned to one of three experimental conditions. In Condition 1, students viewed a brief (15 minute) videotaped lecture about Japanese-American history. At the same time, on a different television screen, they watched either C-Print captioning of the lecture or a videotape of an interpreter. After the videos concluded, students took two brief quizzes—a recall test (fill-in-the blank) and a recognition test (multiple choice).

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Stinson, and Marc Marschark. For additional information about this publication, contact Marschark at *MEMRTL@RIT.EDU.*

In November, Marc Marschark was invited by the Taiwan Association for the Deaf and the Taiwan National Teachers College to present a series of lectures in Taiwan. The lectures served as keynote addresses for conferences in Taipei and Tainan on deaf education and will be published (in Mandarin) by the Taiwan Association for the Deaf.

Bob Whitehead and colleagues recently published an article, "Preservation of place and manner cues during simultaneous communication: A spectral moments perspective" (Kardach, J., Wincowski, R., Metz, D.E., Schiavetti, N., Whitehead, R., & Hillenbrand, J. (2002). *Journal of Communication Disorders, 30,* 533-542). Spectral moments, which describe the distribution of frequencies in a spectrum, were used to investigate the preservation of acoustic

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Michael Stinson is leader of the team that has developed the C-Print speech-to-text system. He currently directs projects funded by the US Department of Education to incorporate automatic speech recognition into the C-Print system and to provide training in C-Print nationally. He is also a member of the faculty of the graduate program that prepares teachers of the deaf and has taught in the program in school psychology at RIT. Stinson has presented and published extensively on instruction of and social integration of deaf and hard-of-hearing students in general education classrooms, as well as on effects of technology, interpreting, notetaking, and tutoring. Stinson is deaf and he received all his education in mainstream classes. For more information, he can be reached at MSSERD@RIT.EDU.

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Students also completed demographic data including communication preference. The following week, students returned and watched another lecture, this time accompanied by either C-Print or an interpreter (whichever format they did not receive in session one).

...students do at least as well, and in some instances better, in retaining information with a C-Print presentation than with an interpreted one.

In Condition 2, students followed a similar protocol to Condition 1, except that before they received the quiz, students were given a copy of notes about the lecture to study. If students viewed the C-Print captioning, they then received the notes generated by C-Print. If the students viewed the video with the interpreter, they then received handwritten notes produced by a notetaker. After reviewing the notes for up to 20 minutes, students took the two quizzes.

In Condition 3, students attended the experiment for four separate sessions. In sessions one and three, students viewed the videos and received notes to study. In sessions two and four, students again reviewed the notes and then took the quizzes.

A key finding for the experiment with the high school students was that students retained significantly more information from the C-Print presentation than from the interpreted one. This result is consistent with that of the questionnaire study, because it indicated that students do at least as well, and in some instances better, in retaining information with a C-Print presentation than with an interpreted one. For both the C-Print and interpreted presentations, students remembered more information in Condition 3, in which there was a delayed test and additional time to study the notes, than in Condition 1 (no notes) or Condition 2 (notes and immediate test), suggesting that the combination of notes, the opportunity of additional time to review them, and the delay in testing facilitated performance.

The second experiment involved the participation of 48 deaf and hard-of-hearing college students at RIT. This experiment followed the same format as the high school experiment, but used different videotapes. The college videos were excerpts from actual sociology lectures given by a professor at RIT. Results for this experiment were more complicated than those for the first experiment. For Condition 1, in which students were required to remember specific terms without the benefit of reviewing notes or printed material, students recalled more information with C-Print than with an interpreter. In particular, for the C-Print presentation, students did not do significantly better in Conditions 2 and 3 when they had C-Print text for study after viewing the real-time display than when they did not. However, for the interpreted presentation, students did better when they had notes from a notetaker than when they did not.

One interpretation of these results is that, for the C-Print presentation, students retained enough information regarding specific terms, spelling, etc., that they did not need the text to resolve ambiguities. However, for the interpreted presentations there were such ambiguities, and consequently, the opportunity to review these notes helped to clarify uncertainties about specific terms in the lecture. These results need to be interpreted in the context of the finding that there were not overall differences in retention (both recall and recognition tests) for the interpreted and C-Print presentations (Stinson et al., 2000).

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cues, e.g., place and manner of articulation, to intelligibility of speech produced during simultaneous communication (SC) in relation to those acoustic cues produced when speaking alone. The spectral moments obtained from speech produced during SC were indistinguishable from those obtained during speech alone, indicating no measurable degradation of obstruent spectral acoustic cues during SC. For more information on this research, contact Whitehead at *RWWNCR@RIT.EDU.*

For the past two years, **Harry Lang** has been developing a website for the dissemination of information to promote learning by deaf and hard-of-hearing students. COMETS (the Clearinghouse On Mathematics, Engineering, Technology and Science) is a project funded by the National Science Foundation to enhance science, technology, engineering and mathematics education for deaf and hearing students. This website provides

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LaTonja Adams, C-Print captionist, and Kevin Barker.

Implications from the Research

Implications from the research conducted with C-Print to date has allowed us to fine tune and improve the system in many ways. For example, based on feedback from students and teachers, we are developing new training materials that will help students and their teachers get the most out of the C-Print experience. This will include workshops for teachers and parents, and printed and on-line instruction for effective software usage and study habits. Feedback we received from captionists has also resulted in physical changes to the C-Print software system and its implementation, which we will cover in the following section.

Looking Ahead to the Future of C-Print

C-Print user-interface software. In the past, captionists used three commercially available software programs running simultaneously—a word processing program, a typing abbreviation program, and a communications program that allows captionist and student computers to "talk" to one another. Based on feedback from captionists, we created an in-house software, called C-Print Pro©. C-Print Pro does everything that the three programs used to handle, only better! For example, in addition to allowing captionists to shorten their typing time with fewer keystrokes, students can also highlight their notes, make their own notes on the screen during class, and even type questions to the captionist without interfering with captioning.

Integrating ASR with C-Print allows captionists to continue captioning long after one hour.... Preliminary research suggests that using ASR, captionists capture about 83% of all idea units and are producing text that is 97% accurate.

In developing these features of the software, the C-Print team kept in mind the difficulty of deaf students simultaneously focusing on watching the teacher or real-time display and taking good notes. Project staff designed the highlighting and notetaking features so that students can use them with minimal diversion from attending to the teacher and/or the real-time text display.

Automatic speech recognition. One limitation of a typing-based system at the postsecondary level where classes are often longer than an hour is fatigue. Prolonged typing may lead to pain and injury. With ASR, captionists can utilize their voices instead of their hands. Integrating ASR with C-Print allows captionists to continue captioning long after one hour. Instead of typing, the captionist speaks into a microphone that is covered with a sound baffler—a dictation mask—that is connected to the computer (Stuckless, 2000). We chose to use an intermediary approach, which requires the presence of a captionist, because ASR technology is not yet sophisticated enough to capture nuances of speech, add punctuation, or detect multiple voices. Our intermediary captionist is able to insert this information into the text and make it readable for the student. Preliminary research suggests that using ASR, captionists capture about 83% of all idea units and are producing text that is 97% accurate (Elliot, Harradine, & Stinson, 2002).

Next steps for the project will be to implement ASR and the new software in high school and college classrooms, adjusting the system to make it even more effective. With both ASR and word-abbreviation approaches to producing text and the new C-Print Pro software, the system is more flexible. In addition, drawing on research and experience, the project will develop new materials that should better help students make the most out of their experience with C-Print.

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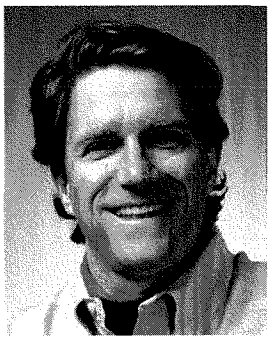

David Baldridge is an assistant professor in the RIT College of Business.

Workplace Accommodation: Is it Really Okay to Ask?

by David C. Baldridge

Introduction

This study investigated situational attributes that influence employees' decisions to request, or not request, needed workplace accommodation due to perceived normative appropriateness—that is, *do others think I should ask?* Past studies (e.g., Florey, 1998; McLaughlin and Gray, 1998) have shown significant reluctance to request needed accommodations. Currently little is known about factors that influence the favorability of requesters' assessments and the likelihood of withholding a request based on perceived normative appropriateness, i.e., what situational characteristics will keep an employee from requesting needed workplace accommodation because s/he believes *others* think accommodation should not be requested?

...the social environment not only influences personal assessments regarding the cost of asking for help, but also influences normative assessments about when help should or should not be sought.

Based on a review of the help-seeking and workplace-accommodation literatures, four requester attributes—age, sex, age of disability onset, and disability severity—and three workplace attributes—employer size, supervisor relationship quality and co-worker relationship quality—are hypothesized to influence the extent to which requests are withheld due to normative assessments. Survey data from 250 deaf or hard-of-hearing, full-time employees was used to test these hypotheses. Details of the study and full results are available from the author.

Theory

Given the paucity of research on the perceived normative appropriateness of requesting accommodation, literature from "help seeking" was used in conjunction with the literature on "workplace accommodation."

Normative appropriateness. In the accommodation literature, a distinction is drawn between individuals' personal assessment regarding an action or behavior and their normative assessments of what others think they should do. Both are predictors of intentions and accommodation-requesting behavior (Baldridge and Veiga, 2001). Gross and McMullen (1983) showed that the social environment not only influences personal assessments regarding *the cost* of asking for help, but also influences normative assessments about *when* help should or should not be sought.

Request attributes. Lee (1997) identified two individual attributes thought to influence the level of help seeking: sex and status differential. Women generally perceive greater normative support. In many cultures men are expected to be more self-reliant and independent. Individuals were less apt to make requests when they feared losing power, and Baldridge and Viega (2001) suggest greater risk of losing power when a request is more likely to reveal new, and perhaps unfavorable, information and when it will change others' perceptions of the requester. Men, younger workers with less severe losses and those who lost their hearing later in life are more likely to withhold requests for needed accommodation.

Request context. Requesters try to seek help from others who will be less burdened by providing assistance (Anderson and Williams, 1996). Baldridge and Viega (2001) suggest that overall relationship quality may influence a requester's assessments on normative appropriateness of requesting

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many resources, including informational pages and complete "workshops" on a variety of topics, which can be used individually by teachers, in pre-service teacher education courses as lessons, or as actual workshops for in-service professional development programs to help teachers interested in renewing certification. The COMETS website is at *http://www.rit.edu/~COMETS*. For more information, contact Lang at *HGL9008@RIT.EDU*.

Susan Foster (PI) and **Gary Long** (Co-PI) have recently receided funding from two programs at the US Department of Education for three year projects to promote access and inclusion for deaf and hard-of-hearing students in postsecondary education. The two awards, totaling over $1M, will allow the project team, including Rosemary Saur (Department of Science and Engineering Support at NTID) and faculty, staff and students from

David Baldridge is an assistant professor of Management in RIT's College of Business. He teaches courses in Organizational Behavior, Leadership and Organizational Change. His research interests include change managment, technology acceptance, inclusion of people with disabilities and family businesses. For more information, he can be contacted at DCBBBU@RIT.EDU.

accommodation. Thus, requesters in smaller organizations, with few resources, and with lower quality relationships with supervisors and co-workers are more likely to withhold requests for needed accommodation.

Methods

...the perceived normative appropriateness of requesting accommodation was more a function of general relationship quality than organization's resources.

The current study focuses on one disability group—people who are deaf or hard of hearing. Surveys regarding workplace accommodation were sent to 688 individuals; 250 usable surveys were returned (36.3 percent). No significant difference was found when comparing the age, sex, and educational level of those who completed the survey and those who did not. For the final sample, 53 percent of the respondents were women; the mean age was 40 with a range of 21 to 63 years. Existing measures were available for the same or similar constructs. Therefore, rather than develop entirely new measures, existing measures were modified and verified.

Discussion

As expected, both attributes of the *requester* and the *request context* were significantly related to the tendency to withhold requests. For example, younger employees were significantly more likely to report that they withheld requests due to perceived lack of normative appropriateness. In terms of request context, supervisor supportiveness was the most dominant factor and highly correlated with co-worker supportiveness. Together this suggests that the perceived normative appropriateness of requesting accommodation was more a function of general relationship quality than organization's resources. Moreover, a supportive relationship with one's supervisor may influence the extent of co-worker supportiveness. Only one study variable, sex, was shown to correlate with both supervisor and coworker supportiveness—women reported slightly higher quality relationships.

Just over half of the respondents reported that they had withheld a request for a needed accommodation at least once within the last year due to perceived lack of normative appropriateness. Roughly one quarter had done so within the last month. Yet, while withholding requests is common, the frequency is uneven and much less likely when supportive relationships are formed.

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the RIT College of Science and the Center for Professional Development, to identify and implement best teaching practices for deaf and hard-of-hearing students. The goals of the project are to 1) conduct a series of experiential workshops and individualized coaching activities, 2) use the workshops and individualized activities to identify challenges and best teaching practices, linking practice to the principles of Universal Design for Instruction, 3) package the materials and activities in a variety of portable formats designed to motivate and actively engage faculty at other postsecondary institutions, 4) field-test the products, 5) disseminate and deliver the products nationally, and 6) establish an administrative model that will enable core project functions to be maintained beyond the funding period, both at RIT and at other postsecondary institutions. For more information on the project, contact Foster at *SBFNIS@RIT.EDU.*

CART in the Classroom: How to Make Realtime Captioning Work for You

June 26, 2001

Duane Smith
National Court Reporters Association
Pat Graves

Introduction

Communication Access Realtime Translation (CART) is a word-for-word speech-to-text interpreting service for people with a hearing loss or who would otherwise benefit from this accommodation. Unlike computerized notetaking or abbreviation systems, which summarize information for the consumer, CART provides a complete translation of all spoken words and environmental sounds, empowering consumers to decide for themselves what information is important to them. Section 36.303(b)(1) of the Americans with Disabilities Act specifically recognizes CART as an assistive technology that affords effective communication access.

A CART provider uses a steno machine, notebook computer, and realtime software to render instant speech-to-text translation on a computer monitor or other display for the benefit of an individual consumer or larger group in a number of settings: classrooms; business, government, and educational functions; courtrooms; and religious, civic, cultural, recreation, and entertainment events. In addition, a CART provider is sensitive to the varying needs of consumers and has had training in conveying a speaker's message, complete with environmental cues.

The demand for CART has grown at a steady pace in recent years in almost all arenas. However, the greatest growth has taken place in the educational setting, from elementary to graduate school, as this technology has gained greater notoriety among educators, disability services coordinators, and students with hearing loss as a useful method for participating fully in the classroom. Several key factors play a role in determining the effectiveness of this service: the competence of the CART provider, the environment in which CART is provided, and the ability of the CART provider, student, instructor, and coordinator of services to work together.

CART Benefits

In the 1999 paper "Real-Time Speech-to-Text Services," the authors, members of the National Task Force on Quality of Services in the Postsecondary Education of Deaf and Hard-of-Hearing Students, referenced a 1988 study at the Rochester Institute of Technology of students who are deaf and hard-of hearing. When surveyed about CART, the students responded favorably. The authors state that "A majority of the students reported that they understood more from the steno-based text display than from interpreting" (Stinson et al., 1999, p. 12).

The Task Force noted several other advantages to the steno-based CART system: 1) CART provides a verbatim record of the class, capturing every word spoken; 2) a single CART provider

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http://www.rit.edu/~techsym

can cover a two-hour class with a brief break; and 3) the steno machine is silent (Stinson et al., 1999, p. 21). Because CART gives students with hearing loss a complete record of what is said in the classroom, several other advantages to this communication access tool become readily apparent:

Flexibility. CART can be used in a variety of settings, whether one-on-one with a single student reading off of the CART provider's laptop computer screen, in a small group with the text appearing on a television monitor, or even in a much larger setting with the CART provider's realtime text projected to a large screen for everyone in the lecture to read.

Independent learning. With the provision of CART, the responsibility for a student's education rests with the student. Rather than relying on notes provided by others, the student will have a verbatim record of the class or discussion from which to determine what is or is not important based upon the student's understanding of the material presented. In addition, students can have the text file fed through a version of litigation-support software as the CART provider realtimes the class. The student can then use the highlight or annotate features of the software to pick out what he or she wants to retain. Thus, the student has the choice of obtaining the verbatim record of the class or only those portions that he or she deems important. As Rachel Arfa (2000), who used CART as an undergraduate at the University of Michigan, explains, "With realtime captioning, I was able to form my own opinions of the subject matter and receive the information firsthand, rather than second, third or fourth hand, since CART takes every sentence that is being said."

Full participation. Because the provision of CART services is in real time, the student with hearing loss has the opportunity to participate in a classroom setting just like any other student. Andy Nelson (2000), who used CART at the University of Washington, says, "Realtime captioning allowed me to get everything the professor says in class, word for word, as well as comments or questions students have during the lecture. This enabled me to actively participate in discussions and lectures, something I had never ever been able to do before." Joan Andrews (2000), a CART consumer while in college, offers another example: "Realtime professionals also can include brief descriptions that provide information about the mood of the person speaking — excited, despairing, angry, heated, placating; signals that the hearing students access easily and which often guide them in choosing their responses to the dialogue taking place. These bits of information play a vital role in effective classroom participation."

Equal access. "CART allowed me for the first time in my entire academic career to follow classroom discussions, participate in classroom discussions, and take my own notes," says Carolyn Ginsburg (2000), who used CART while earning her MBA from Columbia University. "What an incredible experience this was. It was very liberating, made me finally feel equal to my peers in the classroom, gave me equal access to information, and gave me more confidence to express my opinions and answers." Paul Hartley (2000), currently a student at Emory University, offers a similar opinion: "Being at the same level as any other student is the major and most important benefit of CART services. I get the same information, hear the same lectures verbatim, feel more a part of the class, and hear interesting anecdotes or a professor's corny jokes."

The provision of CART services also offers some benefits to the instructor. For example, verbatim lectures may give the college professor an additional tool for preparing tests or integrating

information into a research study. Further, "Some instructors welcome the transcripts as a way of tightening their lectures and reviewing their students' questions and comments. If the instructor chooses, he or she should be at liberty to share them with hearing members of the class also. The transcripts can be of value also in tutoring deaf and hard-of-hearing students, enabling tutors to organize tutoring sessions in close accord with course content" (Stinson et al., 1999, p. 7-8).

The Competent CART Provider

The utility of CART services for the student with hearing loss depends a great deal on the skills of the CART provider. The National Court Reporters Association has been certifying court reporters for more than 75 years, and NCRA is currently developing a certification specifically for CART providers. Until this objective measure of the CART provider's ability is in place, how can you define a competent CART provider?

NCRA's CART Task Force considers the Registered Professional Reporter (RPR) a requisite for a qualified CART provider. The RPR certifies the entry-level reporter's ability to provide a verbatim record at speeds ranging from 180-225 words per minute with a minimum accuracy of 95 percent ("How to Locate," 2001). The Task Force also recommends the attainment of the Certified Realtime Reporter designation. The CRR has proven his or her ability to write realtime at variable speeds ranging from 180-200 words per minute with a minimum accuracy of 96 percent. *The CART Provider's Manual* (2001), published by NCRA, offers some additional factors to consider:

Sensitivity. The CART provider has general knowledge about Deaf culture and understands that the preferred communication mode of a person with hearing loss differs depending on whether the individual identifies him or herself as Deaf, deaf, late-deafened, or hard-of-hearing. A CART provider acquires training in communication techniques through court reporting association seminars, disability agencies, sign language courses, etc.

Staying in role. The CART provider's role is to facilitate communication. A CART provider declines any invitation or suggestion to comment, interject, advise, respond to inquiries, or in any way become involved in the proceedings outside the role of CART provider.

Confidentiality. Courtesy and discretion are required of the CART provider at all times. A casual word or action may betray a consumer's confidences or violate a client's privacy.

Professional development. The CART provider keeps abreast of current trends, laws, literature, and technological advances relating to the provision of CART service.

Preparation. The CART provider must make every effort to ensure an accurate job dictionary for the terminology to be used in each class.

Realtime writing. The CART provider writes conflict free, includes punctuation, and sustains accuracy for long periods of time.

Software/computer knowledge. The CART provider must operate a computer-aided transcription program and understand its realtime translation and display functions. The competent

CART provider knows how to troubleshoot and solve hardware, software, and other technical problems. In order to meet consumer preferences, the CART provider must know how to activate upper/lowercase, colored backgrounds, enlarged text, and other display options. When appropriate, the CART provider must be able to furnish the computer file of the session text as requested.

Language comprehension. Knowledge of grammar, punctuation, sentence structure, spelling, vocabulary, high-frequency colloquialisms, and slang is crucial. The CART provider must listen for continuity, sense, and detail of proceedings, anticipating and preventing errors in translation.

CART Environments

CART services can prove effective in almost any educational environment, from grade school to graduate school. In particular, "Today, steno-based systems rank as an effective support service for large numbers of deaf and hard-of-hearing students in mainstream college environments throughout the country" (Stinson et al., 1999, p. 5).

Why is the steno-based CART system gaining popularity? Much of it goes back to the comments from CART consumers regarding independent learning, full participation, and equal access. As noted in "Auxiliary Aids and Services for Postsecondary Students With Disabilities," published by the Department of Justice's Office of Civil Rights (1998), schools not only must provide auxiliary aids and services in a timely manner, but they must ensure that students with disabilities can participate effectively. And the definition for effectiveness? "No aid or service will be useful unless it is successful in equalizing the opportunity for a particular student with a disability to participate in the education program or activity."

Keep in mind, however, that generally CART consumers are individuals who have developed a hearing loss postlingually, or rather after the acquisition of language. In addition, there is no set age at which a child can begin to make use of this service: "Always remember that each individual case is unique -- there are no hard-and-fast rules on the age level of a student for which realtime translation is suited" (Brentano et al., 2000, p. 22).

Before implementing CART in an educational environment, the most important consideration, of course, is the student's preference regarding a method for communication access. Other factors are prior experience and satisfaction with realtime speech-to-text translation in the classroom, the student's ability or willingness to participate in discussions and to ask questions, and the level of reading proficiency (Stinson et al., 1999, p. 23).

Working Together

The success of CART in the classroom setting depends not only on the provider's skill level, but also on the ability of the CART provider to work effectively with instructors and the coordinator of services to ensure that the student with hearing loss receives the best service possible. Following are several considerations that can help to ensure an effective working arrangement to the benefit of the student with hearing loss:

Control of the classroom. The CART provider is in the classroom with the sole purpose of providing communication access for the student who is hard-of-hearing. To ensure an effective realtime translation, students should speak one at a time. "Noisy" conditions can have an adverse effect on the production of accurate text by the CART provider (Stinson et al., 1999, p 9). The responsibility for controlling the classroom lies with the instructor, who must maintain an orderly discussion to allow for participation by the CART consumer. The instructor may need to restate a student's comments to ensure understanding.

Preparation. "The reporter will work with the instructor for each assigned class to assure that all the technical terminology for that particular class will be provided in advance so that it can be entered into the reporter's computer dictionary" (Brentano et al., 2000, p. 9). This preparation, with the instructor's assistance, allows for a more accurate translation of the spoken word. The CART provider should receive copies of all textbooks and other class materials from which to prepare.

If possible, this preparation also includes a meeting between the CART provider, student, instructor, and coordinator of services before the start of the school year. At this time all involved parties can ask questions regarding requirements or concerns. In addition, "This will allow the reporter an opportunity to view the classroom's physical setup and to work out with the disability coordinator, instructor, and student the best seating and sight lines available for all concerned" (Brentano et al., 2000, p. 22).

Laying out the ground rules. Discuss during the orientation meeting what will be expected of the CART provider. What classes will require CART? How long are the classes? Will the CART provider be following the student to different classrooms? Who is entitled to receive a copy of the notes? What form will the notes for a class take: paper or disk? When will the student receive the notes? Will the CART provider have time to edit the notes? Will the instructor also receive a copy of the class notes?

How will the CART provider contact the instructor or disability services coordinator or vice versa? For example, "If a teacher or professor is canceling class or is giving a test for which the reporter's services are not required, sufficient notice should be given if for nothing other than common courtesy" (Brentano et al., 2000, p. 25). A policy should also be established for when the student is unable to attend class.

Think communication. When possible, the instructor should write announcements, assignments, proper names, technical vocabulary, formulas, equations, and foreign terms on the blackboard (Battat, 1998). In addition, the instructor should not "talk to the blackboard" and have his or her back turned to the class all the time. And when using overheads or referencing material on the blackboard, the instructor should be specific when explaining concepts, formulas, or equations. For example, in a math class rather than pointing to the blackboard and saying, "You add this and this and get that," the instructor should say, "You add 5 and 4 and you get 9."

Just as the primary role of the realtime reporter in the classroom is to provide communication access, it is communication between the CART provider, student, instructor, and coordinator of disability services that will prove critical to the successful provision of this service.

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<u>Contact Information</u>:

Duane Smith
Director, National Court Reporters Association

8224 Old Courthouse Rd.
Vienna, VA 22182
703-556-6272
msic@ncrahq.org
www.NCRAonline.org

Realtime Remote Online Captioning: An Effective Accommodation for Rural Schools and Colleges

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M. Bryce Fifield, Ph.D.
North Dakota Center for Persons with Disabilities
Minot State University
JoLynn Webster

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Background

The faculty and staff of the North Dakota Center for Persons with Disabilities (NDCPD) at Minot State University (Minot, North Dakota) have developed a Realtime Remote Online Captioning System. This system (RROCS) provides realtime captioning via the Internet to rural and isolated classrooms. Initial field testing suggests that the RROCS has the potential for improving access to general curriculum for students with a variety of hearing, language, learning, and attention deficit impairments.

The need for options. Students who have access to a variety of instructional accommodations have the best chance of receiving instruction that meets their individual needs. The accommodations generally used for students with hearing impairments have been categorized into amplifications and strategies for converting speech-to-text or speech-to-sign. Accommodations for converting spoken material into alternate formats currently rely on a trained and available cadre of sign interpreters, note takers, and realtime captionists. Unfortunately, rural communities rarely have access to the person-power required to make even standard accommodations available.

Frontier states such as North Dakota, Wyoming, South Dakota, and Idaho have attempted to respond to these service shortages by increasing the number of trained interpreters. Unfortunately, the distances between schools and communities in such locations precludes a person-centered solution. Further, use of speech-to-text translation software, while entertaining to tinker with, is as of yet inadequate for the dynamic environment of the classroom.

Realtime Remote Online Captioning System

The Realtime Remote Online Captioning System (RROCS) developed by Fifield and his colleagues at the North Dakota Center for Persons with Disabilities (http://ndcpd.org) provides a

tool for delivering captioning services to rural and isolated locations. Audio from the teacher and the classroom is captured via a lapel or handheld microphone and transmitted to a classroom computer running the RROCS software. The software digitizes the audio and transmits it via the Internet to an off-site captionist who is also running the RROCS software. The software plays the classroom audio for the captionist who transcribes it either directly into the RROCS or by using a commercial transcription program such as GlobalCat. The transcribed text is transmitted back to the classroom where it is displayed for the student. The transcript is also posted to a password protected web site for later retrieval or emailed to the teacher and/or student.

The RROCS features a scheduling server that allows a large number of classrooms to schedule a variety of concurrent captioning events and order note taking or verbatim captioning. The scheduling server accommodates differences in time zones, monitors the status of the connection, tracks billing information, and manages the start-up connections for both classrooms and captionists. Likewise, the server plays host to a number of captionists and note takers who are matched up with scheduled classroom events.

The RROCS provides a means of delivering just-in-time classroom captioning services virtually anywhere there is a telephone or Internet connection. The system has a turnaround time of approximately three seconds, depending on bandwidth limitations. It has been successfully used with both high speed Internet connections and medium speed telephone modems.

Equipment. The RROCS has three pieces of software: a classroom client, a captionist client, and the scheduling server. The software operates in Windows 98, NT, 2000, or ME. Because of the audio compression that is required, it is recommended that classroom PCs have a clock speed of at least 600 MHz and 128 Kb of memory. In practice, any microphone system that can adequately capture classroom audio and connect to the computer's sound card should be adequate. A wireless Shure lapel microphone connected to a separate mixer was used in the field test trials.

Costs. There are equipment and personnel costs associated with delivering RROCS. Equipment costs are dependent on how elaborate a microphone system is necessary for the classroom. During the field testing of RROCS, the decision was made to purchase wireless microphones that would not be sensitive to environmental noise. The Shure wireless microphone systems used during field testing cost approximately $800 each. The classroom computers used during field testing were off-the-shelf models costing approximately $1200.

Personnel costs associated with RROCS are no different than more conventional live captioning services. During field testing, captionists who had training as court-reporters and who provided their own steno machines were paid between $35 and $50 per classroom session, depending on their experience. Note takers, who were not providing verbatim transcripts, were paid $8 per hour. In most cases, the captionists and note takers were working from their homes dialing into a local Internet Service Provider.

Availability. Captioning services using RROCS are currently available through the North Dakota Center for Persons with Disabilities at Minot State University. The service can be delivered virtually anywhere there is a telephone or Internet portal. With a modest investment in equipment, either note taking or verbatim captioning can be delivered via the RROCS at any time and for any duration. Once equipment is purchased, customers only pay for the captioning services they access.

Case Studies

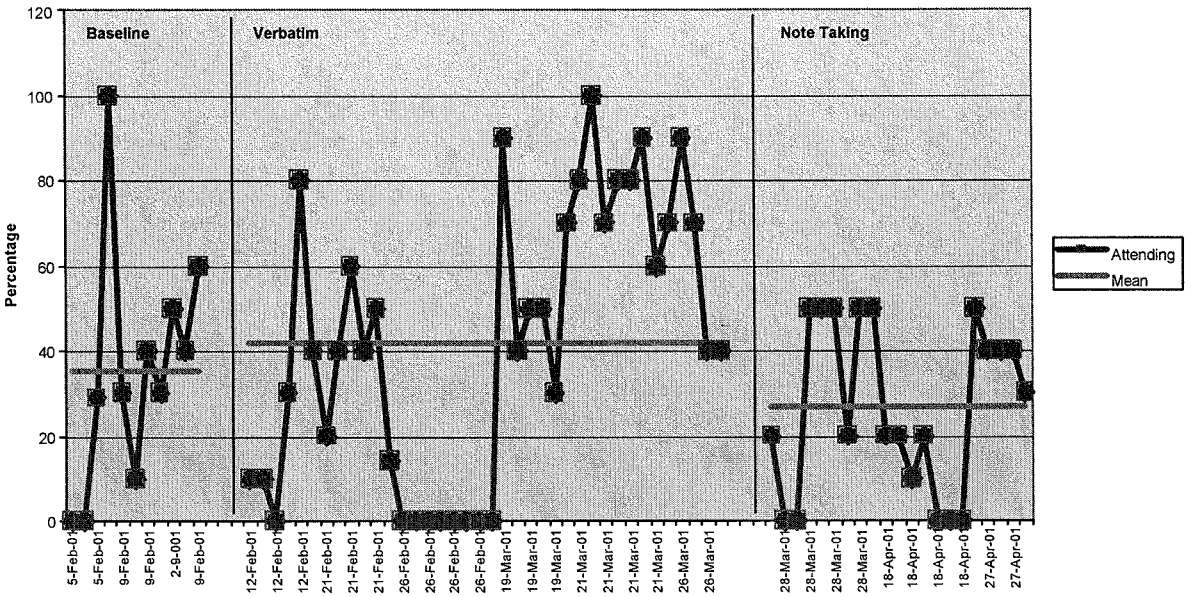
Weekly tests of the RROCS were made in both laboratory and classroom settings during the initial development of the RROCS. This process led to the identification of many design challenges to make the system easy to use, non-intrusive, and robust. More recently, the system has been used to caption workshops, conferences, and committee meetings as well as classroom presentations.

Participating subjects were observed during instructional sessions in each of the implementation classrooms to determine if they were watching the captioned text being displayed on the computer monitor. Every thirty seconds, the observer recorded a code corresponding to the observed behavior (e.g., not academically engaged, academically engaged, or viewing the text). For each interval in which the subject was not viewing the text display, project staff noted the alternative behavior in which the individual was engaged. For each five minute observation session, project staff recorded the percentages of intervals during which each subject was watching the text display.

Subject One. Subject One is a 40 year old undergraduate student at Minot State University. Subject One's hearing loss is described as moderate in both ears. No reading scores were available for this subject.

Subject One received captioning and note taking services in an introductory course for special education. There were 65 students enrolled in this class. The course format included lectures, class discussions, and small group activities. The instructor regularly used overheads and handouts. The subject sat in the front row of the class and viewed the text display on a computer monitor which was positioned directly in front of her. Figure A provides a graph of the percentage of intervals Subject One watched the realtime transcript during each of the experimental conditions.

Figure A: Subject 1

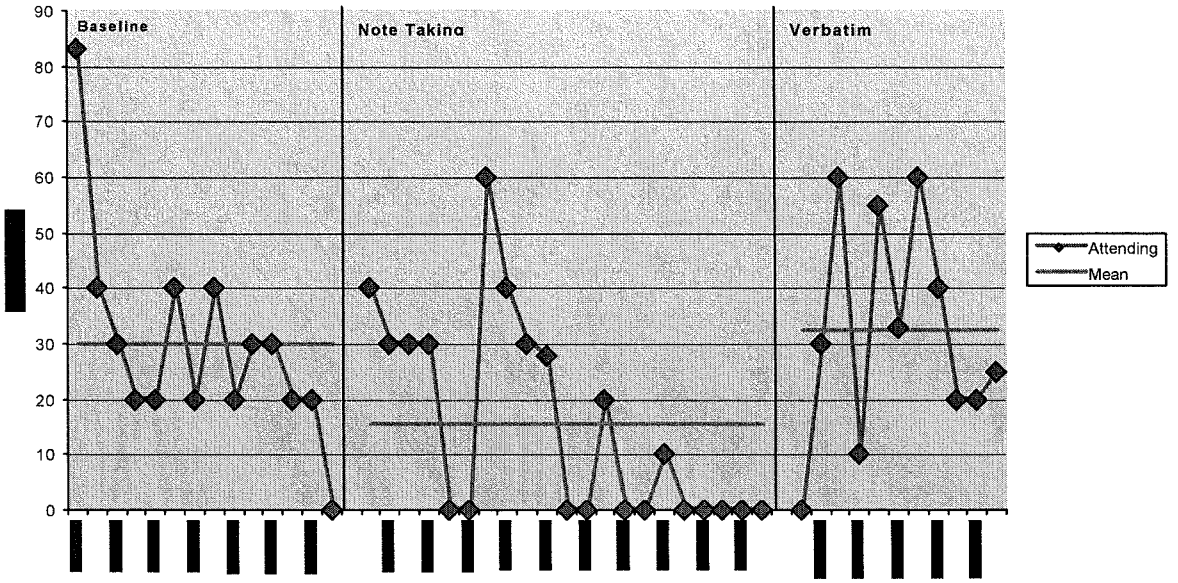


The baseline phase recorded the intervals in which the subject was observing the instructor. During the verbatim captioning phase, the average number of intervals during which the subject observed the text was higher than the corresponding behavior during baseline. Visual inspection of the verbatim phase suggests a general upward trend in the percentage of time being spent watching the captioned text. In contrast, the average number of intervals during which the subject attended to the note taking text was lower than during verbatim captioning. This average was also lower than the baseline condition.

Subject Two. Subject Two is an eleven year old student at a middle school in Minot, North Dakota. Subject Two uses hearing aids and an FM system. His disability is characterized as a severe to profound bilateral hearing loss. Results from reading tests indicated that Subject Two's letter-word identification and passage comprehension skills are above average for hearing students in the same grade. This subject exhibited a particular strength in his ability to sound out unfamiliar words.

Subject Two received note taking services and verbatim captioning in a sixth grade science class. There were 24 students in this class. The subject was seated in the middle of the front row near the teacher and an overhead projector. The text was displayed on a computer monitor placed slightly to the subject's left. Class format consisted of lectures, discussions, and lab demonstrations. During lab demonstrations, the teacher was on the subject's far right. Students recorded answers in a laboratory workbook as the teacher completed experimental procedures. Figure B provides a graph of the number of intervals Subject Three was observed attending to the realtime transcript during the various experimental conditions.

Figure B: Subject 2



During the baseline phase, Subject Two attended to the instructor an average of 30% of the observation intervals. When note taking services were provided, his attention to the transcribed text was only about half of what the comparable behavior was during baseline. However, when verbatim text was provided, his attending was slightly higher than during baseline.

Subject Three. Subject Three is a fourteen year old student at a middle school in Minot, North Dakota who uses hearing aids. His disability is characterized as a sloping mild to profound hearing loss in his right ear and a severe to profound hearing loss in his left ear. Results from reading tests indicated that Subject Two's letter-word identification and passage comprehension skills are below average when compared to hearing students in the same grade.

Subject Three received note taking services in an eighth grade social studies class for one week. Time did not allow for the provision of verbatim transcriptions during this phase of the classroom trials. There were 22 students in this class. The subject was seated in the back of the classroom. The computer monitor on which the text was displayed was positioned on an empty desk in front of the student. Class activities consisted of lectures and discussions. Overheads, handouts, and media presentations were frequently used by the classroom teacher. Students recorded notes on an outline form prepared by the teacher. Figure C provides a graph of the percentage of intervals Subject Three attended to the realtime transcript.

Figure C: Subject 3

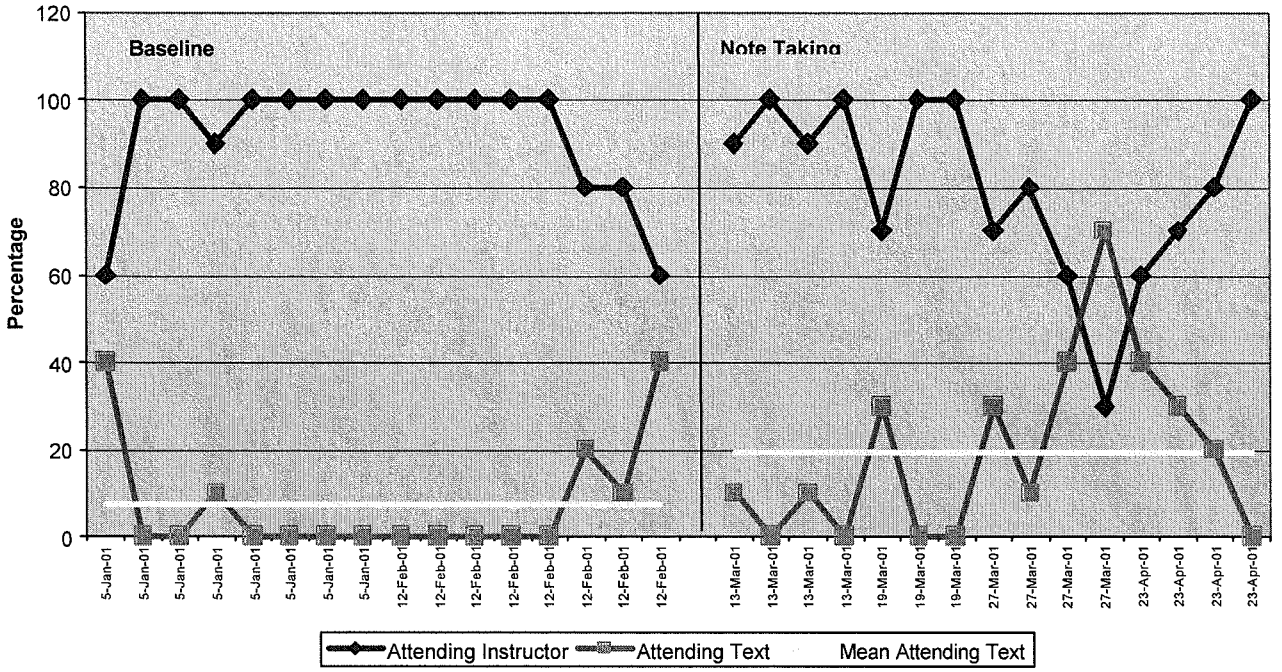


Figure C displays two behaviors, attending to the text *and* attending to the instructor. Because of the layout of the computer monitor in this classroom, it was not easy for the student to attend to both the instructor and the captioned text, they were mutually incompatible behaviors. Thus, as one went up, the other had to go down. During baseline, the student attended well to the instructor or to other instructional stimuli. During the note taking phase, the average number of intervals spent attending to the captioned material went up while the number of intervals spent watching the teacher dropped correspondingly. More than anything else, this classroom trial illustrates the difficulty in integrating the captioning system, whether verbatim or note taking, into the instructional environment.

Implementation Interviews

Interviews were conducted with all three subjects and their teachers to gather additional qualitative information individual preferences. The following table summarizes the content of the interviews.

Subject 1

	Note Taking	Verbatim Captioning	Transcripts
Subject 1	The information is too incomplete. Because the text is so limited, too much information is missed. Notes are not thorough enough to gain adequate access to classroom information.	Word for word captioning is extremely beneficial, especially in classrooms in which visuals and handouts are not used. Verbatim captioning allows students with hearing impairments to totally engage in classroom activities.	Verbatim notes are very thorough and greatly enhance handwritten notes.
Instructor	This service seems to be less accurate. Note taking results in missing large chunks of information. The student responded unfavorably to this service.	Captioning is an accurate and complete system. The student greatly benefited from this format.	Verbatim notes provide missed information and enhancing facts and examples.

Subject 2

	Note Taking	Verbatim Captioning	Transcripts
Subject 2	The notes were somewhat helpful for getting information that was missed through speech reading.	Was not provided	The notes were helpful in studying for tests.
Instructor	The text display not only helped the student with hearing impairments, but was also beneficial for students with poor listening skills.	Was not provided	The student with hearing impairments really benefitted when he used the transcript to study after class.

Support Service Provider	Because all of the students with hearing impairments receive copies of the teacher's lecture notes, the note taking format does not provide any additional information. The verbatim system would probably be more beneficial. Other students, however, were watching the text. The reinforcement in print is beneficial for many students. It increases reading speed and helps improve comprehension by providing information through an additional mode. It is also helpful to see difficult words in print. Students can see the spelling and connect the word with the auditory signal.	Was not provided	Were not accessed

Subject 3

	Note Taking	Verbatim Captioning	Transcripts
Subject 3	The notes were not complete enough, but they did help when what the teacher said was missed.	Having all of the words on the screen was helpful for knowing what was going on in class and for helping to feel more a part of the class.	Were not accessed
Instructor	Because the student already had a copy of the notes on a handout and overhead (as required on his IEP), note taking did not add any new information.	Captioning is much more meaningful and beneficial for the student. Captioning captures all of the examples and stories which are presented to enhance understanding. The student's quiz scores improved after he was exposed to captioning.	Were not accessed

Summary

The Remote Realtime Online Captioning System provides a cost-effective, instructionally viable means of accommodating students with a range of hearing, language, learning, and attention deficit impairments. Data from several classroom trials suggest that the system is amenable to variety of different instructional environments. As any computer program that uses the Internet to stream media, it is subject shortcomings associated with limited bandwidth or inadequate connectivity. However it appears to be robust enough to work in most classrooms with a minimum of teacher intervention.

Students and instructors who participated in the initial field testing have indicated a preference for verbatim captioning over note taking. Observational data confirm that students attend to the transcription text more when it is verbatim rather than note taking. Whether or not this preference has instructional implications is unclear at this point. During verbatim captioning the text can be scrolling off the monitor at a rate of between 100 and 200 words per minute requiring the student to be constantly engaged, especially if there are other things going on associated with the teacher's instruction (e.g., overheads, chalkboard presentation, demonstrations, etc.).

Further investigations are underway to determine to what degree captioning increases the comprehension of participating students. Thompson (1999) reported significant gains for a graduate student with a hearing impairment when captioning was provided. Whether or not this finding is observed in middle school, secondary, and post secondary students has yet to be determined.

Ultimately, the degree to which types of captioning (verbatim or note taking) and what delivery mechanisms (online or live) are most effective may in fact be moot. Much like curb-cuts or ramps, schools need to provide access to instruction. Realtime Remote Online Captioning provides one means for rural and isolated schools and colleges to meet this requirement in a cost-effective and timely fashion.

Contact Information:

Bryce Fifield
Director
North Dakota Center for Persons with Disabilities
Minot State University
500 University Ave. West
Minot, ND 58707
701-858-3580 (voice/tty)
fifield@farside.cc.misu.nodak.edu

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ESTABLISHING A REALTIME CAPTIONING PROGRAM: DESIGNED TO MEET THE NEEDS OF 28 MILLION DEAF AND HEARING IMPAIRED AMERICANS

Barbara Veazey
Paul McInturff

West Kentucky Community and Technical College,
Paducah, Kentucky, USA

With the ability to provide open access at the local, regional, and statewide levels, community colleges are proving that they are truly the people's college. By revising existing programs in a short period of time to meet the needs of 28 million deaf and hearing impaired Americans, we are again proving that we can provide qualified graduates for new jobs demanded by the work force.

Because West Kentucky Community and Technical College has the only court reporter program in the state that has been approved by the National Court Reporting Association, it was only natural that we could make the necessary revisions to take us to the CART level. Our decision to open the program to everyone in the entire state expanded the idea of open access to the community college from a local or regional perspective to a statewide perspective.

There are 28 million deaf and hearing impaired Americans. A broadcast Captioning & Communication Access Realtime Translation Program (CART) was established to train qualified broadcast captioners and CART providers to meet the requirements of the Telecommunications Act of 1996. The CART program was designed in a distance learning format to allow students from all across Kentucky to participate.

We were fortunate because we had an accredited court reporting program; however, from the initial planning phase through revising

Address correspondence to Barbara Veazey, President, West Kentucky Community and Technical College, 4810 Alben Barkley Dr., Paducah, KY 42002. E-mail: barbara.veazey@kctcs.edu

existing courses and developing new courses, it still required a 2-year timeline. Some key factors in the process were as follows:

- **Instructors required additional training.**
- **State-of-the art equipment had to be identified and purchased.**
- **A marketing campaign was designed and implemented.**
- **Curriculum revisions had to be submitted to and reviewed by local and state curriculum committees.**
- **A Congressional Award enabled us to develop and implement the necessary changes in order to get the program up and running in record time.**

The CART Program was established, and the college has enrolled its first class. In another year we will be graduating students to fill good paying jobs as qualified broadcast captioners and CART providers. This will enable Kentucky to meet the requirements of the 1996 Telecommunications Act that requires trained providers for various media events. Partner colleges will be recruited to assist in the process of gearing up to provide satellite centers for hands-on training.

It is imperative that adequate funding is in place, and that personnel are identified who have the skills that—with additional training—can be transitioned to the new curriculum. It is imperative that a qualified support staff be available for the distance learning aspect. Equally important is the development and implementation of an appropriate marketing and recruitment campaign.

College Students' Perceptions of the C-Print Speech-to-Text Transcription System

Lisa B. Elliot
Michael S. Stinson
Barbara G. McKee
Victoria S. Everhart
Pamela J. Francis
National Technical Institute for the Deaf
Rochester Institute of Technology

C-Print is a real-time speech-to-text transcription system used as a support service with deaf students in mainstreamed classes. Questionnaires were administered to 36 college students in 32 courses in which the C-Print system was used in addition to interpreting and note taking. Twenty-two of these students were also interviewed. Questionnaire items included student ratings of lecture comprehension. Student ratings indicated good comprehension with C-Print, and the mean rating was significantly higher than that for understanding of the interpreter. Students also rated the hard copy printout provided by C-Print as helpful, and they reported that they used these notes more frequently than the handwritten notes from a paid student note taker. Interview results were consistent with those for the questionnaire. Questionnaire and interview responses regarding use of C-Print as the only support service indicated that this arrangement would be acceptable to many students, but not to others. Communication characteristics were related to responses to the questionnaire. Students who were relatively proficient in reading and writing English, and in speech-reading, responded more favorably to C-Print.

Within the past few decades, schools have witnessed a dramatic increase in the number of deaf and hard-of-hearing students educated alongside hearing students at both secondary and postsecondary levels (Moores, 1992; Rawlings, Karchmer, & DeCaro, 1988; Schildroth & Hotto, 1994). A major concern for these students is the adequacy of classroom communication, and the communication difficulties of deaf students in mainstream classes are well documented (Osguthorpe, Long, & Ellsworth, 1980; Stinson, Liu, Saur, & Long, 1996). Even when an interpreter and additional support services are provided, students still experience communication difficulties, such as understanding the teacher and participating in class discussions and activities (Kluwin & Stinson, 1993). For example, one problem is the ability to understand hearing classmates. Many hard-of-hearing students and some deaf students use Frequency Modulation (FM) systems to supplement their lipreading of the teacher. Usually the teacher wears the FM microphone. When the students' hearing aids are switched to receive the FM input, they generally cannot hear their classmates' comments.

In response to these difficulties, and also in response to the recognized value of printed information, alternative means of support for mainstreamed deaf and hard-of-hearing students have been developed in the form of real-time speech-to-text transcription systems (Stuckless & Carrol, 1994). The first to be developed was a stenographic-based system in which the code produced by the stenographer was converted by computer into a real-time display of English text (Stinson, Stuckless, Henderson, & Miller, 1988). More recently, with the development of laptop computers, computer-assisted note taking has also been used as a support. In these systems, the support person types on

Victoria S. Everhart is now at the New Mexico School for the Deaf; Pamela J. Francis is now at the Northeast Technical Assistance Center. This study was supported in part by Grant 180J3011 from the Office of Special Education Programs of the U.S. Department of Education. "C-Print" is a registered trademark that belongs to the Rochester Institute of Technology. Correspondence should be sent to Lisa B. Elliot, National Technical Institute for the Deaf, Rochester Institute of Technology, 96 Lomb Memorial Dr., Rochester, NY 14623–5604 (e-mail: lbenrd@rit.edu).

a standard keyboard (Cuddihy, Fisher, Gordon, & Shumaker, 1994; James & Hammersley, 1994; Stinson & Stuckless, 1998; Youdelman & Messerly, 1996). One of these systems has been called C-Print in recognition of the system's display of print ("C" sounds like "see") and the computer basis of the system. In the past 15 years, the use of these systems to support students has increased steadily (Stinson et al., 1999).

It is important to evaluate these systems to determine their educational effectiveness and also their limitations. We report here a study of college students' perceptions of C-Print as a support service. This study addressed four factors related to the use of C-Print: (1) the real-time text display, (2) the hard copy printout of the text provided to students after class (C-Print notes), (3) the effectiveness of the C-Print system without other support services, and (4) individual differences in student responses to C-Print. We first provide a description of the C-Print system before discussing these four factors.

Description of C-Print

As with other computer-assisted note-taking systems, C-Print uses standard laptop computers and word processing software. However, C-Print uses additional technology and training, which permits captionists to more fully capture the lecture. Captionists are trained to use phonetics-based abbreviation software that allows for the transformation of an abbreviation into a full word on the computer screen. In addition, captionists learn strategies for listening actively, for eliminating redundancies, for identifying important points, and for condensing and organizing information (Stinson & McKee, 2000). In comparison to stenography training (usually 2–3 years), C-Print training is relatively short (about 6 weeks). Furthermore, equipment costs for C-Print ($3,500) are less than those for stenographers ($7,000), as is the salary requirement for the captionist (approximately $18 vs. $100 per hour for stenographers) (National Court Reporters Foundation, 1995; Stinson et al., 1999).

The captionist, using a computerized abbreviation system, types the words of the teacher and students as they are being spoken. The system provides a real-time display that the student can read on a laptop computer or television monitor. The text display for the message appears approximately 3 seconds after the words are spoken and remains on the screen for approximately 1 minute. This provides students far more time to consider these words than if they were using an interpreter or lipreading a speaker. In addition, the text files are saved and may be edited after class. These edited notes can be used by students, tutors, and instructors after class by reading them on a monitor or from a printed copy. The system cannot provide word-for-word transcription because it cannot keep up with the speed of speech (approximately 150 words per minute). However, the system does provide for capturing almost all of the meaning of the lecture (Stinson, McKee, & Elliot, 2000). Although the stenographer's notes are verbatim and more detailed, C-Print notes contain the important information in a more condensed format. Consequently, C-Print reduces the number of pages of notes. Students seem to find these C-Print notes easy to study because they feel that the notes contain detailed information about class proceedings and course content (Elliot, Foster, Stinson, & Colwell, 1998).

Real-Time Text Display

The amount of classroom discourse that the C-Print system captures was investigated in an analysis that compared six transcripts produced by a C-Print captionist with verbatim transcripts of teachers' lectures. This comparison found that the mean percentage of idea units captured by the C-Print captionist was 65% and that the mean percentage of important idea units (as rated by three judges) captured by C-Print was 83% (Stinson & McKee, 2000). These findings can be contrasted to those for a stenographic system. Real-time stenographic systems capture virtually every word spoken by the teacher (Stinson et al., 1988).

These findings raise the question of the extent to which students would regard the information provided by C-Print in the classroom as easy to understand and comprehensive. A previous investigation by Stinson et al. (1988) evaluated the use of a steno-based support service in the classroom. Questionnaires were administered to 121 deaf and hard-of-hearing students at the National Technical Institute for the Deaf (NTID) served by the steno-based service. Students reported

that they understood significantly more lecture information with the steno system than with the interpreter. The first question of this study was whether students would respond favorably to the real-time text display of information provided by C-Print.

Hard Copy Printout of C-Print Text as Notes

A major concern of deaf and hard-of-hearing college students is that they have high quality notes for study after class. If the student relies on interpreting services, lipreading the teacher, or a real-time text display, it is often difficult to simultaneously focus on this information and on taking good notes (Hastings et al., 1997). In view of this difficulty, educators, such as Saur (1992), have stated that note taking, when a designated person in the class takes notes, is an essential support for most deaf and hard-of-hearing college students. These notes provide a permanent record that the student can review after class in order to remember the relevant information (Saur, 1992). Note taking is the most frequently used support service for deaf and hard-of-hearing students (Lewis, Farris, & Greene, 1994).

Despite the popularity of note taking, Hastings et al. (1997) and Saur (1992) describe several limitations, including variations in the quality of notes. For example, notes from student volunteers may exclude important information because the student taking notes already knows the information or does not value its importance. Paid note takers may produce better notes. However, all handwritten notes have limitations. They may be messy or disorganized and must include considerable summarization, because note takers cannot write nearly as rapidly as professors can talk.

Text produced by a real-time transcription system in class and distributed to students as a computer text file or as a printout are essentially a verbatim copy of what was said in class. This printout is likely to be considerably more detailed than handwritten notes when a computer-assisted note-taking system, such as C-Print, is used. Previous research on real-time transcription systems suggests that students prefer notes generated by real-time systems rather than handwritten notes. For example, Stinson et al. (1988) found that students perceived the printout produced by the real-time graphic display steno system as more helpful than notes provided by paid student note takers. The second question for this study was how students perceive the printout produced with the C-Print system.

C-Print Without Other Support Services

Although a speech-to-text system is most economical when it is the only support service in a given course, it may be used in addition to other support services, such as interpreting. The Stinson et al. (1988) study included a question about preference among various support services including interpreting, steno system display on TV, note taking, steno system printout, and tutoring. Results indicated that students had a favorable opinion of the steno system relative to other support services. Overall, 62% of the students selected either the real-time display or the printout of the text as their most preferred support service, whereas 36% selected either note taking or interpreting as the single most preferred system. The frequent choices of these two services provided by the steno system suggested that the system could sometimes be used without the support of an interpreter or note taker. Students were not, however, asked directly whether they perceived that system as an appropriate support service if they used it without other support services. The third question of this study was whether students perceived this practice as appropriate.

Individual Differences in Perceptions of C-Print

Given the variations in communication preferences and learning styles of deaf and hard-of-hearing students, they likely will also offer differing favorable or unfavorable responses to specific support services, including C-Print (Kluwin & Stinson, 1993; Lang, Stinson, Kavanaugh, Liu, & Basile, 1998). For example, because C-Print provides printed English, students who are relatively proficient readers may respond more favorably than those who are less proficient. Stinson et al. (1988) considered communication preference and educational background of students who used a steno system and their preferences for interpreting, steno system display, note taking, steno system notes, and tutoring support services. The authors reported individual differences in preferences for various support

services. Students who came from mainstream high school programs and who were relatively proficient in reading, writing, and speech-reading tended to prefer the steno system. On the other hand, students who came from residential or day schools for the deaf, who were relatively proficient in manual reception, but who were less proficient in auditory discrimination, speech-reading, and speech production, were likely to prefer an interpreter.

These results suggest that individual differences in student characteristics would also relate to students' favorable ratings of C-Print. The fourth question of this study was whether student characteristics were related to the ratings of C-Print.

Method

To examine college students' perceptions of the C-Print service, we employed a multimethod research strategy, an approach that has been gaining acceptance in educational research (Garrison, 1986; Howe, 1988). Use of multimethod design enables researchers to develop a deeper understanding than the use of only one methodology (Eisenhart & Borko, 1993; Howe, 1988; Howe & Eisenhart, 1990; Lagemann & Shulman, 1999). To this end, this study collected questionnaire and qualitative interview data and also used information on background and communication characteristics from NTID student records.

Participants

The participants for the questionnaire component of the study were 36 deaf or hard-of-hearing college students (17 women, 19 men). They received the C-Print support service in one of their mainstream courses at the Rochester Institute of Technology between spring quarter 1994 and fall quarter 1996. Students received the C-Print service for all class sessions in the 10-week term. All students who received the services were asked to complete questionnaires and participate in interviews. Virtually all the students who answered the questionnaire had attended mainstream high school programs (32) as opposed to separate day or residential secondary schools (4). The mean pure-tone average for the better ear was 95.12 (SD = 14.32). The students' overall grade point average was 2.85 (SD = .57) on a 4-point scale. All students who apply to NTID or receive support through NTID are asked to complete the Language Background Questionnaire (LBQ) developed at NTID and containing items related to self-perceived skill levels in several modalities (Metz, Caccamise, & Gustafson, 1997). The mean score on the LBQ item providing a self-rating of sign proficiency was 2.83 (SD = 1.11), where 1 = poor skills and 4 = high-level skills, indicating relatively good sign proficiency. Twenty-two students participated in the in-depth interview component of the study. All of these students, except one, also responded to the questionnaire described above.

Courses

Eight students served by C-Print were in business courses; 28 in liberal arts courses. Examples of courses covered by C-Print included "Foundations of Sociology" and "Social Psychology" in the College of Liberal Arts and "Financial Accounting" in the College of Business. The courses were taught by 4 different faculty members in the College of Business and 12 different faculty members in the College of Liberal Arts.

Twenty-seven of the students were in courses identified by the C-Print captionist as primarily lecture-oriented, five in discussion-oriented courses, and four in a course that had approximately equal amounts of lecture and discussion. All students had trained note takers and tutors in their courses, and all but two students had interpreting services as well as C-Print. These two students agreed to use C-Print instead of an interpreter.

Materials and Procedures

The materials and procedures for collecting the three sets of data include the following.

Questionnaire. The questionnaire included items relating to (1) the use and understanding of the real-time display, (2) the use and assistance provided by the C-Print hard copy notes, and (3) the use of C-Print as the only support service. These questionnaire items are presented in Appendix 1. All items except for one were

fixed-alternative questions. Questionnaires were distributed by the C-Print captionist during a class session near the end of the term. Students completed the questionnaire independently, returned it to an office at NTID, and received $3 for their time.

Interviews. The purpose of the in-depth interview was to extend our understanding of how students perceived the effectiveness of the C-Print system and how they used it to aid learning in the mainstream classroom. Some of the information solicited during the interviews addressed the same issues as the questions included in the questionnaire (see Appendix 2). However, the interviews were open-ended and participants were encouraged to pursue their own line of reasoning. This resulted in elaboration that was not possible within the constraints of our questionnaire. The interviews lasted 30 minutes to 1 hour. Students received $10 for their participation. Interviews were conducted by two members of the research team who were proficient in sign communication (Everhart, Stinson). The students' communication skills varied. Most of the students used sign communication with or without speech, and the interviewer used sign communication and speech. A voice interpreter repeated the interviewer's and respondent's sign and voice communication into an audiotape recorder. A few students preferred to use spoken English. If these students had intelligible speech, their responses were spoken directly into the tape recorder. If their speech was judged unintelligble, the interpreter voiced the responses. Interviews were later transcribed verbatim for analysis.

Student records. Students gave the researchers permission to access their records, which are maintained in a database at NTID. Data from five tests of communication proficiency were used for this study: (1) reading comprehension subtest of the California Achievement Test (M = 10.77, SD = 1.07), (2) Michigan Test of English Proficiency (M = 81.76, SD = 12.63), (3) NTID Test of Speechreading with Sound (M = 68.60, SD = 33.55), (4) NTID Test of Speechreading Without Sound (M = 46.90, SD = 22.45), and (5) NTID Test of Simultaneous Communication Reception (M = 84.00, SD = 14.28). The first two tests are standardized achievement tests. The California Achievement Test is now called the TerraNova CAT and is distributed by CTB McGraw-Hill (2000). The Michigan Test of English Proficiency is a retired component of the Michigan English Proficiency Battery distributed by the English Language Institute at the University of Michigan (2000). The last three tests listed above were developed at NTID and are used for student advising and course placement in communication courses (see Crandall, 1978; Johnson, 1976; Subtelny, 1982). For the two speech-reading tests, students viewed a videotape of a person saying sentences (with and without sound) and then wrote out the sentences. For the simultaneous communication reception test, students viewed a videotape of a person signing and saying sentences and were then required to write out the sentences. More detailed descriptions of the tests, the scoring, and examples of test items can be found in Johnson (1976), Crandall (1978), and Subtelny (1982).

Analysis

Questionnaire. Data were summarized using descriptive statistics (e.g., frequency distributions) and standard inferential statistics (chi-square, paired t tests).

Interviews. Verbatim transcribed interviews were analyzed using content analysis techniques described by Bogdan and Biklen (1992). The transcripts were coded into three categories: (1) use and understanding of the C-Print real-time display, (2) use and assistance provided by the C-Print hard copy notes, and (3) appropriateness of C-Print as the only support service.

C-Print index and student records. To examine the relationship between perceptions of C-Print and communication characteristics of individual students, we created an index of the extent to which students responded favorably to C-Print. Scores were combined for three questions: (1) "How helpful is C-Print without the notetaker?" (range of scores: 2–4), (2) "What percentage of the lecture was understood with C-Print?" (range: 50–100), and, (3) "How much did C-Print notes help with the course?" (range: 2–4). To give responses to these questions equal weight in the index, we applied a z-score transformation to individual students' responses to each question. We then created a

C-Print "index" for each student by adding together the three z-scores for that student. This index was correlated with scores on the five communication skills tests described above.

Results

The results for both the questionnaire study and the interview study will be summarized together where appropriate. Not all students answered all questions on the questionnaire, and due to the nature of the open-ended interview, not all students interviewed answered the same questions during the interview. The results are organized according to the study's four main topics: (1) use and understanding of the C-Print real-time text display, (2) use and assistance provided by the C-Print hard copy notes, (3) appropriateness of C-Print as a stand-alone support service, and (4) relations between perceptions of C-Print and student communication characteristics.

C-Print Real-Time Display

Students were asked how much of the lecture they understood from watching the C-Print display. Students felt that C-Print made it easy to understand the teacher. Sixteen out of 25 questionnaire respondents stated that they understood between 90% and 100% of the lecture with C-Print. A majority of the interviewed students indicated that they understood almost all the lecture. According to interview responses, students felt that C-Print facilitated comprehension of the classroom discourse. For some students, C-Print significantly improved their comprehension of classroom dialogues. One student described his experience this way:

> Well, I would say that it helps a lot. And it surprised me because I never realized how much information was provided in class. Before I always thought that the teacher did not provide enough information and it was boring, but when I was using the C-Print it seemed more interesting. It makes me feel like I have been missing something in the past. Like I missed the last few years.

When producing text in real-time in the classroom, the C-Print captionist condenses what is being said. In view of this, students were questioned specifically about whether the C-Print text contained an acceptable amount of information and captured the important points in the lecture. Most students agreed that C-Print fulfilled this function. All 31 students who answered the questionnaire item pertaining to this issue agreed that the C-Print text produced by the captionist included the important points of the lecture (χ^2 [1] = 31, $p < .001$).

Students were also interviewed about the extent to which the captionist captured all the information, and the interviewer specifically pointed out that sometimes the C-Print captionist needed to summarize in order to capture the information. A few students were surprised to learn this given the quantity of text displayed. Some students felt that the information was so complete that it had a verbatim-like quality. One student commented: (for a course served by C-Print alone) "I would understand everything that is going on in that classroom at 100% because everything would be recorded." Another student responded

> Yes, I accept that it is summarized. I can hardly tell if it is summarized. It looks like she is just typing every single word that the teacher is saying. I can hardly tell that she is summarizing. When I look at the interpreter, I can tell that they are summarizing. So I can see the difference.

Some students did, however, indicate an awareness that some information was missing. In particular, several students noted that the segments of the text display that contained other students' comments could sometimes have been more complete. Students recognized that professors sometimes spoke too quickly for their comments to be typed verbatim. In addition, it was mentioned that C-Print was not capturing graphs, formulae, or other visual information. Students commented that there were times when verbatim transcription was preferable. For example, one student expressed a desire to have verbatim transcription of other students' comments or important messages from the professor:

> Student: And most important things that the teacher says that it is important to know this word or sen-

tence then the person really needs to type that down, it really needs to show up on the screen those important words.

Interviewer: So if the professor says, "This is important to know" you want that exact sentence typed in? Because you want to know that the professor said it was important, right?

Student: If the professor says something important you really want to know that, you really want to have those exact words on there or for an announcement like it is time for a test time, for final exams, you want that specific information is really important. I don't want to show up at the wrong place at the wrong time or something like that. That would be upsetting.

In regard to students' participation in class, we were interested in knowing whether students could tell, from the C-Print display, when the professor was asking a question of the entire class or a specific person. The majority of students who were interviewed said they could tell. Several commented that a question mark appeared in the text display. Others commented that they noticed a dialogue occurring between teacher and student in the display. One student, however, commented that she was not able to detect a question posed to the class by watching the display because C-Print does not use intonation to distinguish statements from questions. Other students did not pick up on questions because of the lag time associated with the real-time display. As mentioned previously, in those cases, students may have realized that a question was asked, but by the time they read the display, the time for answering the question had passed.

We also asked students how they would feel using C-Print to relay their questions to the teacher or comments to the group. For example, interviewers suggested to students that they might type a question that the C-Print captionist could voice for them, or the comments might be displayed for all to read on a TV monitor. Several students thought this strategy would work, but others were less certain, as this approach would be quite different from the current practice of having an interpreter voice their signed message.

Students were asked to consider their comprehension of class lectures with C-Print, as compared with an interpreter. The analysis of the questionnaire responses revealed that students assigned significantly higher ratings for percentage of the lecture understood with C-Print than with interpreting (paired t test, $t = -2.43$, $p < .025$). The mean percentage of lecture information understood with C-Print was 84.8 ($SD = 16.5$); for interpreting, it was 69.9 ($SD = 28.4$).

Examination of the interview data indicated that a few students felt both services were comparable. Many more students stated that they felt they understood more with C-Print. However, reasons for better comprehension of the lecture with C-Print varied by student. First, some students had limited proficiency in American Sign Language (ASL), and, thus, the interpreters were difficult to understand. Second, the interpreters' skills varied and sometimes the interpreters missed information. Third, several students commented that they felt interpreters sometimes omitted information because they condensed the message in translating it to ASL. Fourth, several students thought C-Print included more of the actual vocabulary used by the professor and that this was beneficial for test preparation and learning the course material. In regard to the issue of the extent to which C-Print and interpreters modify what the teacher says, one student commented:

> When I watch the interpreter and the teacher, I know that the interpreter is changing what the teacher is saying a lot, and I don't like that because I feel I am losing a lot. Most of the time I will ignore the interpreter and pay attention to the teacher. Some interpreters I have had a few times, and I know if they are good or not. So it depends on the interpreter.

Fifth, some students stated that they perceived the information provided by C-Print as simply more complete than that provided by an interpreter. As one student said, "I am a fifth year student. I have experienced many interpreters, and I know that I missed a lot of information. I have seen them do it. And I know that on the C-Print that all the information is there."

On the other hand, students indicated during the interviews that they recognized the limitations of having the C-Print real-time display in class, as opposed to an interpreter. Some students favored the message provided by the interpreter and thought they learned

more by watching the interpreter because the interpreter captured more of the classroom activity than did C-Print. One student described her feelings this way:

> I would like to add that why I only looked at the in classroom thing for only five minutes, because the interpreter has expression and I have a better sense of what is happening in class. From the C-Print it is just kind of blank. There is nothing there. People are laughing and I don't know it, people are moving, things are happening in class and I can't realize it. And so I only watched the in class thing, the display, for five minutes.

Interpreters add a more personal touch. With an interpreter, the students watch an individual conveying the message, rather than reading text. Also, for a student without intelligible speech, participation in class may be more difficult when only the C-Print service is provided. As one student commented,

> The only problem I would see is if I don't have an interpreter—what if the student has a question? How would they ask? Or maybe the student could type the question and it appears on the screen . . . and the teacher can see the screen, and then they know what the question is.

During the interviews, students were asked to consider in which class settings C-Print was most helpful and in which settings an interpreter would be most helpful. Several students felt that C-Print would be most helpful in lecture-only classes. Some students appreciated C-Print in their discussion-based classes as well, because the C-Print notes provided a transcript of the discussion. Other students supported the idea of an interpreter for discussion-based classes. Clearly, there is no one solution to this dilemma.

As evidenced here, for certain students and in certain circumstances, one service may be more useful than another. Students expressed the opinion that C-Print and interpreting services are complementary. For example, currently, interpreters seem to better capture group discussion, whereas C-Print notes seem to better help students remember that discussion later.

C-Print Notes

An important component of the C-Print system is the hard copy printout of the C-Print text, called the C-Print notes, that is distributed to students after class. The students in the study were asked for their perceptions (1) regarding the C-Print notes relative to the handwritten notes of student note takers, (2) their use of the C-Print notes, and (3) the advantages or disadvantages of the C-Print notes.

On the questionnaire, students rated how helpful they found the C-Print notes. Due to the small number of subjects, the four rating categories were collapsed into three for analysis purposes: "helps little or none," "helps enough," and "helps very much." Almost all students (33 out of 36) rated the C-Print notes as helping enough or very much (χ^2 [2] = 15.17, $p < .01$). Twenty-four out of 34 students responded that they used the C-Print notes more than the notes from the note taker. This difference in frequency was statistically significant (χ^2 [1] = 5.76, $p < .02$). Students were hard-pressed to identify disadvantages of the C-Print notes. The few students who did criticize the notes were concerned with the length of the transcript and the amount of time needed to read the notes, the quantity of paper used for printing notes, and the lack of illustrations or other graphic information.

In the interviews, students were asked about how often they would read a set of C-Print notes. Some students did not integrate reading C-Print notes into their regular study routines. As one student remarked, "It is going to take time for us to fully adapt to C-Print." Other students made the transition to C-Print notes more easily and read the notes regularly. They reviewed the notes between 1 and 3 times for each class session.

We also asked students about specific ways that they used the C-Print notes. For the 36 students who responded to the questionnaire, 29 reported skimming the notes. Sixteen of these students reported noting unfamiliar vocabulary and ideas, and 10 reported using the notes to create their own outline. Fourteen students reported "other" uses of the notes, such as reading.

Similarly, in the interviews, students reported using the C-Print notes for study in a variety of ways: (1) skimming the text, (2) reading and rereading the text, (3) noting special vocabulary, and (4) making an additional set of personal notes. One student reported using the following strategies in studying notes:

> I just read them to see if I know the information. And I know that, know that, fine, no problem. And

> then I get to something I have not seen before, then I mark it, I mark it up. And then I continue reading, and then I go over it again to figure out what they are talking about, and try to understand everything that is going on. And then like words I never saw before or heard before, I underline. And then I write an explanation about what it means. And I use that for tests. Yes, it helps a lot. It has really pulled my grades up a lot.

These results suggest that students' study techniques might be best characterized on a continuum from passive to active approaches, based on the degree to which they manipulated the notes to fit their needs. The more passive approaches for using the C-Print notes involved only reading them. For example, several students looked at the notes only on occasion and just skimmed the notes. Many students said that they read them more thoroughly. Still other students compared C-Print notes with note taker's notes, the textbook, or their recollections of class lecture and discussion. C-Print notes were also used as an additional reference to prepare for tests and class projects.

The more active approaches for using the C-Print notes went beyond a rereading of the notes. These approaches involved reorganization of the material, identification of key points, or the writing of one's own thoughts. For example, many students said that they would read over their C-Print notes and write additional notes or questions for the professor on the margins. Several other students used the C-Print notes as the basis for writing their own notes or outline for the course.

C-Print Without Other Support Services

We asked students for their opinions regarding the use of C-Print without other support services. Students rated how helpful they thought the C-Print system would be in a hypothetical classroom situation without an interpreter or note taker present. Due to the small number of subjects, the four rating categories were collapsed into two: "help little or none" and "help enough or very much." A higher number of students (24) rated the C-Print system as helping enough or very much, as compared to the number of students (2) who rated the system as helping little or none ($\chi^2[1] = 7.92, p < .02$).

During the interviews, students were presented two hypothetical scenarios. Students were asked to think about the acceptability of using C-Print in the classroom without an interpreter, but with a note taker, or on a "stand-alone" basis, without either an interpreter or note taker. Many students felt comfortable with the thought of no interpreter. About half of the students also felt comfortable about using C-Print without a note taker, as well as without an interpreter. Several students expressed confidence that they would understand everything if they had to rely exclusively on C-Print.

Some students indicated that they could get along with only the C-Print service because it provides complete information regarding what was discussed in class, as the following quotation reveals:

> You said one situation is you have a note taker and you have an interpreter. The other situation is that you have C-Print only, right. I would prefer the C-Print only. Yes, I would get all the information, and with an interpreter I may miss some information, and the note taker may miss some information or may only do summaries. With C-Print I am getting everything, and I can see it on the TV screen or on the laptop, and I can summarize it myself if I want to.

In contrast, a few students felt that C-Print alone was not a viable option. One student said that if he were confronted with the prospect of C-Print as a stand-alone service, he would drop the course. One concern that students raised was how they would ask questions without the aid of an interpreter.

Relationship Between Perceptions of C-Print and Communication Characteristics

This study also examined the relationship between perceptions of C-Print and communication characteristics of individual students. To examine this relationship, we correlated the index of extent that students perceived C-Print favorably with scores on five communication skills tests and three background measures (see Method section for descriptions). Table 1 presents the intercorrelations between these eight measures and the index of favorableness toward C-Print.

Relatively favorable responses to C-Print were as-

Table 1 Intercorrelations of the index of C-Print favorableness with communication skill tests and background measures

Tests and measures	*n*	*r* with C-Print index
1. Reading Comprehension Subtest, California Achievement Test	30	−.05
2. Michigan Test of English Proficiency	29	.51*
3. NTID Test of Speechreading with Sound	30	.57*
4. NTID Test of Speechreading without Sound	30	.59*
5. NTID Test of Simultaneous Communication	26	−.07
6. Puretone average	33	.23
7. Language Background Questionnaire item related to sign proficiency	30	.13
8. College grade point average	36	−.22

*$p < .01$.

sociated, at a statistically significant level, with higher scores on the Michigan Test of English Proficiency, with higher scores on the NTID Test of Speech Reading with Sound, and with higher scores on the NTID Test of Speech Reading without Sound. As shown in Table 1, the C-Print index did not correlate significantly with the other communication skill tests or background measures. Thus, preference for C-Print appears to be associated with being skilled in English and skilled in receiving spoken (e.g., English) communication.

Discussion

The results of this study indicate that many of the deaf and hard-of-hearing college students responded favorably to the form of information delivery provided by the C-Print speech-to-text transcription system. Students perceived the system as providing complete information that captured all, or almost all, the important points and details communicated in a college classroom. They also indicated that the C-Print real-time display enabled them to achieve a high level of comprehension of lecture material. Despite this level of comprehension, students did criticize certain aspects of the C-Print display—namely, lag time, captionist's difficulty in capturing other students' comments, and C-Print's inability to capture visual material, such as illustrations or mathematical formulae.

One factor in the favorable response to C-Print may be the permanence of the information on the display and in the printout. For the real-time display on the laptop that is presented during class, each row of words remains on the screen for approximately a minute. This provides students far more time to consider these words than if they were using an interpreter or lipreading a speaker. After class, students can further review the material in exactly the same wording and in much greater detail than notes from a note taker.

In general, students responded favorably to the C-Print notes. Many commented on the clarity and detail of the notes. Students recognized the benefits of the notes to themselves and to others in class. C-Print notes appear to be a versatile study tool. Students read, highlighted, and wrote on these notes. C-Print notes helped students to recall class proceedings, and students used them to study for tests and to write papers. Only a few students criticized the notes for their length and lack of graphic information.

Students generally thought that C-Print enhanced their educational experience. Some students felt that they were more confident about learning and that they could perform better when the C-Print service was provided.

The results of this study are similar to those of a study conducted during the 1980s at NTID with a steno system (Stinson et al., 1988). In the previous study and this one, deaf students assigned higher ratings of understanding to the transcription system (C-Print or steno) than to interpreting. In addition, for both studies, more students responded favorably to the hard copy text than to notes from a note taker. Why might students find the printout more helpful? Comments during interviews for this study, as well as anecdotal remarks during the previous study, suggest that the detail of the printout permits clarification of what was not understood during the lecture. Furthermore, although the content of notes varies among note takers, the C-Print printout is as near the original message as possible and preserves its meaning. The results from this study suggest that students rated C-Print about as favorably as students had rated the steno system in the

previous study. C-Print, however, is generally the more cost-effective of the two systems. Due to the shorter training time of C-Print, approximately 6 weeks, many persons can be trained and placed in classrooms as support professionals at a reasonable cost. Equipment costs are also low.

Educational programs are frequently interested in using C-Print as the only support service because this approach is less costly than including it as an additional service along with others. Student responses indicated that use of C-Print as the only service would probably be acceptable to some students, but that it would not be to others.

Results pertaining to individual differences in questionnaire responses were consistent with the interview data. These results indicated that not all students reacted more favorably to C-Print than to interpreting or note taking. This pattern of relationships between communication background and preferences and response to C-Print was consistent with the previous research with a steno system (Stinson et al., 1988). For both the previous study and this study, students who were relatively proficient in reading and writing English, and in speechreading, responded more favorably to the speech-to-text system. The generally favorable response to C-Print came from a population of deaf and hard-of-hearing students with unusually high reading proficiency; less proficient readers may prefer an interpreter. A study under way with high school students, who are less proficient readers than those in this study, is addressing this question.

One limitation of this study is that C-Print was used only in certain types of classes, primarily lecture-oriented courses in business or liberal arts. For certain instructional situations, such as laboratories, the system may be inappropriate (Haydu & Patterson, 1990). In addition, a little more than half of the students served by C-Print completed questionnaires or interviews. It is possible that students who participated in the study had more favorable attitudes about the system than those who did not participate. Also, the questionnaire sample was small.

Research to develop a more comprehensive understanding of the benefits and limitations of educational technologies, such as C-Print, must use a variety of methodologies and must evaluate the technology with various groups and in different settings. This study used quantitative and qualitative methodologies. Other studies are needed to obtain additional objective data. These include investigation of the effect of C-Print on memory for lectures and of the system's influence on educational achievement. Such studies are currently under way.

This study contributes to the accumulating evidence that indicates that a speech-to-text transcription system, such as C-Print, is an effective way of increasing accessibility to information in the mainstream classroom for deaf and hard-of-hearing students. Evidence also supports the perspective that it is desirable to match support services to the needs and preferences of individual students, given considerations of cost and availability. In making recommendations regarding support services to deaf or hard-of-hearing students, support service professionals can use information such as the finding that proficiency in English appears to be a good predictor of the perceived benefit obtained from C-Print. This does not imply that a student's predicament and preference should not be taken into account. However, it does imply that a student's preference is not the only factor that should be considered in selecting an appropriate support service.

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Appendix 1

Questionnaire Items Used in the Study

Items	Response Options
Which do you use more?	Circle answer: (a) Notes from note taker; (b) C-Print notes
How do you use the C-Print notes to study?	Can circle more than one response: (a) Skim the notes and highlight important information; (b) Make an outline from the information; (c) Note unfamiliar vocabulary and ideas; (d) Other? (write in)
How much do the C-Print notes help you with this course?	Circle one: (a) C-Print notes do *not* help at all; (b) C-Print notes help me a little; (c) C-Print notes help me enough; (d) C-Print notes help me very much
Often the C-Print operator has to summarize information. Is that acceptable to you? Do you feel you are getting the important points?	(Open-ended question; responses coded)
How much of the lecture can you understand from watching the interpreter?	Circle answer: (a) 100%, (b) 90%, (c) 80%, (d) 70%, (e) 60%, (f) 50%, (g) 40%, (h) 30%, (i) 20%, (j) 10%, (k) 0%
How much of the lecture can you understand from watching the C-Print display (TV or laptop)?	Circle answer: (a) 100%, (b) 90%, (c) 80%, (d) 70%, (e) 60%, (f) 50%, (g) 40%, (h) 30%, (i) 20%, (j) 10%, (k) 0%
If there is an interpreter, but no note taker is available, how helpful would the C-Print system be?	Circle answer: (a) C-Print does *not* help at all; (b) C-Print helps a little; (c) C-Print helps enough; (d) C-Print helps very much
If *no* interpreter and *no* note taker are available, how helpful would the C-Print system be?	Circle answer: (a) C-Print does *not* help at all; (b) C-Print helps a little; (c) C-Print helps enough; (d) C-Print helps very much

Appendix 2

Interview Questions

I. Real-time Display

1) How much of the lecture can you understand watching the display?
2) Do you have any problems with the display itself or with watching the display?
3) When watching the display, do you know when the teacher is asking a question and wants an answer?

II. Text "Condensing"

1) The captionist has to "condense" (summarize) information often in class. Is that acceptable to you? Do you feel you're getting the important points?
2) Do you think any information has been missing from the display?

III. C-Print Notes

1) What are the advantages and disadvantages of the C-Print notes?
2) Please tell us what you do with the C-Print notes from the time you get them to the time you are finished with them.

3) How do you use the C-Print notes to study (e.g., skim the notes and highlight important information; make an outline from the information; note unfamiliar vocabulary and ideas; other ways)?

IV. Adequacy of the C-Print System

1) If there was an interpreter, but no note taker was available, how adequate would the C-Print system be?
2) If there was a note taker, but no interpreter was available, how adequate would the C-Print system be?
3) If no interpreter or note taker was available, how adequate would the C-Print system be?

V. General Questions

1) For you, what is the best thing about C-Print?

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Inclusive Instruction and Learning for Deaf Students in Postsecondary Education

Susan Foster
Gary Long
Karen Snell
National Technical Institute for the Deaf
Rochester Institute of Technology

This article explores how students who are deaf and their instructors experience mainstream college classes. Both quantitative and qualitative procedures were used to examine student access to information and their sense of belonging and engagement in learning. Instructors were asked to discuss their approach to teaching and any instructional modifications made to address the needs of deaf learners. Results indicate that deaf students viewed classroom communication and engagement in a similar manner as their hearing peers. Deaf students were more concerned about the pace of instruction and did not feel as much a part of the "university family" as did their hearing peers. Faculty generally indicated that they made few if any modifications for deaf students and saw support service faculty as responsible for the success or failure of these students. We discuss results of these and additional findings with regard to barriers to equal access and strategies for overcoming these barriers.

Deaf students are attending mainstream postsecondary educational programs in ever increasing numbers. Currently, 20,000 deaf and hard-of-hearing students are mainstreamed in approximately 2,360 postsecondary programs (Lewes, Farris, & Greene, 1994). We have come a long way in terms of providing support services such as interpreters, notetakers, and tutors. Yet we have not systematically documented what works and does not work regarding full inclusion of this population. There is always the danger that instructors and students will perceive the presence of support services in their classes as "full accommodation." In fact, this is only the first step. In this article, barriers to inclusive education for deaf postsecondary students, as well as strategies for overcoming barriers, are explored. Findings are presented from an ongoing program of applied research at a large postsecondary program that focuses on inclusive education for deaf students enrolled in mainstream classes.

The article is organized into four sections. In the first section, background information is provided regarding legislation that has had an impact on mainstreaming students with disabilities at the postsecondary level, as well as selected literature on the topic of inclusive education. The second section describes the design of the research, including subjects and methodology. The third section presents research results. The article concludes with a discussion of the implications of this research for inclusive education of deaf students at the postsecondary level.

Background

During the two decades following passage of the Individuals with Disabilities Education Act (IDEA), educational program reform at the local and state levels increased dramatically. The primary goal of the legislation and subsequent reform was to ensure that all students shared equal educational opportunities and access to the same "general" curriculum. According to the U.S. Department of Education (1997), three times the number of young people with disabilities are now

Correspondence should be sent to Susan Foster, Department of Research, National Technical Institute for the Deaf, Rochester Institute of Technology, 52 Lomb Memorial Drive, Rochester, NY 14623 (e-mail: SBFNIS@RIT.EDU).

enrolled in colleges or universities. However, the Department of Education also acknowledges that many children with disabilities remain excluded from the general curriculum.

From discussions of inclusive education (e.g., Chalmers & Olson, 1995), its characteristics (e.g., Dalheim, 1994), and strategies for implementation (e.g., Falvey, 1995), four themes emerge: (1) an inclusive environment can be conducive to learning for all students, (2) some teaching styles are more consistently connected with an inclusive environment, (3) the personal learning styles of students need to be considered in programmatic design, and (4) mere physical proximity is insufficient to achieve the goal of inclusion. Unfortunately, outcome-based evaluations of the efficacy of inclusive education in achieving its goal—equal opportunity and access to the general curriculum—continue to lag behind program reform.

As a member college of the Rochester Institute of Technology (RIT), the National Technical Institute for the Deaf (NTID) is in a unique position to identify the efficacy of inclusive education in achieving the goal of equal opportunity and access to the general curriculum. More than 400 deaf students who are fully matriculated in the other six colleges of RIT receive support services through NTID. Thus, RIT/NTID has a wealth of experience and expertise in providing tutoring, notetaking, and interpreting for students who are deaf.

Several outcome-based studies of inclusive education conducted at NTID support the observation that mere physical proximity often promotes only the illusion of integration and that additional accommodations may be necessary to overcome less obvious barriers (Foster & Brown, 1989; Foster & Walter, 1992; Saur, Popp-Stone, & Hurley-Lawrence, 1987). In a reflective essay written from the perspectives of a hearing instructor and a deaf student, Foster and Holcomb (1990) explored the importance of grapevine information and student rapport in university settings, noting that both are difficult for deaf students to access. Other research at NTID has focused more specifically on the cognitive and affective dimensions of classroom communication and engagement. In this vein, it was found that as students feel at ease with their communication with teachers and peers, they see themselves as having control in the educational setting and are more likely to become engaged, active learners (Braeges, Stinson, & Long, 1993; Garrison, Long, & Stinson, 1993; Long, Stinson, & Braeges, 1991; Stinson, Liu, Saur, & Long, 1996). These and other studies suggest that, even with a comprehensive program of classroom support services, access to classroom communication is a unique challenge for deaf students. Here are examples:

1. Deaf students using an interpreter experience a "lag time" in receiving information. The interpreter will finish signing what has been said about 5–10 seconds after the speaker stops speaking, which can exclude deaf students from participating, since by the time the student has received the full message the instructor has already identified and called on someone else.
2. Deaf students may rely on speechreading for information. Yet instructors often break visual contact between the student and their speech while writing on the board, reading from papers held too close to their faces, or pacing back and forth.
3. In labs or computer courses, instructors may speak while manipulating physical objects or performing tasks on a projected screen. Deaf students must choose whether to watch the interpreter or the instructor/screen, losing half the information.
4. Deaf students are rarely included in informal exchanges among hearing students regarding instructor expectations, study tips, and unspoken rules for class behavior and organization, thus missing important but "unpublished" information.

These examples demonstrate that there is more to inclusive instruction than physical proximity and the provision of support services. Informal conversations, instructor styles and behaviors, student interactions, and the nature of the information being conveyed subtly but significantly shape the teaching and learning experience. In this article the focus is on these less obvious but equally important components of educational access.

The purpose of this study is to describe conditions that affect access to teaching and participation in learning by deaf postsecondary students in mainstream class settings. Critical areas explored include the perceptions of deaf and hearing students regarding communication and engagement within the class and the per-

ceptions of instructors regarding their teaching experiences with deaf students. We hope that this research will lead to the identification of strategies and conditions that enhance full academic access and accommodation of mainstream deaf college students.

Method

During the 1996/1997 academic year, instructors and support faculty working with deaf RIT students majoring in business, computer science, or information technology were invited to participate in a collaborative study of academic mainstreaming. Quantitative and qualitative research methods were used to collect data from students, instructors, and support faculty regarding academic inclusion. Quantitative tools include the Academic Engagement Form (AEF) and the Classroom Communication Ease Scale (CCES). Interviews were conducted with instructors using qualitative methods.

Academic Engagement Form. Engagement refers to the extent that students' efforts, persistence, and emotional states during learning activities reflect a commitment to learning and successful academic performance (Skinner, Wellborn, & Connell, 1990). Engaged students show persistence and interest in academic tasks and tend to achieve academic success. In this study, students were asked to respond to 114 items designed to assess affective and behavioral aspects of engagement. Items look at aspects of active learning, perceptions of teachers, strength of association with other students in class, and feelings of belonging at RIT. These items were adopted from the Rochester Assessment Package for Schools (RAPS), an instrument designed to assess a number of motivational dimensions with hearing students (Skinner et al., 1990). Additionally, students were asked four open ended questions covering class participation and belonging.

Communication Ease Scale. One way of assessing how successfully an inclusive environment promotes equal access to instruction is to compare the perceptions of deaf and hearing students about their ease or difficulty in communicating. For this study, a modified version of the CCES was used, in which communication ease is conceptualized as having two dimensions: a cognitive dimension and an affective one. The CCES (Garrison, Long, & Stinson, 1993), uses a six-alternative Likert scale to examine each dimension. The cognitive dimension is concerned with self-perceptions about the amount and quality of information that students receive and send. The affective dimension asks students to rate how they feel when communicating with hearing and deaf peers, teachers, and support staff. Both positive (feeling good, relaxed, comfortable, confident) and negative (frustrated, nervous, upset) affective responses are explored, and students responded to a total of 110 items. Additionally, students were asked two open-ended questions regarding their best and worst classroom communication experiences.

Deaf and hearing business ($n = 24$), computer science ($n = 4$), and information technology ($n = 48$) majors were paid $10 each to fill out the AEF and CCES. Hearing students were matched by gender, course, and major with the deaf students. Materials were placed in student departmental mail folders and students were informed about the study and reminded via electronic mail to return the questionnaires. Seventy-six students (46 deaf and 30 hearing) responded to the questionnaires. The average student was 23 years old; 26 were female and 50 were male.

Instructor interviews. Interviews are a conventional qualitative research technique used to explore in detail with research participants their experiences, beliefs, and perspectives regarding a particular idea, practice, circumstance, or event (Spradley, 1979). By asking individuals general questions and encouraging them to elaborate on their ideas through personal stories and examples, data are collected that can then be analyzed for code categories, that is, groupings of types of responses similar in nature. This approach often yields information inaccessible through traditional quantitative collection strategies.

A target number of 15–20 instructor interviews was established by the project team as sufficient to describe the range of experiences and perspectives of this group. A list of 31 potential instructors to be contacted for interviews was then developed by NTID faculty who provide tutoring for students enrolled in supported courses. In developing instructor lists, consideration

was given to the diversity of the group. Instructors new to RIT were included as well as those who had worked at RIT for many years. Instructors were selected who had different teaching styles and course structures (e.g., lecture versus discussion). Male and female instructors were included in each of the programs offered through Computer Science, Information Technology, and Business (including Management, Finance, Information Systems, and Marketing). This list was then organized so that, by working from the top of the list down, within programs, we would get the most diverse group possible.

Instructors were contacted via e-mail or telephone by one of the three researchers conducting the interviews. The project was explained, and instructors were invited to participate in an informal, semi-structured interview. The 17 interviews completed represent those who agreed to participate; approximately two-thirds were from the top half of names listed within their program. Interviews were conducted with instructors teaching courses in Computer Science (4 of 6), Information Technology (5/9), Management (1/3), Finance (3/6), Information Systems (2/3), and Marketing (1/2). The range of years teaching at RIT for the interview group was from 2 to 23 years, with an average of 12 years. Of the 17, 11 are male (from a total of 20 on the list) and 6 are female (from a total of 10).

Interviews lasted approximately 1 hour. Core topics covered in the interviews include instructors' perceptions of (1) deaf students enrolled in their classes, (2) barriers to access within their classes, and (3) strategies they use to facilitate access to their course materials. With the instructor's permission, interviews were recorded on audiotape.

Results

Quantitative Results

The first set of analyses focused on comparing the deaf and hearing responses to the Academic Engagement Form and its four open-ended questions. Deaf and hearing respondents were then compared on the Classroom Communication Ease Scale and its two open-ended questions.

The AEF was found to be highly reliable for both hearing (Cronbach's $\alpha = .96$) and deaf respondents ($\alpha = .92$). Deaf students reported being just as actively engaged in learning (mean = 4.08) as hearing (mean = 4.18) students when responses to the entire scale were analyzed. Responses to subscales indicated that hearing students felt more like they belonged at RIT and were more a part of the RIT family than did deaf students. Items such as ("I feel like I belong at RIT," "The people at RIT are like a family," and "I'm proud to be an RIT student") were somewhat more frequently endorsed by hearing students than by deaf students, $t(73) = 1.88$, $p = .06$.

Hearing and deaf students also differed on their perception of the appropriateness of the teachers' pace when presenting information. Deaf students less frequently, $t(74) = 4.21$, $p < .01$, perceived the teachers' pace (e.g., "My teacher makes sure I understand before he/she goes on," "My teacher makes sure that he/she doesn't teach faster than I can learn") as optimal for learning than did hearing students.

As part of the AEF, students were asked to supply their own words to the following incomplete sentence: "I feel like I am part of the classroom when I _____." Both groups reported that participation was the most frequent reason for feeling a part of the class. This sentiment was expressed by 66% of the hearing and 44% of the deaf students. Their comments are best captured by a deaf student who said, "participate and learn by doing" and a hearing student who said, "am encouraged to participate and allowed to figure things out for myself." Thirty percent of hearing students and 33% of the deaf students mentioned that they feel part of the class when they understand the material. Based on the comments of both groups, understanding the material allowed them greater participation, which was the key element to feeling part of the class.

What do students do when they have difficulty learning? Students responded to this statement: "When I get stuck, I _____." in their own words. Twenty-two percent of hearing students and 24% of deaf students said they use friends or classmates to help them when they get stuck. More deaf students (31%) mentioned going to the teacher for help than did hearing students (22%). Deaf and hearing students differed

with regard to their use of tutors and trying to "figure it out myself." Deaf students were less likely (15%) to try and resolve it themselves and were more likely to look to tutors for support (29%) than were hearing students (30% and 4%, respectively). This finding may be influenced by the support system available to deaf students at RIT. Deaf students in the majors under study have full-time faculty tutors available to provide assistance, whereas this support is not provided for hearing students. The availability of tutors and notetakers may also contribute to deaf students being less likely than their hearing peers to try and resolve learning problems independently.

Cronbach's alpha analyses indicated that agreement on the CCES was also highly reliable for hearing (α = .95) and deaf (α = .94) respondents. When overall ease of communication was examined, we were surprised to find no statistically significant differences between responses for the two groups, given the potential for communication difficulties when language interpretation occurs. That is, the deaf students (mean = 3.95) perceived the ease of communication with teachers and peers similar to their hearing peers (mean = 4.01). Deaf students' feelings about communication, both negative (nervous, frustrated, upset) and positive (relaxed, comfortable), were also very similar to their hearing peers'. This finding is important given the complexity and barriers to communication that exist for deaf students in mainstream settings. The success of interpreters and notetakers in providing equal access to communication for deaf learners in mainstream classes is highlighted by this finding.

Students were asked to respond to two open-ended sentences about communication using their own words. "Communication in the classroom is best for me when _____" and "Communication in the classroom is worst for me when _____." Deaf students' responses tended to focus on the role of the interpreter as a mediator of the quality of the communication. Sixty percent of the deaf students mentioned the interpreter when discussing the best communication. The student who said that the "interpreter is being effective with signing skills and understand the concepts in class" is representative of most responses. The complexity of being "effective with signing skill" is clear, insofar as some students refer specifically to the importance of ASL skills while other students mention how important it is for him or her to read lips or have an oral interpreter.

Hearing students' comments about the best classroom communication focused on the teacher being clear, easy to understand, and organized; the pace was not too fast; and the teacher involved students. One hearing student summarized the optimal communication environment as one in which "the classes are small to medium sized, [and] the teacher is interested in listening to the students (usually younger teachers)." Two hearing students indicated that having an interpreter in the classroom helped their comprehension because when "deaf students and an interpreter are present . . . the teacher moves slower in presenting the material which allows me to understand more." Both groups indicated that the instructor's pace influenced ease of classroom communication.

The interpreter was mentioned by 48% of the deaf students in their discussions of when communication in the classroom is worst for them. Not having an interpreter, or not being able to see the interpreter, was mentioned by a number of students: "There is no interpreter and I feel frustrated about participation." When the interpreter is present, the student may need a specific skill level and sign system that is not being accommodated: "The interpreters try to sign ASL and don't understand the content then sign most in English" or "The interpreter does not understand what I am saying, making me to repeat and forget what I wanted to say." Others pointed to the importance of the interpreter understanding the class material: "Interpreter couldn't perform his/her duty if he/she cannot understand the concepts of class." Thus, the central role of the communication facilitator is reflected in both the positive and negative communication experiences of deaf postsecondary learners.

Hearing students' difficulties with classroom communication focused on the pace of the teacher, distractions from other students, and teachers using "straight lecturing" as the primary form of information delivery. Again, the positive influence of deaf students in slowing down instruction was noted. One hearing student commented on how things are difficult for him when

deaf students are not in class. As he put it, "[when] there are not deaf students and the teacher is presenting material too quickly for me to understand, forcing me to exclude myself from class discussions and questions."

Qualitative Results

The quantitative data described before focuses on student perceptions of the teaching and learning experience. However, this is only one piece of the puzzle. Another important piece involves instructors' perceptions of what it is like to work with deaf students. How do instructors feel about teaching deaf students? Do they see differences in the performance or behavior of deaf students? What do they feel are the major barriers to access and participation for deaf students in their classes? Do they do anything differently or special to accommodate the needs of deaf learners? These and other questions were raised through qualitative interviews with 17 instructors who have had deaf students in their classes. Semi-structured interviews were used because this approach is more likely to yield the level of detail and "real-life examples" that we felt were crucial to understanding instructors' perspectives. Tape-recorded interviews were transcribed verbatim and the transcripts coded for recurring patterns and themes (Bogdan & Biklen, 1992). In this section, major topics are reviewed, drawing on the interviews for illustrations.

Who is responsible for access and accommodation? Instructors' comments suggest that there is diversity of opinion regarding the answer to this question. Their responses range from the perspective that the student and NTID are responsible for access and learning, to a perspective in which teachers see themselves as having primary responsibility for the success of deaf students. At a midpoint on this continuum is the notion of shared responsibility, in which instructors, students, support personnel (NTID), and college personnel (mainstream college) share responsibility for ensuring that instruction and learning are accessible for deaf students. Most comments fall somewhere between shared responsibility and the belief that NTID and the deaf students are primarily responsible. The degree to which instructors are willing to modify their classes, instructional materials, and evaluation procedures is an outgrowth of their perspectives about responsibility. The continuum in Figure 1 summarizes the range of both responsibility and instructor-generated modifications.

Comments that suggest that instructors have little or no responsibility to facilitate the inclusion of deaf students within their class and that learning is solely the responsibility of the student, hearing or deaf, with or without support services, were often framed in terms of "doing nothing different," and "it is the student's responsibility to learn." Instructional styles are not modified, nor is special attention given to deaf students or to hearing students who may have specific learning preferences or needs. The basic approach of these teachers is that they do not believe their instruction needs to be modified to fit the needs of any student. Deaf students are simply an extension of this approach, amplified by the level of resources provided by NTID and the large number of deaf students on the RIT campus. Implicit in this perspective is the notion that NTID has "leveled the playing field" by providing interpreters, notetakers, and tutors, and that instructors therefore can, and in fact should, proceed as usual. As one instructor put it, having deaf students in class is "transparent"; he further explains that this is a computing term meaning "that you are unaware that there is anything different." If support services are not provided or fail to accommodate the teacher's preferred approach, the responsibility for change rests with the support team and NTID. The following example illustrates this viewpoint:

> Instructor: The only issues that ever arise tend to be technical, like scheduling an interpreter . . . I run . . . 2-hour classes . . . and I don't take a break. And I am not going to take a break, and this can create difficulties with interpreters. And I have told the support team, "Look, if interpreters can only work for an hour for very logical and defensible reasons, I have no problem with that. Just send another one in at the end of one hour. . . ." And you know, they have to explain to me, "Well, the way we schedule them they need time to get from A to B." And so sometimes there has been a break in

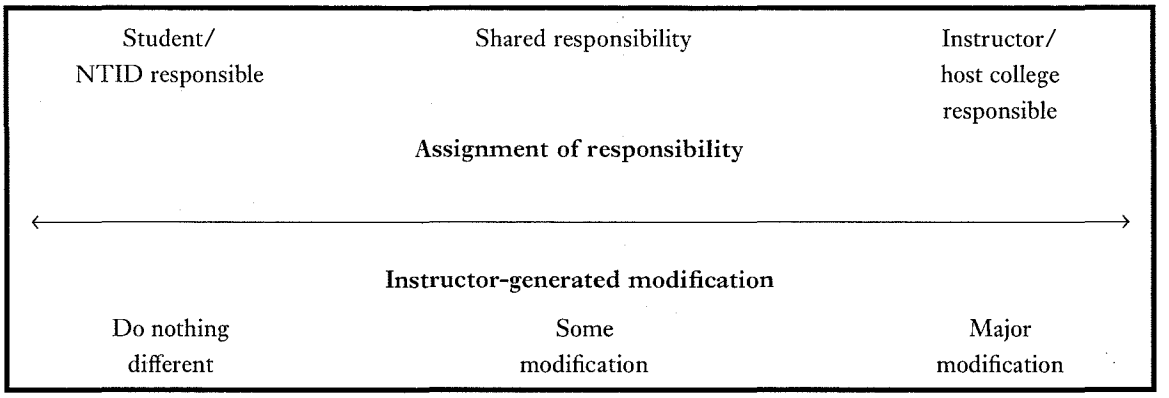

Figure 1 Continuum illustrating range of instructor comments regarding assignment of responsibility for accommodation of deaf students and instructor-generated modifications.

there where there is no interpreter. But it hasn't happened recently.

Interviewer: How do you handle that if that happens?

Instructor: I just teach. The same way I always teach.[1]

At the other extreme is the perspective that instructors play a central role in the success of all students in their classes, including deaf students. In this vein, one instructor said that he always reviews the notetaker notes in conjunction with test development or evaluation of grades in order to ensure that material covered on tests is available in the notes. He also makes allowances for the difficulties deaf students sometimes have expressing their thoughts in written English: "I don't grade hearing-impaired students the same as I grade hearing students. . . . I don't expect good grammar [from hearing impaired students]. I really look to see if it says one thing, to see if there is any way it could actually mean another, correct, thing. I won't do that with a hearing student."

Somewhere between these two extremes is the opinion that responsibility for accommodation of deaf students in mainstream classes is shared. One person described this in a holistic fashion: "It is an instructional system. . . . [Y]ou have got the professor, you have got the interpreter, you have got the notetaker, and you have a tutor . . . so, what I do is view us as a team."

Most instructors make at least a few accommodations for deaf students. Common examples include introducing the interpreter, making sure that there is a notetaker in class, and giving interpreters a break every hour. Others attempt to modify their instructional style or pace, or eliminate activities such as term papers, which they feel place deaf students at a disadvantage. However, even those who fall somewhere near the midpoint of this continuum tend to define NTID as having primary responsibility for deaf students.

Comparisons of deaf and hearing students' academic performance. A major concern raised by many instructors is that deaf students do not perform as well academically as hearing peers. Perceived reasons given include (1) lack of preparation, (2) lack of motivation, (3) overreliance or dependence on support systems, (4) inability of deaf students to get full information (interpreter difficulties, poor notetakers, indirect nature of support services for communication and learning), (5) poor English skills, and (6) the belief that mainstreaming is the result of "political correctness" rather than of sound academic practice. These perspectives are further reflected in instructors' suggestions for further research, which include a more systematic comparison between the grades of deaf and hearing students, the number of times they withdraw from a course or repeat it, and the relative success of deaf students taught by NTID support faculty as compared with those who receive instruction through interpreters.

Learning about deaf students and how to accommodate special learning needs. Instructors' experiences learning about

deaf students and possible accommodations span the gamut from one person with many years of classroom experience teaching deaf students prior to coming to RIT, to another who had no experience at all and was not even informed that he would be teaching deaf students. As he put it, "The first day I was here, I walked into a class with deaf students and an interpreter. I had never worked with one before, no one told me this was going to happen. . . . [F]or five minutes, [I thought] this is the strangest thing in the world! How am I going to do this? And, you know, then I watched the interpreter do her thing and it seemed OK and that was the end of it. . . . I said, 'Who are you?' She was standing up on the stage right next to me and I said, 'What are you doing here?' "

Most instructors, however, were neither as experienced nor as taken by surprise. They learned about deaf students from a variety of sources, often in a serendipitous fashion. Interpreters were often cited as important sources of information, likely because they are in the class with the students and instructors. Often, instructors said they ask interpreters for feedback on their teaching and invite them to tell them when they are speaking too quickly or need a concept repeated. Others said they go to support faculty when they need information. Trial and error is yet another learning strategy, as are informal conversations with departmental colleagues. Physical proximity often dictates who will be tapped for assistance and ideas. In one case, support faculty are housed in the same building as the instructors and often are queried when passed in the hall. Another department is adjacent to the interpreter support group, facilitating questions and communication support on an informal and "on the spot" basis.

Training and professional development Instructors were asked whether they would be interested in training and professional development regarding accommodation of deaf students within their classes. While many said they would be interested in having more information or ideas, most were not enthusiastic about investing much time or energy in these kinds of activities. For many, time was the biggest barrier to participation, particularly in combination with the perceived lack of benefit of this training. This low "cost-benefit" factor made many reluctant to participate in training efforts. Generally, their explanations for low interest levels were tied to the earlier assignment of responsibility to NTID for accommodation, or to the perception that participation would yield few benefits. Several instructors noted that deaf students are just a small percentage of their classes. Also, they may have deaf students only one out of three quarters or not at all. They find it difficult to justify taking time to improve instructional strategies for such a small group, particularly when their annual appraisals and increments are often tied to student evaluations (dominated by hearing students). As one person said:

> I don't think there would be a lot of incentive on my part at this point [to attend workshops about teaching deaf students] because the number of students is so small. I am worrying about the course evaluation scores of the 95% of the other students and some of the things that I do for the other students to improve the course for them will carry over to the hearing-impaired anyway. But to think up special strategies for that 5% of . . . hearing impaired that would just affect them, it is not worth it.

As this instructor cited notes, the most attractive instructional strategies benefit both deaf and hearing students. For most instructors in mainstream classes, deaf students are simply not even a minor consideration. One instructor made the following observation regarding the potential interest in the department for a workshop on teaching deaf students:

> [Having deaf students in class] is a nominal part [of what we do]. It is immaterial. They [colleagues] have only a couple [of deaf students]. They have an interpreter. They have notetakers. And they would get by in their office writing if there is not an interpreter present. And you know, in the meantime their focus is really on very different things. . . . [I]t would be very difficult in the context of the competition for their time and energy for them to view that [workshop] as very important. And I am not saying that because they view deafness as an unimportant social or professional issue. It is just that

there are not enough deaf students to justify that type of effort.

Central to this person's comments is the idea that instructors are busy and have many demands on their time. Research, publishing, curriculum development, and satisfying the instructional needs of the majority of their students take a priority in their schedules. Any efforts to provide information specifically focusing on deaf students must take this perspective into consideration.

Beyond the obvious: barriers to access for deaf students in mainstream college classes. In describing their instructional experiences, instructors were asked to discuss elements of successful instruction with all students and then to compare the impact of these practices on the deaf students in their classes. Analysis of their comments reveals several subtle barriers to access for deaf students in mainstream instructional settings.

The physical set-up of many classrooms creates barriers for deaf students by reducing the degree of direct contact between student and instructor. For example, when instructors were asked how they know whether students in their classes are "getting it," they generally spoke about watching the students for visual cues, including eye contact and body language. They readily admitted that this is less possible with deaf students, who often sit to the side of the room and focus on the interpreter. In a similar vein, an instructor said that he often steps down from the elevated stage and walks along the aisles when lecturing; however, he almost always walks along the aisle furthest from the deaf students, since he does not want to walk between these students and the interpreter.

Some teaching strategies and instructional styles make classroom learning more difficult for deaf students, even with interpreters and notetakers. For example, when instructors are writing a computation on the board and talking at the same time, students must choose whether to capture the comments by watching the interpreter or follow the computation by watching the board. Similarly, in many computer courses instructors project a computer screen and perform manipulations on this screen while describing or explaining their actions; again, deaf students must choose which half of the message they want to receive. While several instructors acknowledged that this is a problem, none was able to offer concrete ideas for improving access to this type of instruction.

Participation of deaf students is sometimes limited by differences in the ways that instructors respond to potentially disruptive behaviors in the class. The most frequently discussed example involves students' talking during lectures. Hearing students talk orally, or "with voice," while deaf students sign among themselves. Instructors said they ask hearing students to stop talking during lectures but often ignore the signed conversations of deaf students. When asked to explain this decision, they said that they speak to the hearing students because they find the spoken conversation personally distracting, or they feel it is distracting for other hearing students. Signed conversations, on the other hand, are not disruptive to the hearing students or to the instructor and are thus more often tolerated. Instructors sometimes added that they are reluctant to interrupt deaf students because they are unsure of what they are discussing. For example, they wonder if students are talking about the class material, which seems a legitimate reason for them to be talking. When asked if they would tolerate conversations about coursework among hearing students during class, they said that they would ask these students to share their question with the class so everyone could benefit but added that this is only possible because they could discern the nature of the conversation before deciding whether to intervene. By not asking the deaf students to share their conversations, they are indirectly limiting the participation of these students and perhaps contributing to the perception of deaf students that they do not "belong" at RIT as much as hearing students.

Discussion

Two themes emerge as important across both quantitative and qualitative findings. First, the perceptions of deaf students with regard to educational environments are generally not significantly different from those of hearing students. Both express similar levels of classroom engagement and communication ease. Both de-

fine participation and understanding of course material as central to their feeling a part of the class. Both indicate that instructors' pace influences their ease of communication in class settings. Their differences are more related to the specific vehicles through which they interact within their classes. For example, while overall communication ease is similar for both groups, deaf students emphasize the role of the interpreter in effective communication of information, while hearing students focus on the role of instructors. Similarly, while both agree that participation is important for feeling a part of the class, deaf students express this sentiment less frequently than hearing students, a result probably influenced by the constraints imposed by indirect communications with instructors and hearing students.

Second, the continuum of responsibility for classroom learning on which faculty vary affects both deaf and hearing students. At the one end are teachers who assume it is their responsibility to share information in a way that helps all students learn, regardless of hearing status. These teachers do not assume that there is something wrong with students who do not understand information. Instead, they assume there is something wrong with the interface between the teacher and the student, or perhaps with their own presentation. These teachers do not differentiate between their responsibility for hearing and deaf students. They want all their students to "get it." At the other end of the continuum are teachers who assume that it is nearly all the students' responsibility to understand information as it is given to them. These teachers do not differentiate between their treatment of deaf and hearing students as much as they emphasize that all students must learn for themselves and that the teacher is not responsible if someone does not "get it." These teachers do not focus on the teacher/student interface; they do not conceptualize an interface. While the special needs of deaf students push both ends of the continuum to extremes, there are nonetheless points along the same continuum that apply to all students and instructors.

Further study of this continuum and the kinds of interactions it represents between teachers and students yields implications for practice. For example, some hearing students commented that the slower pace of instruction used when deaf students are present is beneficial to them. Several instructors indicated that, while they tend not to make adaptations specifically for deaf students, they would do things to improve their overall teaching effectiveness if it enhanced their student ratings. It is therefore important to identify teaching practices that both meet deaf students' needs and are beneficial to all students.

The continuum also holds implications for student roles and responsibilities. While it is beyond the scope of this study, we have observed students (both deaf and hearing) who remain completely passive even when the instructors' pace is too fast to be understood or when course materials are confusing. We recommend further research that explores more fully the behaviors of students along this continuum, as well as strategies that students can employ to increase their access to learning.

What specific recommendations for practice emerge from this study? First, emphasis should be given to the similarities between deaf and hearing students and those instructional practices that enhance learning for everyone.

Second, instructors should be selected for interventions who are interested and willing to modify their teaching strategies to facilitate inclusion of all students. Furthermore, they should have sufficient and continuous exposure to deaf students in their classes. These instructors can then encourage and model good practices for their colleagues.

Third, intervention strategies should be practical and reasonably easy to implement. For example, it is not helpful to suggest that instructors "be more sensitive to deaf learners." More practical suggestions might include (1) seating interpreters near the lectern in order to decrease the visual distance between the instructor and the interpreter, (2) providing handouts of notes that will be displayed on the board during class, or (3) pausing and counting to five after asking a question to facilitate inclusion of deaf students, as well as hearing students who may need an additional few seconds to process information.

Fourth, strategies should be disseminated through user-friendly vehicles. For example, a web page that can be accessed at any time with a list of options (strategies, personal stories of frustrations and successes, and a chat room) may be preferable to traditional work-

shops that often disrupt busy schedules and require travel to central locations on campus.

Fifth, excellence in teaching should be rewarded. The power of professional recognition, merit increments, and positive appraisals cannot be underestimated in changing the behaviors of instructors.

In conclusion, mainstream postsecondary educational settings pose special challenges for deaf students. Interventions must be designed that are specific, involve changes in the behaviors of both students and instructors, and target and reward best practices and educational models. Additionally, the extended benefits of improved access to instruction for deaf students to all students must be emphasized. Efforts to focus attention only on deaf students is almost certain to meet with defeat due to the relatively small numbers of these students and the overall reluctance of college faculty to modify their practices for a single target group.

Note

1. The use of the notation " . . . " indicates that text from the interview is omitted. This is a space saving convention, generally used when there is repetition or extraneous material in the comment. A word or phrase inserted into the text by the researcher is set off with brackets. This is generally used for clarification.

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COMPUTER-ASSISTED REMOTE TRANSCRIPTION (CART): A TOOL TO AID PEOPLE WHO ARE DEAF OR HARD OF HEARING IN THE WORKPLACE

New technologies are needed that will allow people who are deaf or hard of hearing to participate fully in meetings held in

the workplace. Computer Assisted Remote Transcription (CART) is a procedure in which a stenographer transcribes a meeting from a remote location. This study investigated the feasibility of the CART system through an experiment and a case study. An experiment was conducted to learn whether a stenographer could transcribe a meeting of up to 10 speakers accurately from a remote location. In the case study, the CART system's usefulness and practicality were investigated in the workplace for a professional with a hearing impairment. The results indicated that, after a short familiarization period, a stenographer should be able to transcribe a meeting of up to 10 speakers with fairly good accuracy, but the results also revealed several problems with the practicality of the CART system in the workplace.

Evaluation of on-the-job performance and problems of people who are deaf or hard of hearing has consistently shown that one of their major difficulties is participation in meetings (Crammatte, 1968; Foster, 1992; Mowry & Anderson, 1993). Reported accommodations during meetings include the use of lipreading, notetakers, and American Sign Language (ASL) interpreters (Crammatte, 1968; Foster, 1992; Mowry & Anderson, 1993). Lipreading is often ineffective because it depends on the size of the meeting, the lighting and seating arrangements, and the ability and willingness of the hearing speakers to make lipreading available and to repeat information on request (Crammatte, 1968; Foster, 1992). Using a coworker as a note taker is also an inadequate accommodation. Notetaking is slow, and it causes a time lag (Crammatte, 1968). Some people who are deaf or hard of hearing receive written summaries of meetings after they are over (Foster, 1992); clearly, this is an inadequate solution. The use of an ASL interpreter is an effective accommodation for many people who are deaf or hard of heating; however, many adults who were deafened postlingually, or who were educated in oral environments do not have a good understanding of ASL and prefer English as their primary means of communication. In addition, ASL interpreters may be difficult to locate and to schedule, and more than one interpreter must be hired for longer meetings, driving up the cost. Clearly, there is a need for new options that will enable people who are deaf or hard of hearing to participate fully in meetings.

Many deaf students have used the Real Time Graphic Display of Speech (RTGD) successfully in the classroom (Stuckless, 1983; Stinson, Stuckless, Henderson, & Miller, 1988). In this system a professional stenographic captioner (stenographer) provides simultaneous, word-for-word transcription of a speaker's words. The stenographer types the speaker's words as phonetic symbols on a stenotype machine. The sterotype is connected to a computer that

translates the phonetic shorthand into English. This translation is achieved through the use of standard real-time captioning software, which stenographers can customize using a personal dictionary that recognizes their own shorthand techniques and the technical terms and proper names that are appropriate to the course material (Stuckless, 1983). The text is then displayed on a standard TV monitor that can be viewed by any student in the classroom.

Stuckless (1983) described the accuracy of the RTGD system in use at the Rochester Institute of Technology (RIT) for deaf students at the National Technical Institute for the Deaf. In this investigation, all transcriptions were performed by a single stenographer who was certified at 225 words per minute. The accuracy of the transcription was investigated for the stenographer in 10 different courses during one year. After two weeks of use in a course, the accuracy was found to be 85% correct. Transcription accuracy improved to 90% correct after two months in two new courses. After eight months it was found that the highest accuracy achieved was 95%; this varied by professor and course material. The stenographer was able to improve her accuracy as her familiarity with the professors and the course material increased. Another benefit of the RTGD system is that the transcripts are saved on disk and can be printed out as hard copies of class lectures. These can be distributed to all interested students.

In a second study at RIT, Stinson et al. (1988) investigated students' perceptions of the RTGD system in the classroom. They surveyed 121 students who are deaf or hard of hearing who took classes at RIT over a 3-year period. The students had other accommodations available to them, including trained notetakers, tutors, and ASL interpreters. Students were very pleased with the RTGD system. Overall, they reported that the RTGD system allowed them to understand 80% of the classroom material, while they understood 61% of the material with ASL interpreters. When asked which support service they would choose (if they could choose only one) 32% selected the RTGD system and 21% selected ASL interpreting. It appeared that students with better English oral skills preferred the RTGD system and students with better ASL skills preferred the ASL interpreter.

The RTGD system, which has been used successfully in the classroom, would seem ideal in the workplace as well. Stenographers can attend meetings on an as-needed basis. The stenotype machine can transmit directly to a notebook computer that contains the real-time-translation software, and the computer can be positioned so the person who is deaf or hard of hearing can read the material on the monitor As this technology becomes increasingly available, professional court reporters are becoming informed and excited about the new job opportunities available to them (Moody, 1995; Task Force on Realtime Reporting in

the Classroom, 1995). Two major problems may limit the usefulness of using stenographers in the workplace: the availability of stenographers on short notice for occasional work and the high cost associated with stenographers traveling to the workplace.

A possible solution to the high cost and availability of stenographers would be to work with stenographers at a remote location. The stenographer could listen to the meeting through a speakerphone and transmit the transcription through a modem. This could reduce the cost of the stenographer's time, because the stenographer would not have to travel to the workplace, thus reducing travel time and travel costs. In addition, stenographers could be more available for work in a situation such as this, due to the decreased travel time. If this system became widely used, stenographers could be available on a phone-in basis, just as relay service operators are available to interpret telephone conversations using Telecommunication Devices for the Deaf (TTYs).

There are, however, several concerns about the usefulness of CART in the workplace. One problem with this system is that at the present time it is quite cumbersome for a person who is deaf or hard of hearing to set up. It requires that a conference telephone system be connected to one outside phone line and a notebook computer hooked up to a second phone line. If new technology is not easily accessible it may not be used in the workplace (Sokol, 1994). A second concern regarding the usefulness of CART was brought up during the researchers' informal discussions with professional stenographers; stenographers report that it is difficult to understand meetings though conference telephone systems when more than two people are speaking. If the transcription service is only accurate for small meetings, this would severely limit the usefulness of this system. A third concern regards the use of stenographers who are unfamiliar with the speakers and/or jargon used in a meeting. If transcription accuracy is only adequate for familiar speakers and topics, this also limits the usefulness of the CART system

The purpose of the present investigation was to determine the feasibility of the CART system in the workplace. This was accomplished with an experiment and a case study. In the experiment, a professional stenographer transcribed meetings from a remote location (listening over a conference telephone) and from within the meeting room, while the number of speakers in the meeting varied from 2 to 10. The purpose of this experiment was to learn whether the accuracy of the stenographer's remote transcription would decrease as the number of people in the meeting increased. The stenographer transcribed two meetings from the remote location and two meetings from within the meeting room. The multiple-session design allowed us

to investigate practice effects on transcription accuracy. In the case study, the usefulness and practicality of the CART system was investigated for a professional who is deaf in the workplace.

METHOD Participants

Eight doctoral students and two faculty members in the Graduate Program in Speech and Hearing Sciences at the City University of New York participated in the meeting. The stenographer was a Registered Professional Reporter, certified at 225 words per minute.

Meeting

The topic of the meeting was "Graduate studies in audiology and speech pathology." All speakers were given agendas that listed discussion topics. The meeting was led by the first author. Prior to the meeting, the stenographer was given the agenda, a list of all the meeting speakers, and a list of technical terms related to audiology and speech pathology that, based on the agenda, might come up during the discussion.

Four separate sessions were held. During the first and the fourth sessions, the stenographer listened to the meeting over a conference telephone from a remote office. These two sessions were considered to be Trial 1 and Trial 2, respectively, for the remote location. In the second and third sessions, the stenographer was inside the meeting room. These two sessions were considered to be Trial 1 and Trial 2, respectively, for the meeting-room location. Each session consisted of five 5- to 10-minute blocks. During each block of time, 2, 4, 6, 8, or 10 speakers participated in the meeting. The order of the blocks was randomized within each session.

When the stenographer was at the remote location, the meeting speakers were asked to identify themselves by name before they spoke. Speakers also were asked to be sure that they were within three feet of one of the conference telephone microphones and to move the telephone module closer if necessary. When the stenographer was in the room, he sat at the same table as the speakers and was able to see most of the speakers' faces most of the time.

Equipment

The conference telephone was a Shure ST3500 ConferencePhone Teleconferencing System. This consists of a telephone interface box, an acoustic module, and two expansion modules. The telephone interface box supplies power to the system and interfaces between the acoustic module and the telephone and power outlets. The acoustic module consists of a keypad, a loudspeaker, and three condenser microphones. One or two expansion modules can be connected to the

acoustic module via 8-foot cables; each expansion module contains three condenser microphones.

The stenographer used a stenotype machine (Stenograph) connected to a notebook computer. The computer ran realtime software (Eclipse by Advantage), which translates the phonetic symbols from the stenotype into English (Advantage, 1997). The realtime software contains a personal dictionary that includes the phonetic inputs for a basic list of English words. Each stenographer modifies the personal dictionary to translate his or her personal stenotype shorthand. During realtime transcription, the realtime software searches first the personal dictionary then the job-specific dictionary for an English word to match the phonetic input. The software also uses grammatical knowledge to resolve conflicts when selecting appropriate English words.

The stenographer added the agenda information, proper names, and technical terms to his job-specific dictionary before the meeting. The transcript of each session was saved on disk in text format. The transcripts were printed out later for analysis.

Each session was videotaped. This provided a visual and an audio record of the meeting. The videotape was used to determine the accuracy of the stenographer's transcription.

RESULTS

The word-by-word accuracy of the stenographer's written transcript was verified by comparing it to the videotape of the corresponding session. A "percent-correct" score for each spoken phrase was calculated. A minimum of 50 phrases was spoken in each block within each session. Therefore, we analyzed the first 50 phrases in each block. We found a high degree of variability in the stenographer's performance. The data was collapsed in two ways prior to the statistical analysis to decrease the variability of the data and, therefore, prevent spurious findings. Within each block, performance for the first 25 phrases was averaged together and considered replication one, and performance for the last 25 phrases was averaged together and considered replication two. Within each session, performance for the listening blocks with 4 and 6 speakers was averaged together, and performance for the listening blocks with 8 or 10 speakers was averaged together.

The percent-correct scores were subjected to an arcsine transform to stabilize the error variance prior to an analysis of variance. We performed a fourway fixed effects ANOVA; the main effects were replication (first or second), trial (first or second), location (remote or in the meeting room), and number of speakers in the meeting (2,4-or-

6, or 8-or-10). The results were collapsed across the factor, replication, so this factor is not shown in the ANOVA table; the results of the ANOVA are shown in Table 1.

The main effects of location and number of speakers were significant. Follow-up tests were conducted using the Tukey HSD test with a .05 significance level. For the main effect location, the stenographer's accuracy was significantly poorer when he was listening from the remote location compared to when he was listening from within the meeting room. For the main effect number of speakers, accuracy with 2 meeting speakers was significantly better than accuracy with either 4-or-6 or 8-or-10 speakers. When there were more than 2 speakers, there was no tendency for decreased performance as the number of people in the room increased.

The untransformed percent-correct scores were transformed into error rates to ease visual comparisons; these are shown in Figure 1. The significant main effects found in the ANOVA analysis are apparent in the figure. The first block of four bars, (performance when there were 2 speakers) show the smaller error rate compared to the second and third blocks of bars, (when there were 4-or-6 or 8-or-10 meeting speakers). Within each set of bars, the first two bars (the remote location) almost always showed a higher error rate than the second two bars (the meeting-room location).

Another trend that was apparent in the figure is that, within each group of bars, the first bar was always higher than the second bar. This demonstrated that when the stenographer was listening remotely his error rate decreased during the second trial. It appeared that over time the stenographer became familiar with the speakers and the topics of conversation, and his performance improved. This improvement over time was not apparent when the stenographer was inside the meeting room. The tendency for improved stenographer accuracy as a function of the listening trial approached significance in the ANOVA analysis.

Analysis of the transcripts revealed two types of errors: (a) Words or phrases were omitted, or (b) Word or phrases were transcribed inaccurately. These two types of errors occurred with similar frequency across all four sessions. Many of the omitted words were repeated words or words that were not crucial for meaning; however, the stenographer did attempt to transcribe every word, regardless of meaning. When words or phrases were transcribed incorrectly, this was the result of one of three types of errors: (a) The stenographer heard the speech material incorrectly and transcribed the wrong words (hearing errors), (b) The stenographer entered the information correctly or one key off, and the words were translated incorrectly by

the stenographer's software (mistranslate errors), or (c) The stenographer entered the information correctly, but the words were not in the realtime software dictionaries and could not be translated (untranslate errors). Examples of these three types of errors are shown in Table 2. Most of the errors were technical terms or proper names. Hearing errors occurred when the stenographer typed an incorrect phonetic symbol. He heard the word incorrectly, probably due to room noise, a reduced speech level, and/or the absence of visual cues. Because the words were often technical words or proper names the stenographer was unable to use contextual information to determine the correct word. Mistranslate errors often occurred when the stenographer made a fingering error, pressing the wrong phonetic symbol during transcription. The realtime software then translated the wrong word. When this occurs, the realtime software often interprets the word boundaries incorrectly. For example, as shown in Table 2, the word normals became norms always. Untranslate errors occurred when the stenographer typed the correct phonetic symbols but the realtime software did not contain the term in its dictionary so it could not translate the word into English. Some errors were difficult to classify exactly, so we did not include them in the error classification. Certain errors that appeared to be mistranslate errors actually could have been the result of hearing errors. Of all types of errors, hearing errors appeared to occur most frequently. Approximately 48% of all errors were hearing errors when the stenographer was in the remote location and 37% were hearing errors when the stenographer was in the meeting room.

CASE STUDY

The CART system was used over an 8-month period by a person who is deaf who holds a management position in a large corporation. This participant was prelingually hearing impaired and is fluent in both English and ASL. He participated frequently in meetings of various sizes with coworkers who had normal hearing. He used ASLinterpreters at meetings, but at times he had difficulty scheduling an interpreter. In addition, some of the interpreters he used were inexperienced, and he felt that their accuracy was unacceptable for his needs.

The participant used the same Shure conference phone that was used in the experiment. The transcription was set up to be received on a Gateway 2000 Liberty notebook computer equipped with a 14.4 PCMCIAmodem. Initially, two pieces of software were installed for the CART system. Norton pcANYWHERE (Symantec) is communication software that allowed the notebook computer to communicate with the stenographer's computer. This software ran on both the deaf participant's computer (the alternate computer) and the stenographer's computer After a modem connection is made, the software allows the alternate computer to "enter" the stenographer's

computer. Therefore, everything that is seen on the stenographer's screen (the transcript of the meeting) can be seen on the alternate computer. The deaf participant also has a visual impairment, so MAGic 2.0 (Microsystems software) was installed, which doubles the size of the type displayed on the screen.

After the third attempt to use the CART system ended in failure, new software was used. The stenographer ran Legal Assist (Eclipse) communications software along with the realtime software; this permitted an ASCII output of the text. The participant received the ASCII output with REMCAN (remote computer-assisted notetaking), a DOS program developed at the Technology Assessment Program at Gallaudet University. In addition to receiving the ASCII output, it allowed the participant to control the scroll speed, the type size, and the typeface and to save the transcript to a file.

The participant and two of his assistants took part in several training sessions to learn how to use the equipment. They were instructed to ensure, prior to using the service, that the conference room had two single-line analog telephone jacks that they could use, one phone line for the conference telephone system and one phone line for the notebook computer. Because they worked in a large corporate office building, they had an in-house technical staff that could install phone lines on short notice. The participant and the assistants received written, step-by-step instructions regarding the use of the telephone system, the computer hardware and software, and the setup of the conference room.

The participant was given the following list of information that the stenographer covering each meeting would need: a list of all the meeting speakers, a meeting agenda, and a list of all technical terms that might be used in the meeting. This allowed the stenographer to enter the proper names and technical terms into the personal dictionary in the realtime software so they could be translated correctly from the phonetic shorthand. The participant also was told how the meeting should run to maximize the stenographer's understanding over the conference telephone system. He was told to ask meeting speakers to identify themselves each time they spoke, not to speak when someone else was speaking, and to keep the table clear of large objects (to allow for maximal sound transmission to the telephone system's microphones).

A summary of the participant's nine attempts to use CART is shown in Table 3. The first five attempts to use the system were unsuccessful; these were the result of preparation problems, software problems, and hardware problems. Preparation problems resulted from users' unfamiliarity with the setup of the telephone and computer systems.

Software problems were due to the incompatibility of the pcANYWHERE and the MAGic software packages. The hardware problems resulted from the modem's incompatibility with the phone line and from incorrect installation of the modem. After switching to new software and receiving new instruction on the use of the equipment, the participant finally had success with the system. Some problems persisted, however; these problems mostly resulted from the user's unfamiliarity with the equipment and the CART procedures.

Following each hookup, the stenographer and the deaf participant completed questionnaires about their impressions of the service. The participant had two major positive reactions to the service:

1. He felt that the transcription was quite accurate. In general, he felt that he was receiving the transcription with 85% accuracy. The participant felt that this accuracy was far superior to the accuracy he received with ASL interpreters. With ASL interpreters, he often felt that important information was lost in translation.
2. The hard-copy transcript of the meeting provided through this service was valuable because it provided a substitute for the notes the participant could not take while he was using an ASL interpreter, lipreading, or using the CART service.

The participant had two major negative reactions to the service:

1. He reported that, in a busy work environment where conference rooms are at a premium, it was difficult to schedule the extra time necessary to setup the CART service.
2. The system was not ideal for quick-paced discus, ions, due to the 2-to 3-second time lag. The participant always felt behind in the meeting discussion.

The stenographers reported that they were frustrated with the participant's insufficient familiarity with the procedures. They were not always given the list of the speakers prior to scheduled meetings, or they were given incomplete lists. The meeting speakers did not follow conference telephone etiquette, such as identifying themselves before speaking. Despite this, the stenographers consistently reported that they understood 85 to 95% of the meeting over the conference telephone system.

DISCUSSION Transcription Accuracy

The accuracy of the transcription was quite good. During the first session when the stenographer was out of the room and listening remotely, accuracy ranged from 87% correct when there were 2 people in the room to 78% correct when there were 6 people in the room. Overall performance was 83% correct in the first session. By the

fourth session, when he was again listening remotely, the stenographer had become familiar with the speakers and the material being discussed. Performance in the fourth session ranged from 92% correct when there were 2 people in the room to 87% correct when there were 4 people in the room; overall performance was 89% correct in the fourth session.

Stuckless (1983) reported transcription accuracy of 90% correct for a stenographer in a classroom after two months of experience in the setting. The stenographer in the present experiment achieved comparable accuracy after 2 hours.

Based on the present results, CART can be accurate for meetings of up to 10 speakers. Transcription accuracy will vary according to the skill of the stenographer However, it is likely that accuracy will improve as a stenographer works with the same client. This allows the stenographer to add to her or his personal dictionary and to become more familiar with the jargon and the speakers at a particular work setting. In addition, transcription accuracy is influenced by the quality of the conference telephone system and by how the meeting is conducted. Transcription accuracy should be greater for meetings in which speakers introduce themselves before they speak and take hams in speaking and where background noise is minimal.

Ease of Use

Sokol (1994) discussed what could be done to make implementing and using new technologies less frustrating. He pointed out that usability testing helps people modify problems and identify potential future enhancements. The usability testing conducted in the case study identified several problems and possible solutions.

Many of the problems were due to the cumbersome procedure required to set up the CART system. It often was difficult for the participant to arrange for a room with two properly installed single-line analog phone connections. New technologies are becoming available that should solve this problem. Modems are available that can transmit data and voice over the same telephone line. Once these are shown to be reliable, they can be used for CART. Another option is wireless communication. The conference telephone and/or the notebook computer could be adapted for wireless communication.

Other problems encountered in the case study were caused by software that was not designed specifically for CART use. To enhance communication between the stenographer and the system user, new software can be developed that both transmits and receives realtime transcription.

CONCLUSIONS

For CART to be a useful tool in the workplace, the system must be easy to set up and use, and it must allow for accurate, error-free transcription. If people who are deaf or hard of hearing are to rely on this service, they must be able to set it up, have confidence that it will work, and trust the transcription accuracy. This study demonstrated that, after a limited time for stenographer familiarization, users should be able to trust the transcription accuracy. However, the case-study results demonstrated that a more user-friendly hardware and software system is required.

ACKNOWLEDGMENTS

This research was supported in part by the Center for Applied Medicine and Applied Biotechnology (CABB) of the City University of New York and by the Rehabilitation Engineering Research Center on Hearing Enhancement and Assistive Devices at the Lexington Center for the Deaf, which is funded by the National Institute on Disability and Rehabilitation Research of the Department of Education under grant H133E30015. The authors thank the deaf volunteer, who spent many hours with the CART system in the workplace, and Don De Pew and Pat Graves, professional stenographers, who shared their time and expertise.

Table 1. Results of the Analysis of Variance

Legend for Chart:

A - Source
B - Degrees of freedom
C - Mean square
D - F ratio
E - Level of significance

A	B	C	D	E
Trial	1	.06	3.59	.0796
Location	1	.15	8.71[*]	.0118
Trial x location	1	.05	3.00	.1061
No. of speakers	2	.13	7.25[*]	.0087
Trial x no. of speakers	2	.02	1.11	.3610
Location x no. of speakers	2	.02	1.37	.2902
Trial x location x no. of speakers	2	.03	1.74	.2155
Residual	12	.02	--	--

* p<.05

Table 2. Errors in Transcription

Legend for Chart:

A - Type of error

B - Actual phrase
C - Transcribed phrase

A	B C
Hearing	This is good enough for a second level project. This is good fluff for a technical project.
Hearing	That's dichotic listening. That's psychotic listening.
Mistranslate	We tested a whole bunch of normals about 5,000 times. We tested a bunch of norms always about 5,000 times.
Mistranslate	... then we decided to try it out. ... then we design today try it out.
Untranslate	I don't know if the electrophysiology testing ... I don't know if the electric TROE physiology testing ...
Untranslate	I don't think that's dichotic, I think it's monotic. Not die cot EUBG, Monday on the EUBG.

Table 3. Case Study Outcomes

Attempt	Outcome	Reason for negative outcome
1	Failure	Preparation problem
2	Failure	Preparation problem
3	Failure	Software problem
4	Failure	Hardware problem
5	Failure	Hardware problem
6	Partially successful	Insufficient user familiarity with procedures
7	Success	--
8	Partially successful	Hardware problem and insufficient user familiarity with procedures
9	Success	--

GRAPH: Figure 1. Mean error rate as a function of the number of participants.

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By Jill E. Preminger and Harry Levitt

Dr. Preminger is an assistant clinical professor in the Division of Communication Disorders at the University of Louisville, Louisville, KY. Dr. Levitt is a distinguished professor in the Program in Speech and Hearing Sciences at the City University of New York, Graduate School, New York, NY.
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CART Legal Decisions

The primary purpose of the Communication Access Information Center is to provide information of use to people employing or in need of Communication Access Realtime Translation (CART), also known as realtime captioning. The site is sponsored by the National Court Reporters Foundation and supported by the National Court Reporters Association's CART Task Force. Click here for information on what NCRA is doing to increase the number of available CART providers.

What Exactly Is CART?

Communication Access Realtime Translation (CART) is the instant translation of the spoken word into English text using a stenotype machine, notebook computer and realtime software. The text appears on a computer monitor or other display. This technology is primarily used by people who are late-deafened, oral deaf, hard-of-hearing, or have cochlear implants. Culturally deaf individuals also make use of CART in certain situations. Please keep in mind that CART is also often referred to as realtime captioning.

The Americans with Disabilities Act specifically recognized CART as an assistive technology which affords "effective communication access." Thus communication access more aptly describes a CART provider's role and distinguishes CART from realtime reporting in a traditional litigation setting.

Communication Access Realtime Translation is an evolving and maturing profession, and the available technology associated with CART is rapidly advancing. Consequently, the information and guidelines listed here will be updated from time to time. Please check in often.

CART in the Classroom: Meeting the Communication Access Needs of Students Requires an Individual Approach

Students with hearing loss who have access to assistive technology such as CART are provided with the same opportunities to learn and grow as hearing students. This growing technology allows the student to take an active role in the classroom and meet his or her potential as a scholar. (PDF format) More...

Benefits of CART

CART Environments

Digital Hearing Aids

CAIC Home

NCRF Home

NCRA Home

NCRA Develops New Certifications for CART and Captioning

With Congress appropriating millions of dollars in order to establish and strengthen realtime writing programs, CART and captioning have increased in popularity as a profession. Schools receiving federal funds will train writers in order to meet the mandates set in the Telecommunications Act of 1996, which requires all new television programming to be 100 percent captioned by 2006 and allows greater CART access to those with communication access needs. More...

New Brochure Helps Consumers Market CART

Are you looking for a tool to help explain CART to those who will decide whether or not the service will be provided? If so, NCRA's new CART marketing brochure, "CART: Providing Equal Access to People Who Are Deaf or Hard of Hearing," might be just the thing you're looking for. The brochure offers a brief definition of CART, the many environments where it can prove effective, the benefits of employing this communication access service and where to go for more information.

Click here to view an Adobe version of the brochure. To purchase copies, call 800-272-6272 (TTY 703-556-6289 or msic@ncrahq.org) or visit the NCRA Online Store at www.NCRAonline.org.

NCRF/AJF Introduce Model Guidelines for CART in the Courtroom

To provide continuity in the provision of CART services in the legal setting, the National Court Reporters Foundation and the American Judges Foundation have developed model guidelines for the use of CART in the courtroom that offer a structure from which courts can draw in order to meet their individual circumstances. Courts can then manage the accessibility of CART services for people with hearing loss in a uniform and effective manner, benefiting both the court and the CART consumers. View the model guidelines.

How to Locate a CART Provider

If you're in need of CART, whether for the classroom, a doctor's visit or any other setting, here are some of the variables you need to consider when selecting a CART provider. You'll also find links to the two primary online directories of CART providers.

What Are the Benefits of CART in the Classroom?

The following paper, CART in the Classroom: How to Make Realtime Captioning Work for You, presented at the Instructional Technology and Education of the Deaf symposium at the National

Technical Institute for the Deaf in June 2001, explains the benefits of CART for students who are deaf or hard-of-hearing in an educational setting. The paper also discusses how CART providers can work effectively with instructors and coordinators of services to ensure that students with hearing loss receive the best communication access possible.

Researcher Aaron Steinfeld wrote his dissertation on the benefits of captions in the classroom setting. When he presented this information at a convention of the Alexander Graham Bell Association for the Deaf and Hard of Hearing (AG Bell), he was inundated with requests on the studies he used as starting point. He has allowed us to reprint this essay, in which he lists a number of those references, for the use of people who are petitioning for the use of CART in the classroom.

Meeting the Communication Needs of Children in School

The Individuals with Disabilities Education Act (IDEA) addresses the needs of children with disabilities. The following FAQ explains the procedure that should be undertaken for obtaining CART or some other communication access service in the education setting from elementary school through high school. Check out our IDEA FAQ as well as our State Education Agency Listings.

Meeting the Communication Needs of Postsecondary Students

Although CART is recognized in the Americans With Disabilities Act as an assistive technology which affords "effective communication access," obtaining CART service at some universities and colleges can often prove to be a challenge. Here are some resources that can help in your efforts to obtain CART in the postsecondary setting.

CART Legal Decisions

Check in to see the latest legal decisions affecting the terms under which CART is provided.

About NCRF

The National Court Reporters Foundation supports the court reporting and captioning professions through philanthropic activities funded through charitable contributions. Learn more about NCRF by visiting their web site.

About NCRA

NCRA is a 27,000-member nonprofit organization representing the judicial reporting and captioning professions. Members include

official court reporters, deposition reporters, broadcast captioners, providers of realtime communication access services for deaf and hard-of-hearing people, and others who capture and convert the spoken word into information bases and readable formats. Additional information is available by calling 800-272-6272 (TTY 703-556-6289), visiting NCRA Online, or via email.

Research and Publication Request

Date: February 18th, 2008
Client: Bill Clymer, PEN International
Topic: research, publications and guidelines related to the use of the internet to provide remote captioning or interpreting services for deaf students in post secondary settings

Search Terms: VRS (Video Relay Service) and VRI (Video Relay Interpreting)

Contents:

Introduction and Definitions

What is Video Relay Service? Internet Resource: http://www.sorensonvrs.com/what/index.php
Sorenson Video Relay Service (VRS) is a free service for the deaf and hard-of-hearing community that enables anyone to conduct video relay calls with family, friends, or business associates through a certified ASL interpreter via a high-speed Internet connection and a video relay solution (or VRS call option).

Disability Program Navigators, FAQs. Internet Resource:
http://disability.law.uiowa.edu/dpn/faqs/2006_04_17_adv.html
What are Video Relay Services (VRS) and Video Remote Interpreting (VRI), and how can video based communication services enhance access in the One-Stops for customers whose primary language is American Sign Language (or other manual sign language)?

Articles

Riehl, Bambi (2005). Beyond VRS: Video Interpreting in Postsecondary Environments. *RID Views, 22*(6), 17.
Deaf people and interpreters alike have become accustomed to video relay services (VRS). According to the GA-SK Newsletter, April-June, 2003, video interpreting (VI) has been used in the United States by deaf people in the telephone relay video environment since 2000, with many video relay service (VRS) businesses established in 2002 and 2003. Using VI in the postsecondary classroom environment is a newer endeavor. A recent survey of 110 institutions by the Midwest Center for Postsecondary Outreach found that only four campuses used or provided VI, some using portable equipment and others using classrooms equipped for distance learning courses. My campus, the University of Wisconsin-Milwaukee (UWM), has been experimenting with video interpreting for a campus in another part of Wisconsin. We learned much in the early days of our work and continue to look for ways to improve our service. To

examine postsecondary VRI, we can compare it to VRS through the lens of the four parameters established by Mary Lightfoot for the Spring 2005 Gallaudet online course, "video Interpreting: What is it? What can it be?" They are: ergonomics, legal, interpreting, and technology.

Lightfoot, Mary Henry (2006). Video Remote Interpreting... It's a Good Thing! *RID Views 23*(6), 2006, 1.

Video remote interpreting (VRI), where at least one of the participants is at a distance, is gaining momentum. It is rapidly becoming an accepted form of communication transmission in medical, legal, business, and educational settings. As a result, the number of companies that provide VRI services has shown dramatic growth in the past year.

Robitaille, Suzanne (2002). New Telecom Connections for the Deaf. *Business Week Online*, http://www.businessweek.com/technology/content/oct2002/tc2002109_4505.htm

Highlights the benefits associated with the web-based technology *Video Relay Service* for the hearing-impaired people. Advantage of making a business call outside the office for the deaf; Reason for the development of the technology; Similarity of the technology with instant-messaging platforms.

Robitaille, Suzanne (2004). Frustrating Signs at the FCC., *Business Week Online*, http://www.businessweek.com/print/technology/content/may2004/tc2004057_8783_tc116.htm?chan=tc

Discusses the significance of location to the use of *video-relay service* (VRS) by deaf people in the U.S. Advantages of the use of VRS by Stephen Hlibok, vice-president of the Global Private Client Group of Merrill Lynch in Columbia, Maryland; Provision of the Americans with Disabilities Act regarding equal telecommunications access of the deaf; Requirements for the use of the VRS by deaf people according to the regulations set by the U.S. Federal Communications Commission.

Sorenson Video Relay Serice – VRS – Expands Communication for Faculty and Students at the Oregon School for the Deaf, Business Wire, Online resource: http://findarticles.com/p/articles/mi_m0EIN/is_2003_Oct_22/ai_109108147/print

Sordyl, Samantha (2005). Saying It with Feeling: New Techonogy Lets Deaf, Hearing People Enjoy Richer Converstations, Washingtonpost.com http://www.washingtonpost.com/wp-dyn/content/article/2005/09/05/AR2005090501067.html

Research

Hughes, G.; Hudgins, B.; MacDougall, J. (2005). Remote sign language interpretation using the Internet
Communication Networks and Services Research, 2004. Proceedings. Second Annual Conference on 19-21 May 2004 Page(s):345 – 350.

A technological solution was investigated as a way of accessing sign language interpretation services from a remote location by people who are deaf. A number of participants including people who are deaf, health professionals, counselors, employers, and sign language interpreters were involved in communication simulations that mimic what occurs in health care delivery environments, counselors offices and employment settings. Our data suggests the use of Internet based video communication equipment can effectively be used to facilitate communication between hearing and deaf individuals. The impact of the delivery of sign language interpretation services over the Internet has the potential to dramatically change the way sign language interpretation services are delivered.

Kokko, J.; Kemppainen, E.; Rautavaara, A. (2007). Technology and Regional Social Structures: Evaluation of Remote Sign Language Interpretation in Finland in Lecture Notes in Computer Science 4554/2007.

During the years 2001–2004 STAKES implemented a national development project VETURI - networking interpreter services -. Its objective was to improve the preconditions for the availability and quality of interpreter services. The starting point for this development work was to provide a service with a sufficiently large population base, in the form of regionally co-ordinated network co-operation of a variety of stakeholders. A part of the service in the project was given as remote videophone service. Remote interpreting made an interpreter's work easier because she did not need to travel and was able to work from a familiar work location. New ways to produce services enabled the growth of remote interpretation service. Larger population base and service resources made it possible to bring service also there where it has not been earlier.

Steinburg, Joyce Sidra (2003). The Use of Existing Videoconferencing Technology to Deliver Video Remote Interpreting Services for Deaf Vocational Rehabilitation Clients 2003 Dissertation (can be purchased through UMI Dissertation Services)

This research examined the effectiveness of using existing videoconferencing technology, originally designed to deliver distance learning, to support Video Remote Interpreting (VRI). The purpose of the study was to demonstrate that the technology could facilitate a two-way counseling exchange between a non-signing Vocational Rehabilitation (VR) counselor and a deaf ASL client, in situations when there are no local interpreters available. The study involved 37 deaf clients who participated in VR interviews in which American Sign Language (ASL) interpreting, by CI/CT certified interpreters, was delivered either locally [control condition] or on video from a remote location [experimental condition]. Comprehension of VR programmatic material and satisfaction with the interview process were measured using a questionnaire developed by the researcher. The data were analyzed using group means, Standard Deviations, and t-tests of Independent Means.

Policies and Procedures

Canadian Network For Inclusive Cultural Exchange. Internet resource: **http://cnice.utoronto.ca/guidelines/guidelinescomplete.pdf**

These guidelines give a comprehensive review of existing web accessibility guidelines before beginning a discussion of accessibility techniques specific to online cultural content. The document outlines key considerations for creating inclusive online cultural content as well as for translating existing content to other modalities to make it accessible. Suggestions and guidance are provided to the reader around the concept of modality translation for each kind of translation specific to the online environment. Techniques for moving content between audio, visual, tactile and language modalities are discussed and explained at length.

Canadian Network for Inclusive Cultural Exchange (CNICE) Creating Accessible Online Cultural Content Discussion Document Series. Internet resource: http://cnice.utoronto.ca/guidelines/asl.php

Video communication or video conferencing is becoming a much more commonly used and effective means of interpersonal communication (Finn, Sellen & Wilbur, 1997) such as for distance learning, business meetings and social communication. As hardware becomes more available and less expensive, and software, signal processing and compression technologies become more stable and efficient, there is an increasing interest and experimentation with the technology by the general public and by business.

Parton, Becky Sue (2007). Distance Education Brings Deaf Students, Instructors, and Interpreters Closer Together: A Review of Prevailing Practices, Projects, and Perceptions. *International Journal of Instructional Technology and Distance Education*. Internet Resources: http://www.itdl.org/Journal/Jan_05/article07.htm

Distance education is becoming increasingly common in the general population – a trend that is mirrored in programs for students and professionals involved in Deaf education. A review of the literature reveals three distinctive target groups within Deaf education for which distance education serves to advance learning agendas: Deaf students, instructors, and interpreters. This paper will first endeavor to identify and describe the ways in which distance education is positively contributing to Deaf education and training. As a secondary goal, the special considerations and modifications necessary for successful implementation of a distance-learning module targeted toward Deaf students will be discussed. Videoconferencing designed especially for Deaf elementary and high school students, appears to be the most common and successful form of distance education currently since it accommodates American Sign Language communication.

VIDEO RELAY SERVICE INTERPRETING. The Registry of Interpreters for the Deaf, Inc., (RID) Standard Practice Paper (SPP). Internet Resource: www.rid.org/UserFiles/File/pdfs/**Standard_Practice_Papers**/Drafts_June_2006/VRS_SPP.pdf

VRS has revolutionized communication access for deaf people and has had a profound effect on the interpreting profession. RID will continue to work as a resource to consumer groups and the FCC as it represents the interests of the interpreters who serve as the heart of this remarkable service. For more information, please visit the RID website at www.rid.org or contact the RID national office.

Company provides Online Interpreting
Company provides Online Interpreting AND Online Captioning and/or CART
Company provides Online Captioning and/or CART

COMPANY NAME	WEBSITE	ONLINE INTERPRETING	ONLINE CAPTIONING
Birnbaum Interpreting Services (BIS)	http://www.bisvri.com/	YES	
Communication Services for Deaf	http://www.c-s-d.org	YES	
Communications Access Center	http://www.cacdhh.org/vrisvc.html	YES	
Deaflink Inc	http://www.deaflink.com	YES	
MEJ Personal Business Services	http://www.mejpbs.com	YES	
Network Interpreting Services	http://www.networkinterpretingservice.com	YES	
Sign Language Assoc, Inc	http://www.signlanguage.com	YES	
Sign Language Interpreting Services, LTD	http://slisva.com	YES	
SignOn VRI	http://www.signonvri.com/	YES	
Sorenson VRS	http://www.sorensonvrs.com	YES	
Southern Ill University	http://www.siu.edu/~dss/distance.htm	YES	
Viable VRS	http://www.viable.net	YES	
Accommodating Ideas, Inc.	http://www.ai-ada.com/	YES	YES
Deaf Services Unlimited	http://www.deafservicesunlimited.com	YES	YES
Fluent Language Services	http://deafcomm.net/contact.htm	YES	YES
American Sign Language, Inc	http://www.asli.com		YES
Caption First	http://www.captionfirst.com		YES
ecaptions.com	http://ecaptions.com		YES
Remote CART	http://remotecart.org		YES
Sign Shares	http://www.signshares.com		YES
Texas Closed Captioning Services	http://www.texascaption.com		YES
Viable Technologies	http://www.viabletechnologies.com		YES
Visual Language Interpreting	http://www.vli-dc.com		YES
Western Interpreting	http://www.westerninterpreting.net		YES

Start your career path with CSD. Read here to find our job openings, and even apply online. Your future with CSD begins today.

CBI/VRS Sign Language Interpreter (PTOCC) (Austin, TX)

Community Interpreter/Video Interpreter (Part-Time Occasional)

Position Description:

Provide video interpreting service for Deaf, Hard of Hearing and Hearing consumers based in a Video Interpreting Center working with a pool of Video Interpreters and Management support. Provide Community-Based Interpreting services.

Essential Functions:

1. Provide video relay service and video remote interpreting service between Deaf, Hard of Hearing and Hearing consumers.
2. Provide Sign-to-Voice and Voice-to-Sign interpreting/transliterating services via Video Conferencing technology or in community setting.
3. Comply with policies and procedures as outlined by CSD's Interpreting Division.
4. Maintain strict consumer confidentiality.
5. Other projects/duties as assigned.

Qualifications:

6. National or state certification Level III or above, NAD Level 4/5 or RID CI/CT/CSC.
7. Must have a good working knowledge of interpreter code of ethics.
8. 3-5 years interpreting experience in a variety of settings.
9. Experience with Video Interpreting preferred.
10. Strong understanding of Deaf culture.
11. Familiarity with Windows-based software.
12. Good articulation and voicing skills.
13. Ability to work well under pressure.
14. Sensitivity to consumer needs.

Salary: Commensurate with experience and qualifications

Benefits: Employee Assistance Program.

Application Deadline: Until filled

Send online application, resume and cover letter to:

Barbara M. Forinash, SPHR
Human Resources Director
Communication Service for the Deaf
102 North Krohn Place, Sioux Falls SD 57103
(800) 642-6410 or (605) 367-5760 Voice
(605) 782-8454 FAX
bforinash@c-s-d.org

sorenson VRS | What is VRS? | VRS Call Options | Apply for a FREE VP | ASL Videos | Support | Company

What is Video Relay S ?

Apply for a **FREE Sorenson videophone**

VIDEOPHONE DIRECTORY
> Find VP Numbers

NEED HELP?
> Contact Support

HEARING CUSTOMERS
> Place a VRS Call

DOWNLOAD VRS CONTACT CARDS
> Create VRS contact cards

WARNING:
Sorenson Communications is Not Conducting a Lotto.
Protect Yourself Against Scams.
> Read More

WHAT IS VRS?

Sorenson Video Relay Service (VRS) is a free service for the deaf and hard-of-hearing community that enables anyone to conduct video relay calls... > Read More

911 VRS Calls > More Info

ASL VIDEOS

New Videos > Watch
VP-200 Videos > Watch
Call Waiting Videos > Watch

New VRS Video Testimonials
> Watch

Watch All Videos > View

COMPANY NEWS

Sorenson Communications Training Series Helps Prepare Interpreters to Become RID Certified
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Calendar of Events > View
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> PLACE A VRS CALL > WHERE IS MY VP? > JOBS
> UPDATE YOUR PERSONAL INFORMATION

In Partnership with Gallaudet Interpreting Service

SERVICE PROVIDED BY SORENSON COMMUNICATIONS > GO TO THE SORENSON COMMUNICATIONS WEB SITE

Contact / Legal / Disclaimer

What is VRS?

> Frequently Asked Questions

> Placing a Video Relay Call

> Request More Info

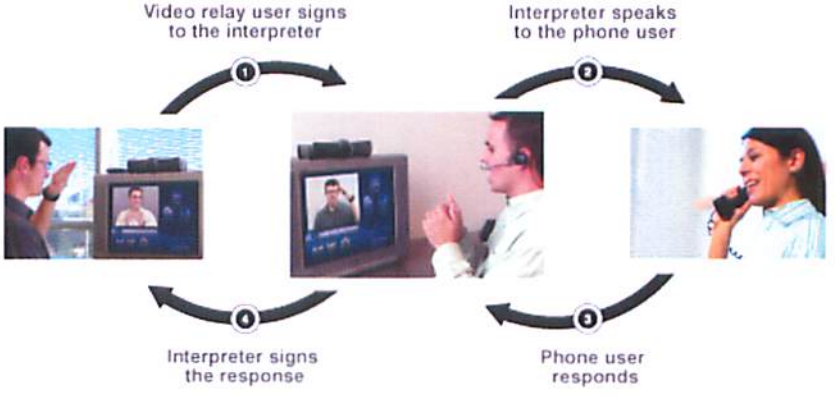
What is Sorenson VRS?

Sorenson Video Relay Service (VRS) is a free service for the deaf and hard-of-hearing community that enables anyone to conduct video relay calls with family, friends, or business associates through a certified ASL interpreter via a high-speed Internet connection and a video relay solution (or VRS call option).

Freqently Asked Questions

Who is Sorenson VRS for?

Video relay calls are placed over a high-speed or broadband Internet connection (i.e. DSL, cable, or T1 line) through an easy-to-use Sorenson VP-100 videophone appliance connected to a TV, or through a personal computer equipped with a Web camera and Sorenson EnVision SL (or Microsoft NetMeeting) software. The deaf user sees an ASL interpreter on their TV and signs to the interpreter, who then contacts the hearing user via a standard phone line and relays the conversation between the two parties. Hearing customers can also place video relay calls to any deaf or hard-of-hearing individual by simply dialing the toll free number 1-866-FAST-VRS (1-866-327-8877) with a standard telephone.



How do I place a video relay call?

Both deaf and hearing users can place a video relay call through Sorenson VRS. To find out more, please click the button below.

Placing a Video Relay Call

How much does a video relay call cost?

All Sorenson VRS calls are free. For high call-volume customers a free Sorenson VP-100 videophone is available.

For customers who prefer to use their existing PC and Web camera, Sorenson EnVision SL, the industry's best video relay software for the personal computer, can be downloaded for free. NetMeeting is also a free download.

How can I find out more about Sorenson VRS?

To find out more about Sorenson VRS, please fill out the request for more information form by clicking on the button below.

Request More Info

> PLACE A VRS CALL > WHERE IS MY VP? > JOBS
> UPDATE YOUR PERSONAL INFORMATION

In Partnership with Gallaudet Interpreting Service

SERVICE PROVIDED BY SORENSON COMMUNICATIONS > GO TO THE SORENSON COMMUNICATIONS WEB SITE

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Law, Health Policy & Disability Center

Disability Program Navigators
& Work Incentives Grantees

DPN FAQs

April 17, 2006 - *[Advanced]*

" What are Video Relay Services (VRS) and Video Remote Interpreting (VRI), and how can video based communication services enhance access in the One-Stops for customers whose primary language is American Sign Language (or other manual sign language)? "

Back to FAQ index

Answer

The Registry of Interpreters for the Deaf, Inc. (RID), a national organization of professionals who provide sign language interpreting/transliterating services for *d/Deaf and hard-of-hearing individuals, proposes that video based communication provides many benefits to *d/Deaf and hard-of-hearing citizens by allowing real time communications and native language accessibility, leading to increased career, educational and social opportunities. While sign language interpreting has been a recognized profession for only forty years, video based interpretation has only been around for the past couple of years. There is still much ongoing research into issues surrounding effective practices and standards, especially given the strong code of ethics and professional standards in the sign language interpreting profession. Therefore, before making recommendations on implementing video based communication in your One-Stops, it is important to first assess the need and market for the services in your community, as well as the compatibility of technology in your One-Stops.

A. Video Relay Services (VRS)

Video Relay Service (VRS) makes it possible for individuals who use sign language (American Sign Language or other manual forms of English/Spanish) to communicate via video-conferencing with a video interpreter through the internet and webcam. The sign language user communicates with the video interpreter via webcam, who then voices/relays the signed conversation over the phone -in real time- to the hearing caller. By using sign language over the full motion video, sign language users may fully communicate in their natural language and convey facial expression and cues to ensure nothing gets lost in the translation. With VRS, there's no typing, no extended delay, and no "GA"s ("Go Ahead" in TTY turn-taking lingo), which can make for hassle-free, faster communication that flows as freely as a natural conversation. As one deaf VRS user states, "for many deaf people, particularly those not yet fluent in English, video relay services that use broadband and webcams are faster and easier to use", (About.com, 'Internet Relay Services, Making Calls with Convenience' 2006).

Video Relay Services are free of charge to all telephone users, d/Deaf or hearing, as mandated by the Americans with Disabilities Act. The Federal Communications Commission (FCC) regulates VRS services and provides the services under contract with a number of agencies. VRS cannot be used as a substitute for in-person interpreting services where both d/Deaf and hearing consumers are in the same

location; VRS may only be used when consumers are connecting with one another through a telephone connection. Be sure to read and share the federal guidelines for using VRS with your One-Stop management and staff before implementing and marketing the system to customers (a web link to these regulations is listed below in **Resources**). The FCC indicates that VRS has become a very popular service and offers many benefits to its users, including the following:

- VRS allows persons whose primary language is American Sign Language (ASL) to communicate in ASL, instead of having to type what they want to say.
- Because consumers using VRS communicate in sign language, they are able to more fully express themselves through facial expressions and body language, which cannot be expressed in text.
- A VRS call flows back and forth just like a telephone conversation between two hearing persons. For example, the parties can interrupt each other, which they cannot do with a TTY call (where the parties have to take turns communicating).
- Because the conversation flows more naturally back and forth between the parties, the conversation can take place much more quickly than with text-based Relay Services. As a result, the same conversation is much shorter through VRS than it would be through other forms of text-based Relay Services.
- VRS calls may be made between ASL users and hearing persons speaking either English or Spanish.

Resources

For more information on the technical specifications to make Video Relay Services available in One-Stops for sign language users (i.e., computer, internet, software and video camera requirements, as well as Firewall support and Macintosh compatibility), visit the websites of VRS providers:

- Federal Communications Commission (FCC) Regulations for Telecommunications Relay Services (TRS) pursuant to Title IV of the Americans with Disabilities Act (ADA), Pub. L. No. 101-336, § 401, 104 Stat.327, 366-69 (adding Section 225 to the Communications Act of 1934, as amended, 47 U.S.C. § 225)
  http://www.fcc.gov/cgb/dro/4regs.html
- Federal Communications Commissions - FCC Consumer Facts on Video Relay Services
  http://www.fcc.gov/cgb/consumerfacts/videorelay.html
- Federal Video Relay Service (FedVRS), for federal employees
  http://www.fts.gsa.gov/frs/vrs.htm and http://www.fedvrs.us/

  FedVRS allows natural telephone communication between sign language and standard phone users.

- Directory of Video Relay Service Providers
  http://www.tdi-online.org/tdi/fs_videorelayservices.html

  This material was compiled by TDI to provide information on the various options in Telecommunication Relay Services throughout the United States. TDI is a resource and advocacy center promoting equal access to telecommunications and media access for people who are deaf, late-deafened, hard-of-hearing or deaf-blind. It includes information on VRS options, as well as links to Video Relay service providers.

B. Video Remote Interpreting (VRI)

Video Relay Service is not the same as Video Remote Interpreting (VRI). With VRI, both the *d/Deaf and hearing individuals are located in the same room and the interpreter is in a remote location. Instead of having an interpreter physically present with the d/Deaf and hearing parties, the interpreter is located at another location and facilitates communication through a video connection, saving the cost of mileage, travel time, and two-hour minimums. VRI can be used in situations such as staff meetings, doctor visits, conferences, or training sessions. Many businesses can utilize the teleconferencing equipment that they already have on site. Keep in mind that conversations may be a little slower than having an interpreter present in person, due to occasional technical glitches. Also, reading sign language on a two dimensional screen is more difficult than watching a live person, so signs may need to be slower and more clear, necessitating a slightly slower pace.

While many still feel there is no substitute for highly qualified "in person" interpreting service, VRI may be the only option in several situations and may be appropriate when:

- You have no local interpreter available.
- Your regular interpreter is out sick or otherwise not available.
- The local interpreter is not qualified for the situation.
- You prefer not to involve a local interpreter in a very private matter.
- The travel costs for the interpreting service are too expensive.
- You need the interpreter **RIGHT NOW**! (24/7 Availability).
- You have high speed internet available in your meeting location.
- You can move your meeting to a location that has high speed internet access.

Conversely, according to SignOn, a communication access consultation service, VRI may not be optimal in some of the following situations in which in-person interpreting services may better suit communication needs:

- Situations which are highly emotionally charged.
- Situations with many participants.
- Situations with individuals who are deaf-blind.
- Situations with individuals who are not frequent users of interpreting services.
- Situations with children.
- Situations with some individuals who are mentally ill.

Resources

- Video Interpreting Standard Practice Paper (Draft) & VRI FAQs (Registry for Interpreters (RID) http://www.rid.org/VIC_SPP11_05.doc

  RID's Standard Practice Papers (SPPs) outline the standard practices and positions on various interpreting roles and issues. These SPPs are excellent resources to educate all interpreters, as well as to pass out to customers who are both hearing and deaf, the general public, business contacts, school personnel, doctors and nurses, etc. The Video Interpreting Committee submitted a proposed Video Interpreting Standard Practice Paper for adoption at the RID National Conference in San Antonio, Texas, July, 2005.

- Video Remote Interpreting (VRI) and Computer Aided Real Time (CART) Captioning Services in Minnesota Workforce Centers: A Technology Project to Improve Job Access Opportunities http://sunsite.utk.edu/cod/pec/products/2002/ (scroll down to abstract in Section V: Using Technology)

This session described and reported the results of the Video Remote Interpreting (VRI) pilot project that used videoconferencing technology to help increase access to WorkForce Center services in three Greater Minnesota locations. Through the project, deaf and hard of hearing (DHH) consumers accessed VRI and computer aided real time (CART) captioning services. While DHH consumers prefer face-to-face communication, direct and timely communication is not always possible due to the shortage of qualified interpreters and captioners, particularly in rural Minnesota. The pilot project pooled resources of the U.S. Department of Labor; U.S. Department of Education - Rehabilitation Administration; Minnesota Department of Economic Security - Rehabilitation Services; CSD of Minnesota; The University of Arkansas - Little Rock Rehabilitation Research & Training Center; and the Minnesota Department of Human Services Deaf and Hard of Hearing Services. The full article can be accessed at: http://sunsite.utk.edu/cod/pec/products/2002/latz.pdf

- Video Etiquette – Emily Post Etiquette Advantages
  http://www.emilypost.com/etiquette/technology/video_conference.htm
- SignOn: Communication Access & Consultation for d/Deaf, Deaf-Blind, and Hard-of-Hearing People
  http://www.signonasl.com/video.htm

  SignOn's mission is to provide quality interpreting services to the community and to foster continued growth and development in the profession of interpreting. VRI uses videoconferencing technologies to access sign language interpreting services without an interpreter on site. SignOn can provide this service to customers all over the country.

NOTE: Big "D" Deaf vs. little "d" deaf Using a capital "D" for Deaf is a cultural distinction, while small "d" refers to physical deafness. You may also see d/Deaf, which refers to both those who have a hearing loss and do not associate with the Deaf culture, as well as those who do follow the culture. Culture results from a group of people coming together to form a community around shared experience, common interests, shared norms of behavior, and shared survival techniques. The essential link to Deaf culture among the American deaf community is American Sign Language and a common sense of pride in their culture and language. For more on Deaf culture - http://www.aslinfo.com/deafculture.cfm.

NOTE: 'Deaf-first' language In the d/Deaf community (which can include d/Deaf, hard-of-hearing, or hearing people), to say 'Deaf person' or 'd/Deaf & hard-of-hearing people' is widely accepted and used by the leaders in this community like the National Association for the Deaf, Registry for Interpreters and Gallaudet University. The belief behind this is that many people in the Deaf community feel that it is good and right to be deaf and saying 'Deaf person' is a positive term, indicative of pride and a communal identity. Some Deaf people prefer 'Deaf person' to 'person who is Deaf', as this is how they identify themselves and do not feel that this labels them as having a disability. In most cases, when reference is made to the d/Deaf and hard-of-hearing community, the Deaf cultural aspect (that is, the term Deaf as a positive identification and not as a disability) takes the lead and cultural rules apply.

Note to DPNs: If you have comments, suggestions or questions relating to the above topic, please email Jamie Robinson at Jamie-Robinson@uiowa.edu. They may be added to this FAQ and the archived one on the One-Stop Toolkit website.

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DPN Checklist - updated Aug, 2007 New!

DPN Checklist (text only) - updated Aug, 2007 New!

Related Resources

- 2005 Top 15 DPN FAQs (.doc)

more money for their work. Recent events in Arizona demonstrate this phenomenon and offer hope that educational institutions, driven by the VRS economic increases, are finally recognizing the vital role and worth of their interpreters.

While VRS is a wonderful service for deaf persons desiring equal telephone access, access to qualified live interpreters for medical appointments, work-related communications, and community events is also imperative to full access for the deaf community. The deaf community is becoming vocal about the effects of the mass exodus of long time community interpreters to the call centers.

There are three VRS centers competing for interpreting resources in the Washington, D.C. area. While the area is home to many interpreters, the impact of VRS is still being felt. Rumors of a fourth company looking to open in this already saturated market are causing new concerns. But the problem is most keenly felt in smaller communities around the nation.

A number of cities host one or more VRS centers, many with limited supplies of qualified interpreters. Agencies in these communities are struggling to fill community service requests without their normal resources. Many of the preferred interpreters are less available to the community because they are now scheduled in VRS.

Interpreters and agencies must be aware of the concerns coming from the deaf community. It is essential that we consider possible solutions. SLA now trains all certified staff members to allow for more scheduling flexibility between VRS and community work. Rotation systems assure our consumers that our highly qualified staff is available to the community on a regular basis. When we receive specific requests for one of our video interpreters, we can often rearrange schedules to accommodate the need.

We are actively recruiting new interpreters for both community and VRS work. This will allow us to better respond to the needs of the community while assuring interpreters of the benefits and perks found in the VRS environment.

Finally, we are looking at video technology to solve some of the problems. Video remote access may become an answer for the communities feeling the strain of fewer available qualified interpreters.

The field is in the midst of a supply and demand transition. In order to adjust to the changes, we need to improve working relationships between the interpreting offices, the interpreters and the Deaf community.

VRS is a wonderful tool for deaf people.

VRS has meant new job opportunities and increased salaries for interpreters.

As individuals, businesses, and as a profession, we must celebrate what this means for our field and at the same time recognize the dangers of losing interpreters from the community. We need to look for proactive ways to assure a healthy balance between video and community interpreting. ■

Beyond VRS: Video Interpreting in Postsecondary Environments

By Bambi Riehl, CI and CT
UW-Milwaukee Deaf/Hard of Hearing Program, Midwest Center for Postsecondary Outreach

Deaf people and interpreters alike have become accustomed to video relay services (VRS). According to the *GA-SK Newsletter*, April – June, 2003, video interpreting (VI) has been used in the United States by deaf people in the telephone relay environment since 2000, with many video relay service (VRS) businesses established in 2002 and 2003. Using VI in the postsecondary classroom environment is a newer endeavor. A recent survey of 110 institutions by the Midwest Center for Postsecondary Outreach found that only four campuses used or provided VI, some using portable equipment and others using classrooms equipped for distance learning courses. My campus, the University of Wisconsin-Milwaukee (UWM), has been experimenting with video interpreting for a campus in another part of Wisconsin. (This project was sponsored by UWM, the Wisconsin Department of Workforce Development and the Division of Vocational Rehabilitation.) We learned much in the early days of our work and continue to look for ways to improve our service. To examine postsecondary VRI, we can compare it to VRS through the lens of the four parameters established by Mary Lightfoot for the Spring 2005 Gallaudet online course, "Video Interpreting: What is it? What can it be?" They are: ergonomics, legal, interpreting, and technology.

Ergonomics and Legal

The ergonomics are relatively similar between VRS and VI in postsecondary: an interpreter sits in front of a computer, works within a specified signing space, and needs to be aware of the placement of the computer screen to avoid body and eye fatigue. Beyond ergonomics, according to our experience, postsecondary VI and VRS are quite different. The legal parameters are significantly different because VRS is bound to follow FCC guidelines, which imposes certain legal requirements and restrictions. In the postsecondary arena, the VI interpreters are likely bound by university policies and the RID or NAD codes of ethics. The comparison between VRS and postsecondary VI is even more complex when we analyze other parameters.

Interpreting issues similar in the two environments are clothing, background, lighting, fatigue, working in a two dimensional environment, and the stress of new working conditions. Beyond those, the nature of interpreting in postsecondary VI is quite different from VRS. First consider content. In the VRS telephone environment, interpreters do not know the topic of a call. Because VI postsecondary courses are pre-arranged, the interpreter will likely know the course and consumers in advance. With appropriate preparation materials, a postsecondary interpreter will simply refer to the course syllabus and prepare accordingly.

A second difference: VRS interpreters must accommodate a wide variety of signing styles and regional differences. This might also happen in postsecondary VRS situations if we begin interpreting for courses taking place anywhere in the United States, which is certainly a possibility for the near future. In general, however, interpreters and consumers would ideally remain the same for one semester.

Turn-taking is an important issue in VRS interpreting. Phone calls have a prescribed etiquette and expected turn-taking. Postsecondary work has standard turn-taking behaviors also, though if a course is mostly lecture, there would be little or no turn-taking. This issue does surface during small group work or in participatory classes, and then the issues are complex. The interpreter needs to be aware of the group dynamics and turn-taking behavior even though s/he cannot always see the entire class at

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Best Practices

By Brenda Cartwright, MS, CSC, CI and CT, Michigan

DEAR BEST PRACTICES: I took the RID performance test four times before I passed. Apparently, I should be ashamed of this, but on the contrary, I'm thrilled I finally made it! I got very little support over the years from the deaf and interpreting communities. Many people even told me that I should look for another career. This only made me more determined to prove them wrong. It wasn't easy. I took every class (many twice), attended every workshop for miles around, slowly but surely improved, and here I am. I know I will never be able to rest on my laurels, but these same people feel the need to remind me often and publically of how awful I once was. Please don't tell me time heals. What can I do now?

EXPERIENCED INTERPRETER'S RESPONSE: Don't worry. We've all heard that myth many times, often in an attempt to comfort someone who is in pain. The reality is this: What time does is pass. It's what we do while time is passing that makes the difference. I know people who have had huge tragedies in their lives and because of the way they handled it, were doing fairly well relatively soon. I've also worked with people who have had misfortune in their lives who talk about it as if it were last week when in fact it occurred 15 years ago. They have kept it alive and recent for themselves. You are now a role model for all the up and coming interpreters, and you can teach them all the positive lessons you learned along the way. As for those colleagues you will continue to see at workshops and in the field, it's your attitude that makes the difference not theirs. Congratulations on your accomplishment!

EXPERIENCED DEAF CONSUMER'S RESPONSE: If there is one thing that I have learned, it is who I am and how I act that rubs off on the people around me. My background only impacts how I interact with others if I let it. Your struggle to become an interpreter is now part of your background. It does not define who you are as a whole. I hav had many competent interpreters ov the years. However, I did not care ab their background (and I do know man of them). Again, it is who they are no that matters. So if I were you, I would stop focusing on how your struggle to become certified impacts others. You not have to justify yourself to anyone. Unless there were situations where yo reacted poorly or were characterized l an attitude, the past doesn't have to affect the future. You have the ability t be part of the solution. Be honest with yourself and others. Show them you a worthy of their respect, and remember the solution is within yourself. It will not be easy, but good luck.

This column appears monthly in VIEWS with responses from guest interpreters a consumers. Have a question or want to respond? Write to:

Brenda Cartwright
C/O RID
333 Commerce Street
Alexandria, Virginia 22314

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the remote site. This is one obvious complicating factor that is generally not present in VRS. A postsecondary classroom can contain anything from a handful of students to hundreds, each class providing its own unique set of circumstances for the interpreter. The VRS environment is more static: it is usually a deaf person making a phone call via VRS. In the postsecondary environment, the interpreter often cannot see all of the students, the faculty member or the classroom board or screen. While there are several similarities between the VRS and postsecondary VI, there are clearly more differences.

Technology

While both VRS and postsecondary VI require some of the same basic technology and equipment, there is one major difference. VRS does not require two-way audio with the full-motion video required for interpreting. When VRS interpreters are working, they are communicating in sign language with the deaf consumers and speaking into a telephone to a hearing consumer. The requirement of two-way audio to receive the sound of the postsecondary classroom further complicates the technological aspects for that work. Another technology difference: Some VRS companies have installers who set up the cameras/equipment in deaf consumers' homes. In the postsecondary environment, and in our case, we rely on the expertise of those working at the remote university to purchase the appropriate portable equipment and test the connection between the classroom where the course will be held. This might require many hours of work for both our program and the remote university. On the positive side, once the equipment has been purchased and a student trained in its use, it is generally easy to launch another course at a later date in a different room on the same campus.

Suggestions for the Future

While the postsecondary environment is ripe for the use of VRI because of the ongoing shortage of interpreters, there is room for much research and improvement. A few suggestions for improvement on issues raised above:

- Standardization of technology/equipment: It would be helpful if the university/agency providing the postsecondary interpreting would purchase start-up sets of equipment including a camera, software and necessary microphones and batteries to be sent to institutions purchasing the service. This equipment could be lent to them for a semester and the cost then rolled into the overall service fee. In addition, research is needed to determine a variety of options to get reliable, portable, two-way sound for different classroom environments and the best software to allow for full access to the remote classroom.
- Orientation for remote participants: Because this service is relatively new, it would serve everyone well if an orientation was available for the faculty member and the student. In a live classroom situation, it is much easier to get necessary materials and handouts and establish rapport with the faculty member. Video interpreting requires that the interpreter get handouts or overheads before the class, either via e-mail, fax or an online classroom tool.
- Turn-taking: To facilitate turn-taking during small group work, a wireless microphone, not a central table microphone or microphone in a camera, could be passed among the group participants. If the deaf student is using a laptop, the interpreter is rendered nearly invisible to other students so it is easy for them to assume that the interpreter is able to handle anything, even if they are all talking at the same time. Passing a microphone will make it easier for the interpreter to handle the flow of the discussion.

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WELCOME, NEW MEMBERS!

A heartfelt welcome goes to our new members who joined in April. We're glad to have you with us!

REGION I

Delaware
Slocomb, Denise Enger
Massachusetts
Irvin, Adell
Lawrence, Joanna
New Jersey
Bertrand, Margaret S.
Lang, Christopher
New York
Bissette, Kim C.
Coles, Christopher
Finocchio, Renee
Matzen, Amanda
Pursley, Brenna
Sanders, Deborah
Pennsylvania
Jones, Stephanie L.
West Virginia
Hottle, April

REGION II

District of Columbia
Bahl, Kari
Florida
Belcher, Natalie
Cass, Abigail
Collins, Jessica
Patterson, Joann
Georgia
Hamby, Kimberly S.
Peters, Carlene
Reeves, Michelle
Maryland
Cole, Patrick
Dunston, Michelle
Fetterman, Michelle
Paschall, Mary Elizabeth
Mississippi
Jordon, Wanda F.
North Carolina
Clary, Susan W.
Quintero, Cynthia R.
South Carolina
Bentley, Barbara
Tennessee
McCoy, Sherry R.

REGION III

Illinois
Hill, Denise
Jensen, Jennifer
Indiana
Morris, Heidi
Minnesota
Evangelist, Alisha
Gress, Tiffany J.
Kastner, Alexis
Keller, Iris
Ohio
Buch, Tiffany
Clark, Michelle R.
Comello, Lindsay
Groseclose, Susan I. L.
Katz, Julie
Maust, David Lee
Molignoni, Roxann
Wisconsin
Hartmann, Jake
Stockford, Melissa

REGION IV

Colorado
Hernandez, Valerie
Johnson, Carmela V.
Lucas, Sheila
Louisiana
Kuyrkendall, Jennifer
Missouri
Breneisen, Angela
New Mexico
Perea, Maria
Propp, Margie
Oklahoma
Gengler, Amy
Texas
Afflerbach, Kimberly
Anguiano, Michelle
Sessions, Ronald T.
Thuesen, Randy

REGION V

Alaska
Robertson, Lonya
Arizona
Denava, Diane
Flansburg, Jane
Kleindorfer, Keli Jean
California
Alvarez, Maria Alejandra
Barnes, Diana M.
Burke, Tina Cetrone
James, Tanisha
Jeffers, Sarah E.
Johnson, Kelly
Klein, Vanessa A.
Moscovitz, Alvin B.
Nolan, Farrah
Norrod, Ramon
Sumner, Shauna Charlotte
Vance, Nakysha K.
Idaho
Doncouse, Teresa
Hansen, Esther
Hill, Melanie
Romriell, Kimberly
Voglewede, Jeanne
Walker, Jerri
Oregon
White, Christina
Utah
Duran, Dawn
Washington
Belsvik, Taylor

INTERNATIONAL

Canada
Thibert, Christie

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the technical requirements of video interpreting to factors of communication; to evaluate what is needed for appropriate working conditions in this new branch of interpreting. The spoken language interpreting field has researched the physical and psychological ramifications of remote interpreting. We need to expand this body of research to look at effects of fatigue on performance, physiology, and psychology of the interpreter. We need to continue to explore ways to enhance service provision while maintaining the health of interpreters.

Conclusion

Albert Einstein said: "It has become appallingly obvious that our technology has exceeded our humanity."

Video communication has exceeded our dreams of reality. Let us work together to provide effective encounters of the 2-D kind! ■

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These are small, specific examples to improve the work in the postsecondary VI environment. There is much more we can consider as we forge new developments in VI and VRS. Perhaps there will be more collaboration between universities and VRS call centers. California State University Northridge has already investigated job-sharing situations with a VRS company, understanding that there will be more competition for the best interpreters in cities housing VRS call centers, according to Lauren Kinast, Coordinator of Interpreting Services. (PEPNet Listserv post, January, 2005) Universities and VRS providers could go a step beyond job sharing and consider providing VI out of VRS call centers.

While postsecondary VI certainly faces challenges, the popularity of VRS has shown that deaf people have become comfortable with remote technology; using VI in postsecondary environments seems the likely next step to providing more accessibility for deaf students.

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PEPNet listserv. Personal post, Lauren Kinast, Coordinator of Interpreting Services, California State University Northridge, January 21, 2005. ■

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VIEWS

A MONTHLY PUBLICATION OF THE REGISTRY OF INTERPRETERS FOR THE DEAF ■ ■ ■ ■ ■ ■ JUNE 2006

Video Remote Interpreting...It's a Good Thing!

Mary Henry Lightfoot, CI and CT, Maryland, RID Video Interpreting Committee Chair

Video remote interpreting (VRI), where at least one of the participants is at a distance,[1] is gaining momentum. It is rapidly becoming an accepted form of communication transmission in medical, legal, business, and educational settings. As a result, the number of companies that provide VRI services has shown dramatic growth in the past year.

The good thing about VRI is that there are no federal regulations to mandate its use. The challenging thing about it, however, is that there are no professional guidelines for this type of interpreting either.

Sign language interpreters must vigilantly maintain interpreting protocols and professional standards as we progress in this technological era. We must continue to use established interpreting practices such as preparation, matching an appropriate interpreter with the consumer based on quality factors, and limit the length of time an interpreter is required to sign based on fatigue factors. We should also persist in using the process protocols set forth by interpreting standard-bearers like Seleskovitch, Gish, Colonomos, and Cokely.

As interpreters working in virtual settings, the decision-making process becomes critical. Although we can appear anywhere in the country at a moment's notice, we must perform our task in an informed way.

For guidance, we can look to other fields that have experience with virtual communication such as spoken language interpretation and videoconferencing. We can also transfer some emerging practices used in legal interpreting to video remote interpreting.

Spoken Language Interpreters

Spoken language interpreters have been researching the use of video/audio distance work since the 1990s.[2] The research points to working conditions, stress factors, technology standards, and establishment of best practices. The process of these interpreters involves first researching components of distance interpreting, developing standards, pilot testing, and then forming established practice. The sign language interpreting profession must perform qualitative and quantitative research for evidence of what successful practice entails. We must pair current business methodologies with research-based interpreting methodologies. As Panayotis Mouzourakis stated, "...the best way to ensure the successful introduction of ICT (information and communication technologies) in interpreting is to involve interpreters directly in it, encouraging them to assume direct responsibility for the future of their own profession."[3] Sign language interpreters must become more involved with the establishment of video remote interpreting practices according to setting, parameters needed for consideration, and practical considerations. Thus, the interpreter in VRI settings must be able to assess preparation materials while exploring ways to access content and process information in the most efficient manner possible. Use of technology will aid this process. For example, clients can forward background materials to the interpreter along with the request for services, giving the interpreter time to preview the infor-

The good news about VRI is that it's not federally regulated. The bad news is there are no professional guidelines either.

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mation, and assess requirements for the assignment.

Videoconferencing Standards

Videoconferencing is an established form of communication in business, education, and medicine. Protocols have been established to manage the conference process. Room setup, turn taking, use of technical support, and technology standards have all been addressed through research. *Videoconferencing for the Real World* states, "Several factors contribute to the success of a network of videoconference systems. Among the most important of these are proper design, support from management and users, competent and timely technical support, and effective user training."[4] Of these factors, "user training" is important for our field. VRI users must understand the best practices for using interpreters in remote locations and its limitations. Users must understand that, although we may appear instantly, our work requires more than instantaneous movement of hands and mouth. Partnering with participants is a must when working in this medium.

We need to consider questions such as how media will be used during meetings; what is its impact on the interpretation process; what is available for the interpreter to see; and what arrangements are there for content and logistical preparation (this could involve activities such as faxing and e-mailing materials and having warm-up time with consumers).

Legal Interpreting

Legal interpreting already has guidelines at the federal and state level. In addition, the use of remote interpreting services has been explored and researched for both spoken language and sign language interpreting. Defendants have the legal right to be "present" during proceedings according to Rule 43. Discussion of the concept of "presence" has a bearing on the legal right to proceed with remote services. The concept of presence is defined as being physically present during court proceedings at the federal level. According to *United States v. Torres-Palma* (2002), Rule 43 states:

> "(a) Presence Required. The defendant shall be present at the arraignment, at the time of the plea, at every stage of the trial including the impaneling of the jury and the return of the verdict, and at the imposition of sentence, except as otherwise provided by this rule."[5]

At the state level, video interpreting is currently in practice for a variety of situations. Best practices for remote interpreting for the courts mirror best practices in the field of videoconferencing in many ways.

The California court system performed an extensive pilot project of remote interpreting, including a nationwide survey of the court system's use of remote interpreting services. The study looked across languages and specifically at telephonic interpreting.[6] Many of the findings easily transfer to video remote sign language interpreting.

The California court system was considering remote interpreting services to help reduce delayed proceedings due to the unavailability of interpreters, to decrease the use of unqualified interpreters, as well as to realize cost reductions.

With remote video sign language interpreting, the goals are often the same. The weight of these objectives varies according to the requester. Sign language interpreters often advocate for the provision of qualified interpreters, and sometimes the use of a remote interpreter is the best option.

The California pilot project found that the value of the remote interpreting service depends on:

- Qualifications and competence of the interpreter
- Ability of the trial court parties, led by the judge, to understand the limits of the technology and to maximize the remote interpreting resource
- An environment conducive to the delivery of interpreting services
- Short-term (less than 30 minutes) proceedings
- Equipment that facilitates delivery of service
- Interpreters and court staff with adequate training and experience in the use of the telephonic equipment
- Specific support and understanding among court participants for the challenges of telephonic interpreting.[7]

Notice that these factors include training and knowledge of remote interpreting equipment, process, impact, and limitations. In order for VRI to be effective, everyone involved- - participants, interpreters, judge, lawyers, and staff—needs to understand how VRI works and its limitations. Thus, practical solutions are given, such as access to a fax machine or e-mail, that would allow the interpreter to obtain documents for preparation.

The Wisconsin court system developed a list of appropriate uses of remote telephone interpreting, which is limited to non-evidentiary hearings. This again points to the need for VRI to have boundaries. In addition, many of Wisconsin's core parameters can be applied to non-court situations (for example, preparation for technology, content, and logistics).

Conclusion

Looking at VRI from the interpreter's perspective is only one piece of the puzzle. When we look at remote interpreting from a variety of perspectives, we see that it can be a good solution providing easier and faster access to communication, access to quality services, and effective use of fiscal resources. Given the complex task of remote work with important decision-making needs, VRI requires consistent use of the most competent interpreters.

Looking at the components of VRI, we must consider appropriate application of modern theory such as "Deconstructing the Myth of Neutrality" by Melanie Metzger. Interpreters must be knowledgeable of technology's affects on our work and use that knowledge to create workable solutions.

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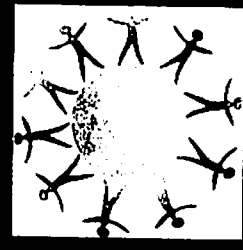

CDILC
Cultural Corner

Valuing and Validating RID's Membership

Wanda L. Newman,
CDILC Chair, NAD IV, NIC
Master, Washington, D.C.

RID is working progressively to develop a framework of valuing and validating its members regardless of race, ethnicity, social class, gender, or sexual orientation. Chavez, Guido-DiBrito, and Mallory (1996) developed a diversity development model with a framework consisting of unawareness, awareness, questioning or self-exploration, risk-taking or other exploration, and integration. This framework provides a guide to interacting confidently in and out of our own culture. RID promotes a global view and authenic understanding of embracing diversity within our organization as well as in our personal lives.

Ross-Gordon, Martin, and Brisco (1990) outlined nine characteristics of effectively serving minority populations. Among the nine characteristics, three particularly stand out:

- Preserving the cultural distinctness of groups
- Reaching out to the most disenfranchised
- Sponsoring activities that increase the level of intercultural sensitivity.

The Cultural Diversity in Leadership Committee (CDILC) encourages RID members to recognize and change their mental model related to growing ethnic and cultural diversity of our population. Naisbitt and Aburdene (1990) observed "even as our life styles grow more similar, there are unmistakable signs of a powerful counter trend: a backlash against uniformity, a desire to assert the uniqueness of one's culture and language."

Improving our knowledge and understanding of other cultures within RID, particularly in relation to our profession, will help us grow as an organization as well as a community of people.

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Continued from page 7.

We must also look at modern questions such as "Will increased use of VRI lead to globalization of our work?" as is the case with spoken language interpreting.[8]

Given its complexity, the emergence of video remote interpreting is an exciting challenge. I urge each of us to become involved in its future development through the upcoming RID standard practice paper on video remote interpreting (coming the fall), through an understanding of the technologies that impact our work, and by giving voice to appropriate uses of the medium. ■

Mary Henry Lightfoot, BA, CI and CT is an interpreter, mentor, and interpreter trainer who has worked in the field of interpreting for over 20 years. She currently works for Gallaudet University Interpreting Service and teaches through Gallaudet University's Graduate School and Professional Programs. Currently, Mary Lightfoot is chair of the RID Video Interpreting Committee and can be reached at *Mary.Lightfoot@gallaudet.edu.*

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BusinessWeek

OCTOBER 9, 2002

ASSISTIVE TECHNOLOGY
By Suzanne Robitaille

New Telecom Connections for the Deaf

Web-based technology is giving hearing-impaired people more options to communicate more effectively with everyone

Minutes before a staffwide conference call with the head of his brokerage firm in late September, Danny Lacey logged onto the Internet and contacted a Sprint Corp. relay center in Texas. A communications assistant appeared on Lacey's laptop via a Web camera. Then Lacey, who is deaf, sat back and watched as the Sprint operator relayed the entire call in sign language at the same time that hundreds of his colleagues at Kramer Financial in Austin listened in. Lacey even asked questions in sign language that the operator relayed verbally to the audience. Lacey says this was the first time he was able to participate on an equal footing with the company's other financial advisers.

Lacey's call is one of the most exciting examples of how the Internet is helping deaf, hard-of-hearing, and even speech-impaired people communicate fluidly with the hearing world. The Video Relay Service (VRS) that Lacey used has gained rapid acceptance since its introduction earlier this year. In addition, deaf people now can hold phone "conversations" by sending typed questions and answers via a laptop or personal digital assistant to an intermediary employed by the phone company, who then speaks the written words to the hearing person on the other end of the line.

LESS RESTRICTIVE. That approach is far superior to the former state-of-the-art -- the clunky, nonportable teletype (TTY) machine. About the size of an old Bell telephone, the TTY is a terminal with a keyboard that a deaf person can use to type messages to a phone company operator, who reads them to the other party on the call. The TTY's tiny screen can display only one or two lines at a time, and it must be plugged into an outlet and connected to a landline, which restricts its use and makes it passé in a world gone mobile.

Having the option to make a business call outside of the office via a laptop or PDA is a huge advance for the deaf: It makes them more competitive with other workers and job seekers, and thus more employable in the corporate world. They're also less likely to ask employers for face-to-face sign-language interpreters or real-time captioning, a service that's similar to court stenography and can cost $200 an hour.

By contrast, Lacey, who regularly participates in conference calls from his office, uses video relay and its sign interpreters for free, whenever he wants. "With video relay, the time and cost obstacles are virtually nonexistent," he says. "It's really easy for me to call my hearing clients at a moment's notice."

NO EXTRA CHARGE. Sprint and AT&T have spearheaded efforts to put telecommunications for the deaf onto the Web, largely because they already have exclusive contracts with state agencies to supply traditional TTY services. Moreover, the Federal Communications Commission requires that telecoms try to make their products and services accessible.

With the deaf population proving to be lively communicators on the Internet via e-mail, chat, and instant messaging, Sprint and AT&T chose the Web as an inexpensive way to meet federal requirements and improve communications for some 54 million deaf and hard-of-hearing Americans. What's best about these services is that they're entirely funded by state agencies, users simply pay long-distance charges.

The most basic service -- the one that emulates TTY -- is called Internet Telecommunications Relay Service, or TRS. Deaf people log onto Sprint Relay Online or AT&T Internet Protocol Relay Service and use their computer keyboard to dial a number that connects them to a communications assistant, who converts written messages into spoken words.

JUST LIKE I.M. The TRS sites of Sprint and AT&T have the look and feel of the instant-messaging platforms that already are common on the Web. Their interfaces provide a choice of text and background colors, and Sprint's lets users punctuate their sentences with stylized emoticons, such as a smiley or sad face -- representing a laugh or angry tone of voice. Users can save, print, and e-mail their entire conversation log, an advantage for business calls. They can also choose relay operators who speak Spanish or French Creole.

For the more mobile set, Sprint just launched PCS Vision Service. With a Handspring Treo phone, the hearing-impaired can make calls on a PDA via the Internet, similar to the way they would with a laptop. While users typically pay wireless service charges of around $45 a month, plus the cost of any long-distance calls, the new service is free. "Internet protocol is the technology of the future for those with hearing disabilities," says Mike Ligas, vice- president of Sprint Relay. "They will soon have the same mobility that hearing users have."

Deaf or hard-of-hearing people who choose to use their own voice have an even faster option, called two-line voice carryover, or VCO, which requires only the Internet and a standard phone line. This service is an excellent backup for those who can hear a little but not enough to make a truly independent call.

INVISIBLE LIAISON. At the Sprint or AT&T Web sites, they can instruct the operator to call them on their landline or cell phone. They then use the conference button on their phones to dial the party they're calling. The operator becomes an invisible liaison whose only job is to type what the hearing caller is saying into the Web site's dialogue box, while the deaf or hard-of-hearing people speak for themselves.

At the other end of the spectrum is a service for those who can hear but have lost their ability to speak clearly. For this group, phone companies offer speech-to-speech services -- just the opposite of text-to-text telephony. Communications assistants who are trained to understand a variety of speech listen -- and then enunciate the message clearly to the hearing party. Speech-to-speech services are available on both landline and cell phones.

Video relay is likely to be the preferred salvation of people who describe themselves as completely deaf -- and who rely on sign language or lip reading, or a combination. This technology -- the kind Lacey uses -- is provided by Sprint through a partnership with **USA VRS** and is based on widely available videoconferencing software, such as Microsoft NetMeeting.

"MORE CONNECTED." People who are completely deaf say video is more effective than its text-based counterpart because sign-language operators are trained to convey not just the words of the caller but also the mood. Since it requires no typing, it eliminates delays and makes video an excellent alternative for someone who prefers sign to English. "VRS is very human-like. I feel more connected, and I can express my emotions," says Rene Pellerin, a deaf vocational counselor in Waterbury, Vt. Lacey says his ability to communicate with clients has improved vastly since he started using video in August.

Internet technology for the deaf isn't perfect yet. For one thing, poor image quality can hinder a video call. Though many shrug off grainy or slow images while reading signing via a computer, others get a headache or become frustrated. Lip reading is also affected by jerky video, as small distortions in timing can throw off even the best lip readers. It will take better broadband to fully mitigate such problems.

The bottom line is that the deaf and hard-of-hearing still can't make truly independent -- meaning unassisted -- calls. That will require speech-to-text technology that goes beyond current software. But for now, phone companies deserve applause for putting their services on the Web and for making communications faster and more convenient for millions of people who for decades have had to work extra hard to keep up in a hearing world.

Robitaille writes **Assistive Technology**, only for BusinessWeek Online

BusinessWeek

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ASSISTIVE TECHNOLOGY
By Suzanne Robitaille

Frustrating Signs at the FCC

The agency regulates a phone service that lets hearing-impaired workers "talk" with clients. Why won't it help people in the same room?

Many deaf people will tell you that video relay -- which allows them to communicate by phone in sign language -- is one of the greatest tools ever invented. Stephen Hlibok is one of those people. A vice-president in Merrill Lynch's (ML) Global Private Client Group in Columbia, Md., he uses video-relay service (VRS) to "talk" with his hearing clients.

Hlibok connects to VRS -- a free, public, on-demand telecommunication service -- with a videophone that sits on top of a TV in his office. Via a high-speed Internet connection, he dials up a call center, which enables two-way live videoconferencing with a sign interpreter, who then contacts the hearing party via a standard phone line. The interpreter relays the conversation to Hlibok in sign language.

For Hlibok, the ability to sign his conversations instead of typing 50 words a minute on a text-based telephone (TTY) has dramatically improved his job performance. "When I first had an interview with my manager 16 years ago, he showed me he could make 10 calls within 30 minutes, but I could only do one TTY conversation in 30 minutes," Hlibok says. With VRS, he says, "my calls have quadrupled."

LOCATION MATTERS. Philippe Montalette, a software engineer at Sun Microsystems (SUNW), also loves VRS. He uses it about three hours a day to talk to his managers and co-workers or to listen to company presentations. The difference between him and Hlibok? Using it to communicate with colleagues, since Montalette works from home. "Before I used VRS, I had to go back to the office for meetings and arrange for [on-site] interpreters," says Montalette. "It was too much work to do."

Why can't Montalette use VRS in his office? Title IV of the Americans with Disabilities Act (ADA) requires equal telecom access for the deaf, everywhere, including the workplace. According to the Federal Communications Commission, VRS is the functional equivalent of a regular phone call. But here's the catch: VRS can be used only for phone calls between parties in two different locations, according to the FCC.

So while the nation's 28 million deaf and hearing-impaired individuals can use VRS from their homes and offices, they can't use it in daily meetings and presentations when they're under the same roof as their co-workers. For such events, the FCC says the deaf should schedule an interpreter to come to their offices, as Montalette used to do.

Of course, getting an interpreter isn't only a lot of work, it's also expensive: At about $75 an hour (with a two-hour minimum, plus travel expenses), an in-house interpreter can be anything but a cost-effective and convenient solution.

NEGLECTED ALTERNATIVE. In some ways, FCC oversight of VRS is a good thing. The service must meet rigid technical and customer-service standards, including round-the-clock access over a heavily secured network. Interpreters must be competent to handle all types of subject matter, and all calls have to be confidential. Quality and speed are important, too, since sign language involves rapid hand, arm, and finger movements, as well as changes in facial expressions and lip movements.

Phone companies such as AT&T (T) and Sprint (FON) and video-technology outfits like Salt Lake City-based Sorenson Media supply the equipment and operate call centers that employ certified sign interpreters. Through a federal fund administered by the National Exchange Carrier Assn. (NECA), a pool of telecoms, providers are reimbursed about $14 per minute. In fiscal 2004, NECA set aside $115 million to compensate providers for providing telecom services to the deaf.

Yet the FCC's rules can also backfire. Not everyone can work from home, as Montalette does. And the FCC won't fund or regulate video-remote interpreting (VRI), a lesser-known service that offers the deaf another way to connect with colleagues. VRI is designed for communication between people in the same room -- colleagues, for example, or a doctor and patient at a hospital.

UNTAPPED POTENTIAL. VRI, which is offered by select sign-interpreting agencies, uses a high-speed Internet connection to link a deaf employee to a VRI sign interpreter via a videoconference. Unlike VRS, which is designed for two-way communication over a phone line, VRI is more like a transcription service for the deaf, relaying what is being said in meetings to them in sign language. The cost per minute is $1.75 to $3, usually sold in 15-minute blocks. Employers who use it foot the bill for the service and equipment.

The FCC contends that because no physical phone call is being placed to an outside party, VRI is out of its jurisdiction. While the agency may be sticking to the letter of the law, it's hardly true to the spirit of the law. Without regulatory standards, VRI will never be as useful as VRS. It's not an on-demand service, its use must be scheduled ahead of time, and interpreters aren't required to be certified or to take every call.

Also, the FCC is balking at the high cost of VRS. Last June, it temporarily slashed VRS compensation rates to $7.75 per minute from $14, and put the rates under review. NECA says one of the reasons VRS is more expensive is because its interpreters are available on-demand and highly skilled, which means higher labor costs. But the FCC says VRI and VRS are "essentially the same" services, so they should have similar costs.

BIG BENEFITS. The FCC's hands-off approach keeps VRI from reaching its potential as a workplace tool for the deaf. The agency should consider opening up a separate pool to fund more highly skilled VRI interpreters and some on-demand services or to reimburse companies for video-conferencing gear. In Britain, government grants cover 80% to 100% of the cost of services, adaptations, and equipment required by disabled people for the working environment, including VRI.

Why not let deaf employees tap into on-demand VRS call centers, even at a higher cost per minute to their employer than VRI, or during limited hours? Advances in broadband and video technology make this an increasingly viable and cost-effective choice. As more employers seek to comply with the ADA and offer "reasonable accommodations" to disabled workers, they will be more open to bringing video-relay gear into their offices and conference rooms.

Access to on-demand interpreting at the office -- whoever pays and however the call is routed -- will help deaf employees stay on top of their game. For the deaf, a wider range of options for video relay at work add up to a richer work experience, better productivity, and maybe even a glowing yearend performance review.

Robitaille is a reporter for BusinessWeek Online in New York

washingtonpost.com

Saying It With Feeling

New Technology Lets Deaf, Hearing People Enjoy Richer Conversations

By Samantha Sordyl
Washington Post Staff Writer
Tuesday, September 6, 2005; HE01

Jeff Kelly used to tell his girlfriend, Terri Vincent, that before calling him at work, she should "be prepared with what you want to say."

Kelly, a 29-year-old Frederick resident, wasn't being rude; he was just acknowledging the time-consuming nature of their calls. Because Vincent, 25, is deaf, she had to type her message into a computer or hand-held pager and transmit it over the Internet to a go-between in a remote location. This intermediary would call Kelly, read Vincent's words to him and then keyboard Kelly's reply into a computer and forward it to Vincent.

This slow, cumbersome process, known as Internet protocol relay (IP Relay), stripped conversations of emotion, nuance and spontaneity. But many deaf people who are comfortable with American Sign Language (ASL) have begun using a faster, easier system called video relay service (VRS), one of several emerging technologies designed to improve life for people who are deaf or hard-of-hearing.

To reach Kelly from her home in Frederick, Vincent now uses a videophone connected to a standard television monitor. When her call to a VRS interpreter is connected, Vincent's TV shows a split screen of two live images: the interpreter on one side and Vincent herself on the other. (The videophone includes a camera and transmits images over a high-speed Internet connection.)

Using sign language, Vincent asks the interpreter to call Kelly, who is frequently away from his office and available only via cell phone. When Kelly answers, the interpreter signs his words as Vincent watches on her screen. When Vincent signs back through the videophone, the interpreter voices the message on to Kelly with little pause.

Finally, Kelly said, "it's a normal conversation."

"This technology just really puts us on a level playing field," said Vincent in an interview assisted by an interpreter.

Lisa Marie Wilson, 27, a financial management specialist at the National Institutes of Health, agreed. "The videophone has changed the deaf community's lives -- changed our world," said Wilson, speaking through a VRS interpreter.

VRS is free to the deaf through the Americans with Disabilities Act. According to the Federal Communications Commission, 7,215 minutes of VRS interpretation was used in January 2002, the first month the service became generally available. By June 2005, usage was up to 2.1 million minutes.

Full Conversation

Thanks to VRS, a phone conversation with a deaf person is no longer a dry, impersonal affair. One key reason is that VRS lets deaf people express and perceive mood and personality. Contrary to common belief, said Billy Kendrick, an interpreter at Visual Language Interpreting in the District, ASL is not English represented word for word through

signs but rather a language all its own, with signs representing nuanced phrases and thoughts.

Meaning is also conveyed by how a deaf person uses space while communicating. For instance, signing "is generally enlarged when there's high emotion involved," like excitement, anger or shock, Kendrick said. A VRS interpreter might speak sharply or slow down his speech for emphasis to convey those feelings to the hearing party.

How many people use ASL is unknown. "Researchers in the field of deafness are confident [that the number is] more than 250,000, and would be surprised if it were more than 1 million," said Ross Mitchell, a research scientist at Gallaudet Research Institute, part of Gallaudet University, a college for the deaf in Northeast Washington.

Wilson says VRS has allowed her to remain close and communicate regularly with family in Boston.

"My family [all of whom are hearing] really prefers video relay services over the text relay services," said Wilson through a VRS interpreter. "The sign language interpreters can see if I'm happy or sad and can relay that in their interpretation." (When face to face with family members, Wilson said, she signs and speaks simultaneously.)

With text communication systems such as IP relay or e-mail, said Wilson, "misunderstandings happened quite frequently." Even with family members, Wilson said, she often had to tell them explicitly, "I am happy."

Another plus: With VRS, "I can interrupt" before the translator is finished, just as people routinely do in spoken conversations, Wilson said. "With text relay, I can't do that," since the messages would become garbled. This ability makes even mundane calls -- like getting insurance quotes -- a lot easier, she said, probably cutting in half the time needed for such a call.

Robert Rice, president of BayFirst Solutions, a District-based management and technology consulting firm, is deaf and often uses phone interviews to screen job candidates. He appreciates VRS and a Web camera/computer variant instead of a videophone.

"Trying to do a phone interview was extremely difficult" with text communication, Rice said through a VRS interpreter. "Now, I can *see* the personality [of the candidate] on the phone by way of the interpreter."

Rice cannot actually see the job applicant, but the interpreter aims to convey more than just the hearing person's words.

"A good VRS interpreter will indicate via a roll of the eyes or an exasperated facial expression that the candidate is bored," Rice wrote in an e-mail. "The twiddling of the thumbs or a twirl of the hair may be expressions chosen by the interpreter to indicate extreme boredom, if it is clearly sensed in the candidate's voice." Sometimes, he wrote, an interpreter will "state directly [in sign language] . . . if the hearing candidate seems enthusiastic, bored, polished or inarticulate."

The speed of the new technology improves communications, too. With text-based calls, said Claude Stout, executive director of the advocacy group Telecommunications for the Deaf Inc., or TDI, most deaf people could type "40 words per minute. But now, with VRS, we sign . . . about 200 words per minute."

Continued Stout, through an interpreter, "With VRS, there's no lag time, no delay, [so hearing] people in the community are willing to call us. They don't feel dread in calling us -- that translates into employment and education opportunities."

But Rice points out that with demand for VRS interpreters high -- this is also true for services like in-person interpreting in schools and hospitals -- initiating a call can take patience: "Sometimes it can be forever. This morning, I had to wait maybe five to 10 minutes."

Some deaf people have taken the interpreter out of the equation altogether when speaking with other people who know ASL: They simply sign to one another through videophones or Web cameras.

"I have a friend who lives in Minnesota," Wilson said via a VRS interpreter. "Through the videophone, I can see my

friend as well as her baby. . . . Since I can verbalize, I call [the baby,] who is hearing, and she will look up and walk toward the [videophone] -- a wonderful experience, really."

Old and New

VRS doesn't mean the death of IP relay or older text-based formats like TTY (a tool that typically lets a user see only one line of text at a time). For instance, TTY is the only way for deaf people to call 911 directly, since Internet technologies make it difficult to identify a caller's location.

Despite the awkward features of the IP relay system, Kelly and Vincent aren't ready to abandon it; unlike VRS, IP relay is something Vincent can use when she's away from a computer screen or videophone. Her T-Mobile Sidekick pager allows her to place IP relay calls and send and receive other types of text messages.

For all of the new system's virtues, there still are times when even a skilled VRS interpreter just can't do a fully convincing job.

For Kelly, it's "most awkward, when [his girlfriend's interpreter is] a man," he said. In that case, Kelly might hear a male voice saying: "I love you, baby. I'll see you later." ·

Sorenson Video Relay Service -VRS- Expands Communication for Faculty and Students at the Oregon School for the Deaf

Business Editors/High-Tech Writers

SALEM, Ore. & SALT LAKE CITY--(BUSINESS WIRE)--Oct. 22, 2003

The Oregon School for the Deaf (OSD) and Sorenson Media(R) announced today that OSD will implement Sorenson Video Relay Service(TM) (VRS) for both its students and staff. OSD decided to adopt Sorenson VRS based on its ability to deliver the highest-quality video relay service through its state-of-the-art video relay solutions and reliable interpreting service.

"OSD offers a full range of curriculum and provides individually designed instruction for students leading to a variety of post-high school options, including college, competitive employment, and supported work," said Jane Mulholland, director at the Oregon School for the Deaf. "Sorenson VRS is a resource that will not only be utilized by students daily on campus, but also when they graduate and rely on the service to communicate for employment and other pursuits."

Sorenson VRS enables deaf and hard-of-hearing individuals to effectively and naturally communicate with the hearing world. Using the Sorenson VP-100(TM) videophone appliance connected to a TV, or a personal computer equipped with a Web camera and Sorenson EnVision(R) SL video relay software or Microsoft(R) NetMeeting(R), both deaf and hard-of-hearing users are able to place calls to family, friends, or business associates through an American Sign Language (ASL) interpreter.

Several Sorenson VP-100 videophones have been installed in school buildings, the Deaftech Lab, the Outreach Center, and the student dorms. Additionally, VRS training is being incorporated into the communication and transition curriculums, thus helping students prepare for independent living and employment.

Mulholland added, "The Sorenson videophone technology and relay service was demonstrated to families and visitors at a recent open house at OSD. Many parents and students explained how this technology has positively impacted their family communication."

"With my son away at OSD, Sorenson VRS has greatly improved the way we communicate and therefore, changed our relationship for the better," said Jessica Thirkell, hearing mother of OSD deaf student, Austin Martini. "Being able to communicate instantaneously has allowed him to reach me in an emergency, when he has had a bad day, or when he has had the best day of his life. I no longer have to wait for the weekends to catch up with him. Sorenson VRS lets me know now. That is a huge relief to a mother who doesn't get to see her child every day."

"Sorenson VRS is honored to be selected by OSD," said Pat Nola, COO at Sorenson Media. "Whether students are staying in touch with loved ones while away at school, sharing an

experience with a close friend, or contacting a faculty member about a class project, Sorenson VRS continues to be the ideal communication bridge for deaf and hard-of-hearing students."

About Sorenson VRS

As a service to the deaf and hard-of-hearing community, Sorenson Media developed the Sorenson Video Relay Service (VRS), an exclusive integrated solution of videophones and video relay software that offers the highest-quality video relay service in the nation. The deaf and hard-of-hearing are able to conveniently place video relay calls to anyone through either the Sorenson VP-100 videophone appliance connected to a TV, or a personal computer equipped with a Web camera and Sorenson EnVision SL video relay software or Microsoft NetMeeting. Hearing users who want to place a video relay call through a standard telephone line to a deaf or hard-of-hearing user may access Sorenson VRS toll free by calling 866-FAST-VRS (866-327-8877) and giving their contact information (i.e., name, videophone number, or IP address) to the video relay operator. Sorenson VRS takes care of the rest by routing the call with the user's preferences through the Sorenson VRS Call Center to a certified interpreting agent. For more details on Sorenson VRS, please visit www.sorensonvrs.com.

About the Oregon School for the Deaf

Established in 1870, the Oregon School for the Deaf (OSD) is one of Oregon's oldest and proudest state-operated programs. OSD is an important part of the Oregon Department of Education's services to children, families and school districts in the state of Oregon. OSD provides comprehensive, specialized, educational services for children who are deaf or hard-of-hearing in a setting that is communication accessible through the use of American Sign Language by all staff. High-quality teachers, educational support services specialists, and residential staff work closely with parents, school districts, and other professionals and community partners to meet the needs of each child. Approximately 140 students who range in age from 5 to 21 are served at the Salem campus, while the Outreach program serves as a clearinghouse for information about deafness for Oregonians of all ages.

About Sorenson Media

Sorenson Media (www.sorenson.com and www.sorensonvrs.com) is the recognized technology leader in video services, video compression, and video communication to improve the quality of communication over the Internet. The company's products and services include the industry's highest-quality video relay service, award-winning video compression solutions, and the market-leading broadband Internet videophone technology.

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Mulholland added, "The Sorenson videophone technology and relay service was demonstrated to families and visitors at a recent open house at OSD. Many parents and students explained how this technology has positively impacted their family communication."

"With my son away at OSD, Sorenson VRS has greatly improved the way we communicate and therefore, changed our relationship for the better," said Jessica Thirkell, hearing mother of OSD deaf student, Austin Martini. "Being able to communicate instantaneously has allowed him to reach me in an emergency, when he has had a bad day, or when he has had the best day of his life. I no longer have to wait for the weekends to catch up with him. Sorenson VRS lets me know now. That is a huge relief to a mother who doesn't get to see her child every day."

"Sorenson VRS is honored to be selected by OSD," said Pat Nola, COO at Sorenson Media. "Whether students are staying in touch with loved ones while away at school, sharing an

experience with a close friend, or contacting a faculty member about a class project, Sorenson VRS continues to be the ideal communication bridge for deaf and hard-of-hearing students."

About Sorenson VRS

As a service to the deaf and hard-of-hearing community, Sorenson Media developed the Sorenson Video Relay Service (VRS), an exclusive integrated solution of videophones and video relay software that offers the highest-quality video relay service in the nation. The deaf and hard-of-hearing are able to conveniently place video relay calls to anyone through either the Sorenson VP-100 videophone appliance connected to a TV, or a personal computer equipped with a Web camera and Sorenson EnVision SL video relay software or Microsoft NetMeeting. Hearing users who want to place a video relay call through a standard telephone line to a deaf or hard-of-hearing user may access Sorenson VRS toll free by calling 866-FAST-VRS (866-327-8877) and giving their contact information (i.e., name, videophone number, or IP address) to the video relay operator. Sorenson VRS takes care of the rest by routing the call with the user's preferences through the Sorenson VRS Call Center to a certified interpreting agent. For more details on Sorenson VRS, please visit www.sorensonvrs.com.

About the Oregon School for the Deaf

Established in 1870, the Oregon School for the Deaf (OSD) is one of Oregon's oldest and proudest state-operated programs. OSD is an important part of the Oregon Department of Education's services to children, families and school districts in the state of Oregon. OSD provides comprehensive, specialized, educational services for children who are deaf or hard-of-hearing in a setting that is communication accessible through the use of American Sign Language by all staff. High-quality teachers, educational support services specialists, and residential staff work closely with parents, school districts, and other professionals and community partners to meet the needs of each child. Approximately 140 students who range in age from 5 to 21 are served at the Salem campus, while the Outreach program serves as a clearinghouse for information about deafness for Oregonians of all ages.

About Sorenson Media

Sorenson Media (www.sorenson.com and www.sorensonvrs.com) is the recognized technology leader in video services, video compression, and video communication to improve the quality of communication over the Internet. The company's products and services include the industry's highest-quality video relay service, award-winning video compression solutions, and the market-leading broadband Internet videophone technology.

Remote Sign Language Interpretation Using the Internet

Glen Hughes[1], Bernard Hudgins[1] and James MacDougall[2]
[1]*Institute of Biomedical Engineering, University of New Brunswick (ghughes@unb.ca)*
[2]*Canadian Deafness Research and Training Institute (james.macdougall@mcgill.ca)*

Abstract

A technological solution was investigated as a way of accessing Sign Language interpretation services from a remote location by people who are Deaf. A number of participants including people who are Deaf, health professionals, counselors, employers, and Sign Language interpreters were involved in communication simulations that mimic what occurs in health care delivery environments, counselors offices and employment settings. Our data suggests the use of internet based video communication equipment can effectively be used to facilitate communication between hearing and Deaf individuals. The impact of the delivery of Sign Language interpretation services over the internet has the potential to dramatically change the way Sign Language interpretation services are delivered.

1. Introduction

Clear communication is essential for effectively interacting with people in many important situations such as when accessing health care services, government services or when interacting with employers. A portion of our population use Sign Language as their primary communication language. Sign Language is a visual language which is complete and includes its own culture. There are several variations of Sign Language such as American Sign Language (ASL) and Langue des Signes Québecoise (LSQ) which is similar to the concept of having various spoken dialects as found around the world. This project investigated and developed feasible technological solutions that can eliminate some of the communication barriers, and evaluated the technological solutions effectiveness, using simulations of real life scenarios encountered by people who are Deaf. In addition, the project tested the technology during the first inter-provincial remote Sign Language interpretation session using LSQ between Bathurst, New Brunswick, Canada and Montreal, Quebec, Canada.

The importance of this project is driven by the need for a solution to provide Sign Language interpretation services to people who are Deaf when they access health care services. The Canada Health Act mandates universal medical coverage to all its citizens. The primary objective of Canadian health care policy is to protect, promote and restore the physical and mental well-being of residents of Canada, and to facilitate reasonable access to health services without financial or other barriers [1]. Language barriers have been demonstrated to have adverse effects on access to health care, quality of care, rights of patients, patient and provider satisfaction and patient health outcomes [2]. Both case study literature and recent prospective studies indicate that absence of accessible services often results in failure to utilize preventative care, and delayed presentation for care [3][4]. Failure by a health care provider to take steps to remove any communication barriers that may result in misunderstandings by the patient, therefore providing invalid consent to treatment, could result in hospital liability [5]. The error rate of untrained "interpreters" (including family and friends) is sufficiently high as to make their use more dangerous in some circumstances than no interpreter at all. This is because it lends a false sense of security to both provider and client that accurate communication is actually taking place (US Office of Minority Health, 1999). Fear of losing confidentiality when professional interpreters are not available may result in both avoidance of care and reluctance to disclose information that may be embarrassing or stigmatizing [4][3]. A landmark ruling in 1997 by the Supreme Court of Canada determined that hospitals were required to provide interpreters for patients who are Deaf [6]. A study by Zazove in 1993 revealed in a survey of 87 people who are Deaf that 59% stated they understood their doctor "sometimes" or "not at all" [7]. The patients also noted their health care providers often wrote illegibly or wrote notes that were beyond their literacy level.

The use of a Sign Language interpreter is often the only way non-signing individuals can communicate effectively with people who are Deaf [8]. Accessing interpreters in an emergency situation is often difficult in rural areas. Interpreter accessibility for people who communicate using LSQ outside of Quebec and for people who communicate using ASL in the province of Quebec is also difficult to arrange in a timely manner.

Using modern technology, services in Sign Language can be delivered to remote and rural areas from a distant location where a health professional who communicates in

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Sign Language resides [9]. This has been successfully implemented using dedicated high bandwidth communication lines with mental health professionals proficient in Sign Language at the remote station [9]. The concept of using a video conferencing link to provide interpretation has been applied in a number of areas and several firms in the United States provide "video relay" interpretation services. Using this service, when a client wishes to telephone someone, the client and the interpreter use a videoconferencing system to converse using ASL and the interpreter then speaks on the telephone with the person to be contacted. These systems are most often built around multiple ISDN telephone lines that allow data transmission at 128Kbits/second. They are relatively expensive and generally are unavailable in a practical way in a small facility or home. The minimum bandwidth to provide 30 frames per second video at reasonable resolution is approximately 400Kbits/second, which requires roughly three ISDN telephone connections. Video conferencing used in commercial and hospital applications frequently use double the number of lines. Internet based interactive video offers an alternative that has the potential to be equivalent or better picture quality, less expensive, and more convenient [10][11]. These concepts are modified and refined in this project to investigate the provision of Sign Language interpretation services to people who are Deaf using the services of a remote interpreter via the internet.

2. Methods

2.1 Project locations

The project required the location of equipment at a number of different sites to facilitate the collection of data. Systems were located in Saint John, Moncton, Fredericton and Bathurst in the province of New Brunswick and a system was located in Montreal, Quebec (see Figure 1).

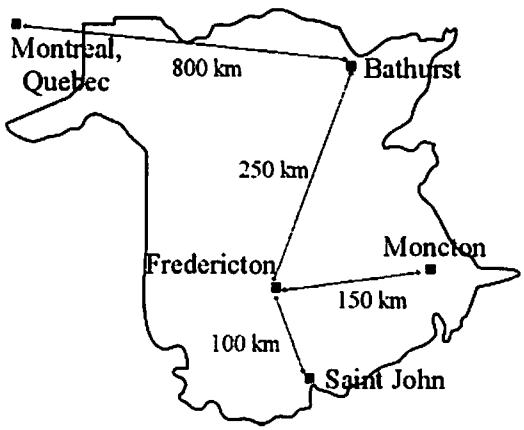

Figure 1. Project equipment sites in Canada.

2.2 System design

The video communication systems used in this project were developed by Polycom Inc.. The Polycom equipment was chosen due to their product quality, affordability and because of the availability of their small computer based unit, the Polycom ViaVideo system, which is compatible with their other video communication equipment. The system cost was identified as an important aspect of the solution if widespread use was to become a reality.

Two different types of Polycom systems were acquired for the project, namely SP128 Viewstation systems and ViaVideo systems. The SP128 Viewstation systems were used with a 27" television screen mounted on mobile carts and resembled typical videoconferencing equipment.

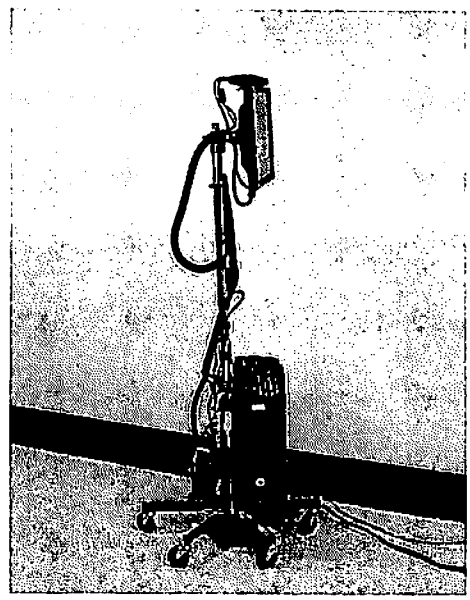

Figure 2. ViaVideo system on infusion pump stand.

The ViaVideo systems were used with Pentium 4 based computers, both desktop systems with 17" flat screen displays and notebook computers. Two of the desktop computer based ViaVideo systems were mounted on mobile infusion pump stands (see Figure 2) so they could easily be moved around and raised/lowered in a medical setting. The infusion pump stand was chosen because it provided a safe means of raising the screen and ViaVideo camera vertically allowing for viewing and video capture of signing when a client was lying on a hospital bed. Two other desktop computer based ViaVideo systems were mounted on mobile multimedia carts allowing for easily repositioning the systems within an office setting. There were also additional ViaVideo systems used with notebook computer systems for mobile use.

The systems connected to the internet via ADSL connections. The ADSL connectivity used was rated capable of up to 640 kbps upload and 2Mbps download.

The SP128 Viewstation systems needed a router to provide a user name and password to the ADSL modem to establish a connection to the internet. The computer based units could connect directly to the ADSL modem. In addition to the ADSL connectivity, some testing was done using the University of New Brunswick computer network and high speed cable internet connectivity as well.

2.3 Applications

The applications being investigated as part of this project focused on the use of the equipment to access the services of a Sign Language interpreter located in another city or province. The Sign Language interpreter facilitates communication between the person who is Deaf and the hearing person by signing the hearing person's speech to the person who is Deaf and vocalizing the signed communication to the hearing person (see Figure 3). In particular, the usage of the equipment was evaluated when accessing physical health care services, mental health services, community and social health services, employment counseling and employment related meetings. In addition, usage when communicating in both American Sign Language (ASL) and Quebec Sign Language (LSQ) was validated.

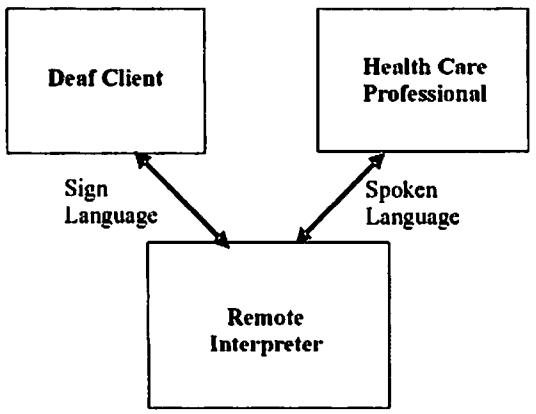

Figure 3. Communication channels.

2.4 Data acquisition

Data was collected using questionnaires that were completed following simulated sessions of typical encounters between people who are Deaf and hearing participants in the target applications for the project. The target applications were physical health care services, mental health services, community and social health services, and employment related services. The questionnaires were completed by the three main participants in the simulated sessions, namely the client/patient who is Deaf, the Interpreter and the Health care/Information provider. The questionnaires gathered information about the session characteristics, technology quality and session experience. Additionally, some testing, data gathering and analysis was done to get a better understanding of the impact of the different internet connectivity options we were experimenting with.

3. Results

The following tables summarize the results from the technological aspects of the questionnaires completed by all the project participants as well as some observations made of the system performance when using different connectivity options.

Question	Client	Health Care Professional	Interpreter
Session length (in minutes)		12.41 (10.10)	
Picture quality*	4.88 (1.45)	NA	2.47 (1.59)
Sound quality*	NA	5.67 (0.56)	4.82 (0.88)
Used finger spelling	60%	NA	70.59%
Quality for finger spelling*	4.71 (1.65)	NA	3.69 (1.23)
Position of system when sitting*	5.12 (1.36)	5.71 (0.77)	4.35 (1.93)
Position of system when lying down*	5.56 (0.73)	5.89 (0.33)	5.20 (1.79)
Comfort level with system*	5.29 (1.26)	5.12 (0.86)	2.47 (1.62)
Suitability of system for task*	4.88 (1.41)	5.53 (0.72)	4.47 (1.70)

Table 1. Physical / mental health sessions (n=17)

Table 1 contains the results from the physical/mental health sessions. There were a total of 17 sessions in this category with a distribution of 10 different clients, 6 different information providers and 3 different interpreters. A six point linear scale was used for items marked with a * which assigns a value of 6 for best and 0 for worst. The values listed in Table 1 are the mean response from each group with the standard deviation listed in brackets below the mean value. All clients indicated they understood the health care professionals and thought the health care professionals understood them. All information providers indicated they understood the clients and thought the clients understood them.

Table 2 contains the results from the community and social health, employment counseling, and employment related meeting sessions. There were a total of 23 sessions in this category with a distribution of 16 different clients, 8

different information providers and 3 different interpreters. A six point linear scale was used for items marked with a * which assigns a value of 6 for best and 0 for worst. The values listed in Table 2 are the mean response from each group with the standard deviation listed in brackets below the mean value. All clients indicated they understood the information providers and thought the information providers understood them. All information providers indicated they understood the clients and thought the clients understood them also.

Question	Client	Information provider	Interpreter
Session length (in minutes)		14.00 (7.34)	
Picture quality*	4.5 (1.19)	NA	3.65 (1.67)
Sound quality*	NA	5.13 (0.97)	4.26 (1.18)
Used finger spelling	80%	NA	86.96%
Quality for finger spelling*	4.57 (1.12)	NA	3.68 (1.32)
Position of system*	5.09 (0.97)	5.22 (0.95)	5.47 (0.84)
Comfort level with system*	5.32 (0.78)	5.57 (0.90)	3.00 (1.24)
Suitability of system for task*	4.91 (1.06)	5.22 (0.95)	5.04 (0.82)

Table 2. Community and social health, employment counseling, and employment related meeting (n=23).

4. Discussion

There are a number of issues that need consideration with regards to this project and its results. The environment in which the equipment is located, Internet connectivity / inter-network delays and performance, equipment selection, session type and the participants involved in the sessions are all important factors.

4.1 Environment

The environment is an important aspect that has considerable impact on the quality of the sessions. The primary environmental issues of concern include the lighting, background colors, background noise, and participant clothing.

The environmental lighting should come from ceiling lamps or from lighting mounted behind the video communication system and facing the participants. Lighting provided naturally from a window is difficult to control and is preferably eliminated as this can create some unwanted shadows and color contrasts that reduce the clarity especially when the window is located on a side or behind the participant. Natural lighting provided from a window behind the video communication system is less than optimal as well due to the frequent fluctuations in intensity which impact the brightness and colors of the video being sent.

The background colours and clothing worn by the system users can have a significant impact on the quality of the session. Clothing colors that contrast with the background colors and skin color provide the better combination for Sign Language communication with the system. Plaid, vertical stripes and complex designs on shirts made sessions quite difficult due to the constant movement and changes in colors on the shirts. There also appeared to be some over-compensation occurring on some systems when the participant wore a dark shirt that had little contrast to the background color. This resulted in the persons face appearing excessively illuminated with loss of facial features rendering Sign Language communication, which relies heavily on facial expression, more difficult.

Background audio noise can be a problem when using the system in a noisy environment. The Sign Language interpreters found the sessions more difficult in a noisy environment. The noise is more problematic when the interpretation is provided remotely than when provided in person. This is due to the loss of visual cues from the vocal participant as this participant is not always within the view available to the remote Sign Language interpreter.

4.2 Connectivity and equipment selection

The internet connectivity used in the project consisted primarily of ADSL connections with some testing done using Cable internet connectivity. We found that communicating at a bandwidth of 384 kbps allowed for close to 30 frames per second quality which was determined to be adequate for communication using Sign Language. We discovered that the quality of service (QOS) had an impact on the quality of some sessions and that equipment selection, network delays and network performance issues impacted the quality of sessions as well. The ADSL service in New Brunswick is rated at 2Mbps download and 640kbps upload. The Cable internet connectivity is rated at 2Mbps download and 384kbps upload. Table 3 displays our qualitative assessment of performance using different equipment and internet connectivity options. A qualitative evaluation of the performance was chosen because of difficulties in collecting useful technical data about the data communication session. We noticed that the stand alone SP128 unit and the computer based ViaVideo systems seem to handle network errors, delays and performance issues differently. The stand alone SP128 unit reacted to QOS issues by maintaining a good quality picture which was jerky at times while the ViaVideo system would tend to maintain a smoother video flow with some pixelation appearing in areas on the screen. There were some particularities that we encountered when using different

combinations of equipment choices and internet connectivity that we can only theorize about. Some instances of this are as follows:

When using the SP128 with ADSL to connect to a ViaVideo system on Cable, the SP128 would not be useable for communication. We theorize the SP128 was not useable with this configuration as a result of the fairly large time lag between the ADSL and cable networks in our area which we discovered was on average 97ms and included 17 hops. We did not notice any excessive amount of packet loss or packet jitter using this connectivity combination. The same network configuration using a ViaVideo system to ViaVideo system for communication provided a quality communication channel and we theorize that the computer based systems were better able to handle large network time lags than the SP128 system.

Base unit	Remote unit	Internet Connectivity	Quality of Session
SP 128	SP 128	ADSL / ADSL	Good
SP 128	ViaVideo	ADSL / ADSL	Very good
SP 128	ViaVideo	ADSL / ADSL(2)	Good
SP 128	ViaVideo	ADSL / ADSL(3)	Good
SP 128	ViaVideo	ADSL / Cable	Not useable
ViaVideo	ViaVideo	ADSL / ADSL	Very good
ViaVideo	ViaVideo	ADSL / ADSL(2)	Not useable
ViaVideo	ViaVideo	ADSL / ADSL(3)	Good
ViaVideo	ViaVideo	ADSL / Cable	Good
ADSL = Dynamic IP (in New Brunswick)			
ADSL(2) = Static IP (older ADSL network in New Brunswick)			
ADSL(3) = Dynamic IP (in Quebec)			

Table 3. Influence of equipment and internet connectivity on quality of session.

When using a ViaVideo system and ADSL to connect to a ViaVideo system on an older ADSL network within New Brunswick we discovered the connection would spontaneously disconnect after a few seconds and was thus unusable. We found in this instance that packet jitter was twice the maximum amount we had ever experienced in any sessions on other networks. We did not notice any excessive packet loss or excessive time delay using this connectivity combination. We theorize that the ViaVideo systems have difficulties maintaining a connection to another ViaVideo system when experiencing excessive jitter. The same network configuration using a SP128 system to ViaVideo system for communication provided a quality communication channel and we theorize that the SP128 is able to handle packet jitter more effectively than the computer based ViaVideo systems. There may be other reasons to explain the above mentioned particularities such as packet size variations between systems, Internet Service Provider (ISP) networking equipment components and configurations, etc. but these issues are beyond the scope of this project. A combination of limited in-depth technical documentation about the systems used and the limited value of data provided from the units regarding networking issues made precise identification of problems difficult. It is good to know there are network related performance issues that may arise when implementing such systems that may need to be resolved to allow optimal function of the equipment, and that these performance issues may not be apparent when using other types of bandwidth intensive internet applications.

4.3 Session types

The sessions simulated during the data collection process encompassed typical sessions the video communication could be used for in order to provide access to a Sign Language interpreter services. The sessions included communicating with health care professionals when sitting or laying on a hospital bed, communicating with mental health counselors, communicating with social and employment counselors, and communicating in employment situations.

4.4 Participants

The participants involved in the data collection process included typical users of such a system. We captured feedback about the sessions using questionnaires that were completed by the participants after each session. This provided three different perspectives on the usage of the video communication system during simulated sessions.

The participants who are Deaf were impressed with the video image quality and that it could be used to communicate effectively in Sign Language with people at another location. All participants who are Deaf indicated they were able to understand the person they were communicating with (the vocal participant), and they indicated they thought the person they were communicating with (the vocal participant) understood them as well. A sample of opinions expressed by participants who are Deaf include preferring the remote Sign Language interpreter to a live interpreter for privacy reasons, preferring the live interpreter at all times, seeing the technology as a needed communication option until a live interpreter could be present during an emergency, and no preference between a live or remote interpreter.

Health professionals expressed a need for either training on how to use the system effectively and independently or preferably having the system set up and supported by readily available technical support in case they encounter technical problems. The health providers indicated the

system works well but they find it difficult not having / maintaining eye contact with the patients when communicating. Some found they were looking more at the interpreter on the screen than the patient and that this is something they would need to try and avoid during actual use of such a system. Health professionals stated it gets easier after each session. One health professional stated she thought the remotely located Sign Language interpreter was less distracting for her than when the interpreter is present in the room with her and the patient.

The Sign Language interpreters were more critical of the system and its performance than the other participants. This may be as a result of their professionalism and concerns about what they view as shortcomings of the system compared to their standard method of live interpretation service. The Sign Language interpreters had concerns about not being able to see the vocal participants in some sessions which they indicated was important although they indicated this was less of an issue for sessions of short duration. Attempts were made when possible to include the vocal participant in the view of the interpreter after this concern was voiced which alleviated this concern. The interpreters were concerned about jerky and pixelated video images that would occur at times during sessions which we attributed to network QOS issues. Some interpreters expressed concerns about the colors and patterns on the clothing worn by some of the participants who are Deaf which made communication more difficult. Some interpreters felt like they were missing out on information because they were not able to easily see items being shown or demonstrated to patients such as technical aids. Overall, on a linear scale from 0 to 6 where 6 is the best, the Sign Language interpreters gave a rating of 5.35 to the question "Do you think the health professional understood the client?" and a rating of 5.13 to the question "Do you think the information provider understood the client?" for the sessions where the vocal participants were not health professionals.

5. Conclusion

This project demonstrated that communication in Sign Language using high bandwidth Internet connectivity is possible. The project also demonstrated that the provision of Sign Language interpretation services from a remote site using high bandwidth Internet connectivity is possible. The impact is a potential shift in the way Sign Language interpretation services can be delivered to people who are Deaf when accessing certain services. This new way of delivering services should lead to a better quality of life for people who are Deaf due to easier and timelier access to interpreters. Sign Language interpreters should also benefit from the introduction of remote video interpretation as a result of a reduction of the travel requirements associated with this line of work. There are still challenges such as quality of service issues and excessive packet delays such as experienced when communicating between systems that are on different networks. The impact of this should be reduced in the future as communication networks and video communication codecs become faster and more efficient.

6. Acknowledgements

This research was possible due to financial contributions by CANARIE Inc., the New Brunswick Innovation Foundation, and the University of New Brunswick. Additionally, the involvement and insight provided by project participants, both hearing and Deaf, and project partners were paramount to the success of this initiative and must be acknowledged. We would also like to acknowledge the invaluable help and guidance provided by Lynn LeBlanc from the Saint John Deaf and Hard of Hearing Services, Laura Peters from the South East Deaf and Hard of Hearing Services, and the Association of Visual Language Interpreters of New Brunswick.

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Technology and Regional Social Structures: Evaluation of Remote Sign Language Interpretation in Finland

Jouko Kokko, Erkki Kemppainen, and Aulikki Rautavaara

Stakes, PBox 220, 00531 Helsinki, Finland
Jouko.kokko@stakes.fi

Abstract. During the years 2001–2004 STAKES implemented a national development project VETURI - networking interpreter services -. Its objective was to improve the preconditions for the availability and quality of interpreter services. The starting point for this development work was to provide a service with a sufficiently large population base, in the form of regionally co-ordinated network co-operation of a variety of stakeholders. A part of the service in the project was given as remote videophone service. Remote interpreting made an interpreter's work easier because she did not need to travel and was able to work from a familiar work location. New ways to produce services enabled the growth of remote interpretation service. Larger population base and service resources made it possible to bring service also there where it has not been earlier.

Keywords: Disability, Interpretation service, hard of hearing people, ICT.

1 Introduction

The aims of Finland's disability policy are equitable treatment and support for life management, working capacity, functional capacity and independence. Measures include services, rehabilitation and removal of barriers. The aim is for all general services to be appropriate and sufficient for all citizens; special services such as housing, assistive devices, transportation and interpreter services are never a first resort.

A personal service plan is drawn up for each disabled person to clarify the services and support he or she requires. Officials of the municipality together with the client and his or her carer or relatives prepare the plan. The service plan is designed to improve the clients' autonomy and their possibilities to influence their situation. A counsellor, who is tasked to accommodate the various services together and call meetings of other relevant officials, checks the plan within specified timeframes [6].

1.2 Interpretation Services

People whose hearing is severely impaired, who are deaf and blind or who suffer speech disabilities are entitled to free interpretation services arranged by their municipality. Interpretation services are provided in sigh language or, for example, using new technology [6].

C. Stephanidis (Ed.): Universal Access in HCI, Part I, HCII 2007, LNCS 4554, pp. 716–721, 2007.

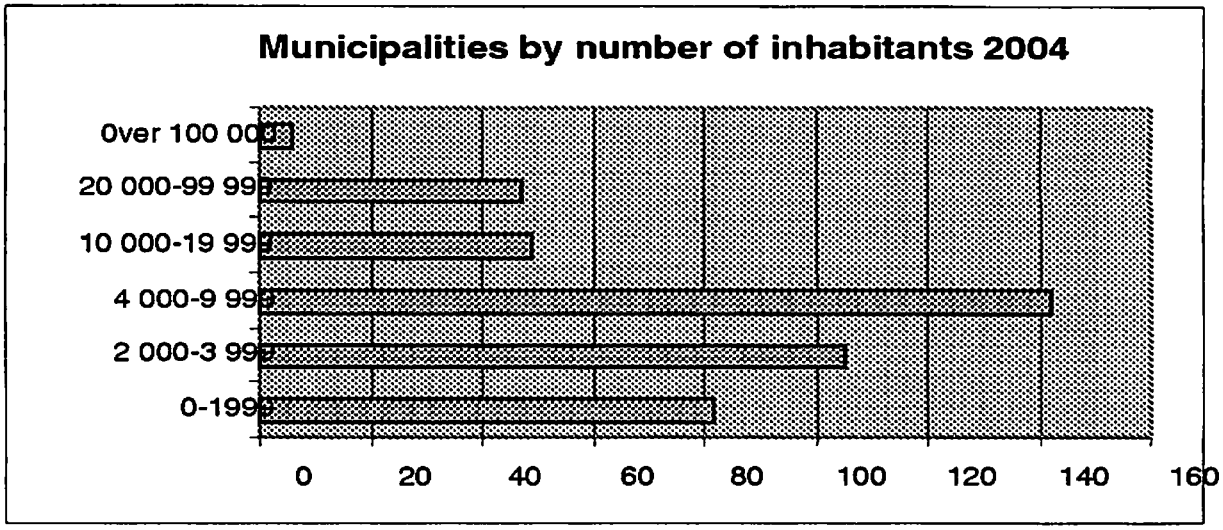

Fig. 1. Municipalities by number of inhabitants 2004 in Finland

The responsibility for the arranging of interpreter services lies with municipalities, which must arrange a minimum of 120 hours of interpreting per year for deaf sign language users (1.1.2007 180 hours). There were 432 municipalities year 2005 (417 year 2007) in Finland. Most of municipalities are rather small, the number of inhabitants is under 10 000 [1]. The population is concentrated in South-Western Finland and eastern and northern parts of Finland are sparsely populated, 2-7 persons per km^2. Also the distances are rather long. About 30 % of all municipalities did not give interpretation services in 2005 [5]. This means that usually small municipalities don't have the skill.

Table 1. Interpreter service recipients during the year [5]

1994	2000	2003	2004
2716	3137	3351	3398
% of the population			
0,05	0,06	0,06	0,06

2 Development Project

During the years 2001–2004 National Research and Development Centre for Welfare and Health (STAKES) implemented a development project VETURI - networking interpreter servioces - commissioned by the Finnish Ministry of Social Affairs and Health. Its objective was to improve the preconditions for the availability and quality of interpreter services set by the Act on Services and Assistance for the Disabled, throughout Finland. The starting point for this development work was to provide a service with a sufficiently large population base, in the form of regionally co-ordinated network co-operation of a variety of stakeholders [4].

A part of the service in the project was given as remote videophone service. In the project videophone consisted of pc-computer, video camera, ISDN or IP connection and videophone software. In the beginning there were more ISDN connections but later most of them were changed to IP connections. The project did not provide any new equipment but both the customers and services centres used their own equipment.

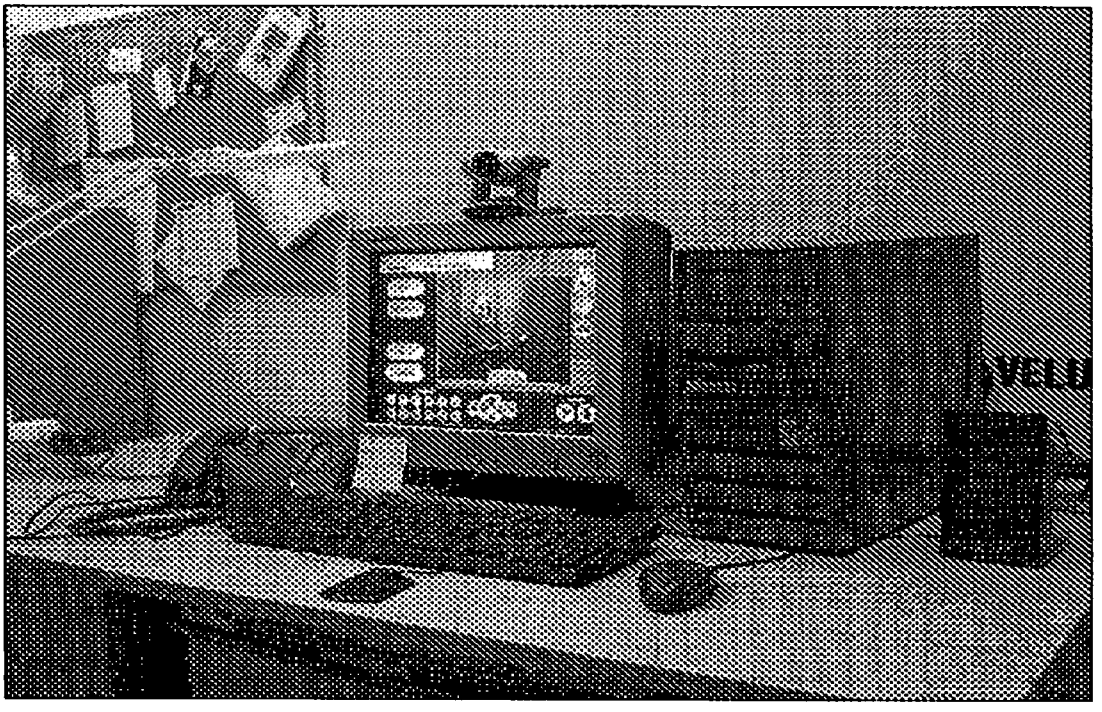

Fig. 2. Videophone workstation [3]

Interpreter was using one workstation and user contacted her/him from another workstation. Usually hard of hearing or death person uses her/his own workstation to order interpretation service. Workstation can be also in some other place for instance in social office. Then often social worker takes connection to interpreter and dialog between hard of hearing customer and social worker begins via interpreter. This is called a two point service.

A multipoint service started during the project and this is a goal. There all three persons can be in the different places. The service centre takes all the calls. The interpretation service is decentralized to different interpretation organisations and locations in the country. A duty list is prepared for interpreters. The caller can see the list of available interpreters and can connect to the first in the list or someone familiar. In some cases the server in the service centre has software for invoicing. It has records of clients, interpreters and the municipalities which pay the service. According to time used and other circumstances program calculates the bill and sends it to responsible municipality.

Requirements to equipments and software are: basic pc or laptop computer, video camera, ISDN (2x3x124 Kb) or Internet connection (2x 384 Kb, recommended 1 Mb), videophone software with voice communication facility (recommended also text) (frame rate minimum 18 p/sec, recommended 25 p/sec).

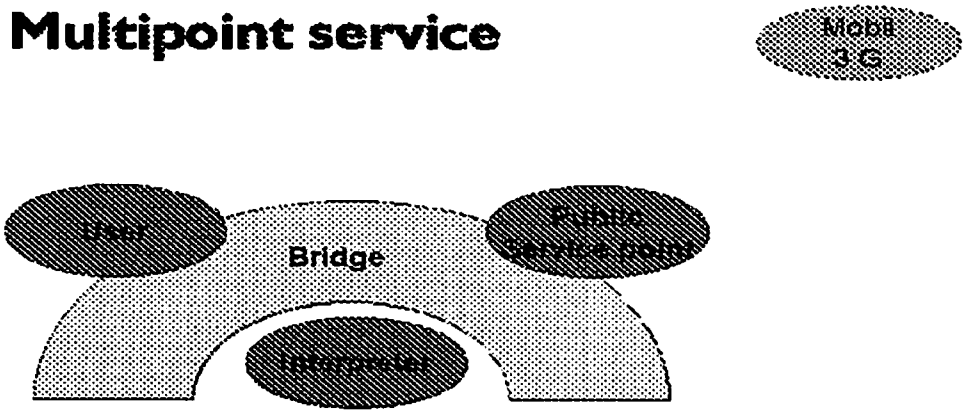

Fig. 3. Multipoint remote interpretation service

There have been technical problems especially with firewalls. Some programs change all the time ports for communication. This means that several ports ought to be open through the firewall during connection. Certain software requires fast IP address, but home users have it rarely. Compatible problems occur also quite often. But all the same technology has been working pretty well. To get a reasonable video picture a user needs 384 Kb connections to both directions. In practice the speed ought to be bigger rather 512 Kb to both directions. Selected software seems to work well also in wireless (wlan) environments [2].

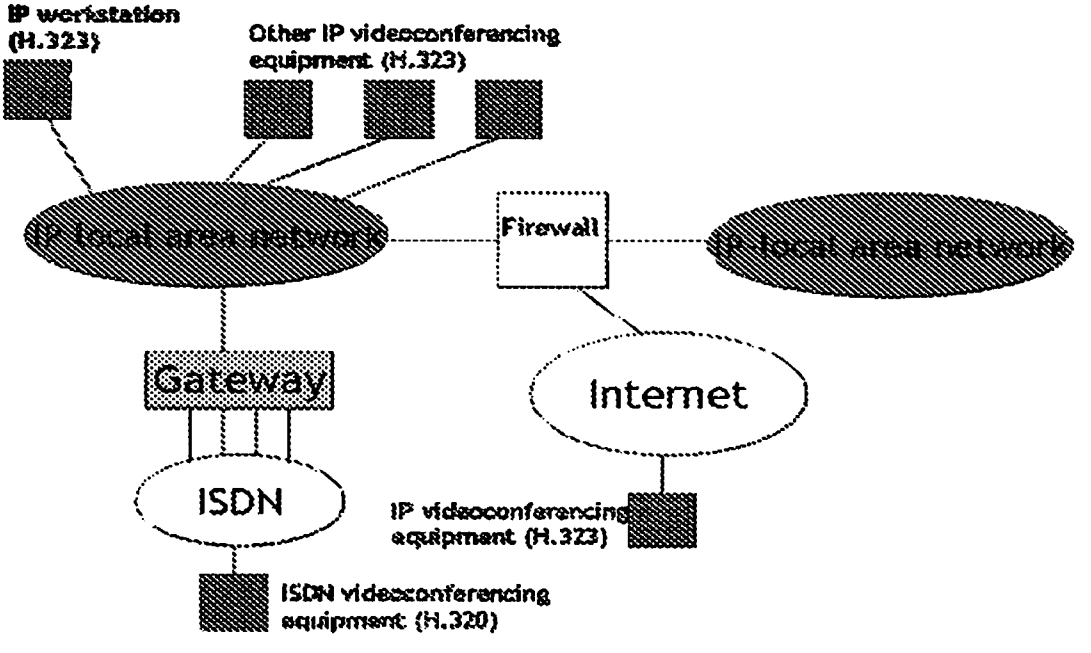

Fig. 4. Remote interpretation network [2]

3 Evaluation

The goal of the evaluation was to define the efficiency of the network project and its impacts on the regional development work of the interpreter service. The main source of information was the response data obtained from a thematic survey addressed to the regional presidents of the VETURI groups. Additional source material included project feedback from 2005, obtained from STAKES Information Services, as well as documentation and interim reports of the project. This material was related to the organisation and co-ordination of the project and contained descriptions and analyses of information systematically collected during the project from the presidents of the regional groups.

According to the impact evaluation, VETURI project generated the expected benefits. Positive outcomes include strengthening regional thinking with regard to organising and providing interpreter services. The utilisation of regional resources and their channelling in support of municipalities has been improved. The project set significant regional change processes in motion. New service structures, working and operating methods were developed out in different parts of Finland. Some of these are now established as permanent activities in the service structure, and some results will be further developed in new development projects. Concrete decisions have been made and confirmed by agreements, on the regionally organised provision and sourcing of interpreter services, and more decisions are to be expected. Rising trends in demand for, and the supply of, interpreter services were confirmed in all project areas that answered the survey. Hidden demand in the regions is in the process of being identified. None of the groups using interpreter services faced a decrease in the provision of these services. The deployment of new technology showed progress in the regions, but differences existed in the speed of such development.

The preconditions for the availability and quality of interpreter services appear to be improving in different parts of Finland, in the intended direction. An interpreter service cannot be replaced with other services. Users of interpreter services need them during their entire lives, or the rest of their lives, after the initial need has arisen. An interpreter service is essential to the person needing it, in terms of the realisation of equality and social inclusion. There are ways and various alternatives for improving the irregular service situation for different regions and disability groups. In VETURI project, progress was made in finding solutions for many essential issues concerning regional co-operation. In the future, interpreter services will enjoy the support of expert resources organised into regional networks, newly launched projects and high-level interpreter training.

Despite this progress, mutual co-operation between municipalities in organising the services seems very challenging. It will also be necessary to continue finding solutions to issues concerning the division of work between, and specialisations of, regional providers. Much remains to be done regarding the use of information and communication technologies and their integration into service provision, as well as ensuring professional know-how and communication on the municipal level. The need for information within various disabled groups remains extensive.

The development of regional networks for one service type designed for the disabled has opened up horizons for the regional development of other services. In the

future, a possible and natural step will be to develop services for the disabled further, according to the customers' individual needs. This can be achieved by developing a particular service or by integrating services into a larger entity, necessitating agreement on how to ensure a sufficiently strong structural and economic base for them [4].

Remote interpreting made an interpreter's work easier because she did not need to travel and was able to work from a familiar work location. On the other hand, remote interpreting posed new challenges to an interpreter's work, because interpreting assignments came unexpectedly with a variety of topics and without a chance to prepare in advance. The use of technology also contributed to the challenging nature of the work [3].

New forms to produce services enabled the growth of remote interpretation service. Bigger population base and service resources made it possible to bring service also there where it has not been earlier. In some areas like in Northern-Carelia which is rather sparsely populated the amount interpretation service given as remote service raised to 12 %. Introduce of new technology can help in the strained economic situation of municipalities [4].

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CANADIAN NETWORK *for*
INCLUSIVE CULTURAL EXCHANGE

Remote Real-time ASL Interpretation Guidelines

Companion Document to the CNICE
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Editors and Contributors:

Michael Boyce, Sara Diamond, Deborah Fels, Elle Gadsby, Rob Harvie, Wendy Porch, Lake Porter, Jan Richards, Vera Roberts, Marc Rosen, Nancy Sicchia, Charles Silverman, Jutta Treviranus

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4 Remote Real-Time ASL Interpretation

1.1 Introduction

Video communication or video conferencing is becoming a much more commonly used and effective means of interpersonal communication (Finn, Sellen & Wilbur, 1997) such as for distance learning, business meetings and social communication. As hardware becomes more available and less expensive, and software, signal processing and compression technologies become more stable and efficient, there is an increasing interest and experimentation with the technology by the general public and by business.

Video communication technology is designed to support real-time communication between one or more users when long distances separate them. Video-mediated communications, as well as other forms of remote interpersonal communication (e.g., traditional telephony, email, and audio-only communication) are distinctive by the nature of the medium from which they are constituted (Olson, Olson & Meader, 1997). Each form of communication has particular strengths and weaknesses. The goal in using a particular communication medium is not to replicate identically that which can be easily achieved when interlocutors are face-to-face. Rather, it is to find ways to provide participants with a means to achieve all the interactions that are necessary to complete the defined task in a productive and efficient manner. We need to understand the strengths and weaknesses of each medium of communication in order optimize its use and find ways in which to overcome their weaknesses.

One of the strengths of video conferencing technology is the opportunity it offers people with disabilities to communicate with each other, with service providers and with business associates without having to travel. One important benefit relates to sign language users, who can communicate in their own language (using their own cultural expressions and dynamics) with each other and with people who are hearing and at a distance.

ASL speakers living in remote communities can now have access to and participate in Deaf culture where Deaf cultural events are often limited to urban settings with a large population of ASL speakers. Other telecommunications technologies such as the telephone, TTY devices and synchronous chat use text and so do not allow sign language users to communicate in their first language. For people who use sign as their primary language, text based expressions of a spoken language like English should be a viewed as second language and as such is a significantly less expressive and intuitive language for sign language users. Through video communication technology, sign language users can now have access to a more equitable means of communication. Sign language users have been

experimenting with video mediated communication for some time and many lessons have been learned to mitigate some difficulties encountered with video conferencing technologies.

In order to ensure that people with disabilities are adequately served by video conferencing technologies and remote meeting procedures we must ensure that the technology and procedures are inclusive and accessible. Guidelines that have been established for video conferencing situations may not be inclusive particularly for users who are deaf. Researchers at Gallaudet University have devised some guidelines to assist sign language users in experiencing more effective one-on-one video mediated signed communication (Williams, 2002) based on the findings and recommendations of the above research. However, these guidelines only apply in one-on-one situations with small field-of-view cameras; they have not been extrapolated to one-to-many situations with high end technology or where there is an interpretation need – a potentially common application.

While video conferencing technologies offer exciting opportunities to support people with disabilities, there is a dearth of research, case studies and best practice literature to support the procurement, installation, management and operation of inclusive video conferencing services. This report provides a set of guidelines and best practice statements that will assist organizations and individuals in establishing accessible video conferencing.

In this document, there is a focus on guidelines for users who are sign language users or who are hard of hearing. These two groups of people have the greatest variety of unique needs for video conferencing. Lack of accessibility therefore has the greatest impact on them. In this document, we provide an overview of the technology, a description of remote sign language interpretation issues and requirements, small case studies and user reports. Specific access issues are identified and discussed followed by guidelines and recommendations to address these issues. Many of these recommendations are based on our experiences since 2003 using high-end video conferencing for remote interpretation.

1.2 Technology Overview

Before addressing the unique aspects of video communication for people with disabilities, we will provide a brief review of common video communication technologies. There is a standard and common set of hardware technologies and configurations for video conferencing regardless of how the system is used and who the users may be. First, video conferencing relies on having network connectivity so that video and audio signals can be transmitted in real-time over a distance (often over long distances).

There are two main types of network transmission technologies used for video conferencing, Integrated Services Digital Network (ISDN) and Internet Protocols (IP). ISDN, introduced in 1984, is designed to allow fast digital point-to-point connections over the public telephone network (Total Access Networks, 2004). Video communication signal processing and transmission are guided by the International Telecommunication's Union (ITU) H.320 video standards (Polycom, 2001). Guaranteed and consistent quality of service is provided by ISDN as the signal does not fluctuate with network availability

because it is a continuous feed and direct connection. Common transmission speeds for ISDN used in video conferencing applications range from 128 kilobits per second (kbps) to 384 kbps. These transmission speeds allow audio-video signals to be consistently transmitted at near broadcast quality (broadcast quality video transmission is 29.95 frames per second (fps)). The cost of this service is based on a monthly line charge (e.g., for 128 kbps service, two 64 kbps lines are required) plus "on air" charges per minute. Video conferencing is "on-air" as soon as a connection is made and is only disconnected when the video conference is complete.

IP videoconferencing involves using Internet Protocols and technologies to process and transmit live video and audio signals. Video conferencing using IP protocols is governed by the ITU H.323 video standard (Polycom, 2001).

Internet protocols (IP) require that data signals are divided into small data packets and routed through various available networks rather than through the continuous feed, direct point-to-point connection available with ISDN. The IP video conferencing signals must share the network with all of the other Internet traffic resulting in inconsistent and fluctuating quality of the video and audio signals (ranging from 2 to 29.95 fps). As a result, high-speed Internet connectivity is required to have effective IP-based video conferencing. Much research and development effort has been placed in developing technical solutions for improving the quality of service for IP video conferencing. Some of this research that has met with some success includes better compression and signal processing techniques (Muresan, et al., 2002), and ways of assigning transmission priorities to video and audio signals (Babich & Vitez, 2000).

Gatekeeper technology is a network device that provides addressing service for H.323 (Internet-based) videoconference clients. It may also be configured to impose network bandwidth restrictions and to allow or disallow a call. Registration by the videoconference client usually takes place when the client is started; the address of the gatekeeper is put into the client's configuration. Use of a gatekeeper allows a videoconference device to "dial" another device using the videoconference address rather than an IP address (which could be changed by DHCP). Gatekeeper services might include bandwidth and call management. Bandwidth controls the number of H.323 terminals permitted simultaneous access to a LAN. Call Management maintains a list of active H.323 calls. This information indicates when a called terminal is busy, and provides information for the bandwidth management function. One or more gatekeepers may reside anywhere on the network, fully integrated into another networking device or operating as a standalone software application on a desktop computer.

Costs for IP-based video conferencing can be significantly lower than ISDN and are mostly related to the speed or bandwidth of connectivity rather than the length of time the video conference is in session. Cable modem or Digital Subscriber Line (DSL) connectivity is generally available and relatively inexpensive, and would be considered as the minimum bandwidth required. Similar to ISDN cost structure, the cost of this service is also based on a monthly rate plus "on-air" per minute charge for use. However, these costs are considerably less than ISDN because of the shared nature of IP-based networks. High-

speed networks, and/or fibre-based Ethernets only improve the quality and reliability of video conferencing but costs are significantly increased.

A multipoint videoconference allows more than one site to connect at the same time. A multipoint videoconference involving 3 or more sites is possible through the use of a bridge or multipoint control unit (MCU). Some pre-configured systems such as the Polycom FX have built-in bridges which allow you to connect to multiple sites. Third party services such as Bell Canada bridge services can be rented on an hourly basis.

The video communication system itself consists of two subsystems, one at each end of the network connection. Each subsystem is composed of at least one video camera with optional zoom controls, microphones (desktop or wireless), speakers, a small preview screen (picture-in-picture capability), and monitors or large screen televisions. These subsystems can be PC-based such as iVisit and Netmeeting setups or can be dedicated hardware such as a PolyCom™ ViaVideo® II. Many sources are available to describe the characteristics of the various hardware/software options (e.g., Video Development Initiative's Video Conferencing Cookbook, (VIDe, 2004) is a good source for general detailed information about video conferencing hardware).

There are many different types of subsystem hardware that range in quality and cost. The simplest and least costly hardware is a webcam (at $50.00) and PC-microphone. Often this type of hardware is "plug and play" technology that is directly accepted by the computer. As a result this type of setup can be installed directly and used immediately with software such as NetMeeting or iVisit. However, this type of hardware has few controls and adjustments. For example, a simple webcam may be limited to focus control (there are not lighting, motion or zoom controls).

The audio system for video conferencing consists of some combination of audio headset, telephone handset, microphones, speakers, and digitising devices (hardware and software). One of the most traditional microphones in video conferencing is the lavaliere microphone, which is a miniature microphone that you clip onto the clothing of the person speaking. Wearing a lavaliere microphone reduces the feedback noise that is picked up by the other type of microphones. A second common type of microphone is the room microphone, which is a unidirectional boundary microphone. These microphones lie on the surface of a conference table or desk. They detect speech with a clear, natural sound. This type of microphone is specially designed to filter out room acoustics – much more so than a conventional microphone on a desk stand. A third microphone type that is often used with desktop video conferencing is the stick microphone or microphone built into the camera. Such microphones lack good audio quality and can effectively shut down a video conferencing. These types of microphones are the least expensive audio solutions but they are also the lowest quality. There is no adjustment in the echo or gain features for these microphones.

As the quality of the camera and microphone setup increases there is a corresponding increase in functionality, controls and the cost of the hardware. For example, a top of the line camera may cost $2,500 but will have a considerable number of functions such as

zoom, pan and tilt controls, back light, and automatic tracking. In addition, the optics system in these types of cameras is of a much higher quality than typical webcams. These types of cameras are typically used with systems that allow remote control of camera functions so that the remote participant can control the zoom, pan and tilt functions of the remote camera.

1.2.1 Connecting IP technologies with ISDN

IP video conferencing systems and ISDN systems can be connected together using a gateway communication system. A gateway offers the most flexible link between ISDN (H.320) and IP (H.323) videoconferencing standards and delivers full interoperability between ISDN and IP endpoints. The Gateway integrates seamlessly to provide H.323 management and to control network capacity. For instance, you can conduct conference calls seamlessly from any endpoint to any other endpoint – regardless of system type or network configuration.

1.2.2 Bandwidth recommendations

Videoconferencing requires a large amount of data to be transmitted in a short amount of time. The recommended minimum amount of bandwidth is 384kbps for a typical business quality videoconference.

The main consideration for any video conference is how many frames per second are being transmitted. A good quality video conference requires 30 frames per second video transmission.

Any data rate higher than or equal to 384 kbps will support a video screen update of 30 frames per second, equivalent to VCR playback quality television.

Any data rate lower than 384 kbps will support a video screen update of 15 frames per second or less, which is still usable, but will appear slightly jerky under rapid motion.

1.2.3 Applications

A typical video conferencing interface is based on a telephone metaphor where remote participants are connected using telephone or telephone-like (IP address) numbers. Terminology such as dialing, hanging up, answer, busy, and address book is used to refer to the connecting tasks accomplished by users with the system. Unique aspects of the interface include video displays (local and remote windows) where the local window often appears as a picture-in-picture window in the main video window. Settings menus are often available to customise the look and placement of the video windows, and to adjust various technical properties such as compression quality or levels, video and audio settings and controls, and file management. On the high-end video conference interfaces there are also specialized camera settings for remote and local camera controls and automatic speaker detection.

Video conferencing can involve more than just the real-time transmission of audio and video images. Applications such as file and application sharing, logging audio and video, capturing and sending of static images, simultaneous text chat can be incorporated into video conferencing software. While all of these applications can be very useful in supporting work group needs, they can also interfere with communication strategies. In addition, appropriate access to all of these applications must be included for people with disabilities.

1.2.4 Physical space/Room technologies

Although the number of hardware providers of high end video conferencing equipment is relatively small and system configurations are limited, it is important to carry out a needs and task analysis, (i.e. what is the purpose of the video conferencing system in the organization and for what tasks will it be used) and an environmental survey. These surveys are useful in determining the system requirements, the human resources required to manage the system and an appropriate room or room modifications that might be required. The results of these analyses will have cost, management and timeline implications. For example, if lighting renovations are required the project budget will increase.

1.2.5 Environmental Considerations

In order to have effective video communication, the hardware must be properly configured and housed in an appropriate environment. There are numerous technical guidelines published to assist organizations and individuals in proper environmental assessments and setup for various configurations of video conferencing hardware (see Polycom, 2004; McAteer, 2000; and Brightline, 2002 to name a few) but few of these guidelines address the special considerations required to accommodate people with special needs, particularly sign language users and remote interpreters.

1.2.6 Future Considerations

Some industry pundits (Lee, T., 200X) suggest that instant messaging and mobile cell phone technologies will assist in the acceptance of personal video conferencing. Already, cell phones incorporate instant messaging capability with image processing and video capabilities. As the next generation enters the workforce they will already be exposed and using instant messaging and video conferencing., "These kids are ready for video conferencing because they were brought up in front of cameras their whole life." (Brandofino, M. Glowpoint Inc. page #.)

1.3 Technology issues related to accessibility

Video conferencing technology mostly involves audio and video communication mediated through computing and network systems. There is some, although considerable less, interaction with computer software required to carry out a video conference. Accessibility by people with disabilities involves access to communication. For people who have no communication disabilities, video conferencing remains accessible. For example, for

people who are blind or have low vision, the video conference becomes an audio-only conference. All of the standard audio conference issues such as, ensuring software applications are accessible to screenreaders, and the need to have visual materials made available prior to the conference and readable by a person who is blind are relevant here. However, none of these issues is unique to video conferencing and guidelines for inclusive audio conferencing, and access to images and other visual materials are available from other sources. An example of web guidelines are the Web Accessibility Guidelines of the W3C, (W3C, 2004).

For people who are keyboard users, there are also very few issues related to video conferencing applications that are different from other software applications. One unique issue is the accessibility of camera controls and pre-set buttons. These controls are often available through a remote control or button panels and/or software buttons. Remote control settings may need to loaded into specialized assistive technologies such as an environmental control unit in order to this person to access the camera controls. Where controls are provided through software, keyboard access is required to allow use of these controls.

The people with the highest need for access solutions to video conferencing then are people who are deaf or hard of hearing and who are non-speaking. The remainder of this report will focus on access issues and guidelines to ensure that there is access to audio and video communication for people who are deaf or hard of hearing.

1.3.1 Video conferencing and use with sign language interpreters for people who are deaf.

One exciting opportunity offered by video conferencing technology is that of supporting people who are sign language users in accessing sign language interpreter services; services that can be particularly difficult to obtain in geographically remote locations. Sign language interpretation is required to mediate communication between deaf and hearing people. When sign language users are in geographically remote locations, it is now feasible for them to have access to interpreter services using video mediated communication technologies. However, there are important considerations and differences to address. In this section, we discuss the unique issues that arise when remote interpretation is required and provide amendments to technical and use guidelines to account for these special needs. These recommendations are based on our experiences since 2003 using high-end video conferencing for remote interpretation.

We will also provide a brief introduction to sign language interpretation and video remote interpreting as a sub-specialty within sign language interpreting.

1.3.1.1 Sign Language Interpretation

Sign language interpretation is required when people who are deaf must interact with people who are hearing such as in business meetings, for court, and for accessing social and medical services. It is essential for providing equal access to these activities and services

for people who are deaf, and in many western countries it is required through legislative initiatives (for example, see the Americans with Disabilities Act, US Department of Justice, 2003).

American Sign Language (ASL) is the most prevalent sign language used in North America although it is not the only one (e.g., in Quebec, Canada Langue des Signes Québécoise is used). ASL, like other sign languages, is a visual-spatial language without much grammatical similarity to English (Stokeo, 2001). It is considered a linguistically complete, natural language system where the elements of the language are not equivalent to vowels and consonants of written languages, and it is not a translation of English. Vocabulary and meaning of concepts in ASL are expressed using a series of hand gestures, facial gestures such as eyebrow motion and lip-mouth movements, and body movements that change in time and space. This series of gestures cannot easily be represented by a single written or spoken word. Fingerspelling is used to spell out a word in alphabetic characters that has no sign. For example, there is no unique sign for email and it is therefore represented as the hand gestures for an "e", an "m", an "a", an "i" and an "l" separately.

In order for communication with hearing people to be effective in any situation, the person who is deaf must be able to completely express herself, and must also have complete access to the meeting and communication activities. Interpreters are required to provide a translation of what is said as well as broker any linguistic clarification required and cultural differences experienced between the two parties (Avery, 2001). In face-to-face situations with inexperienced participants, communication can be awkward and difficult. Common practices of turn-taking, participation, maintaining a common understanding and access are noticeably different from meetings that occur between all hearing participants or all sign language participants. For example, common cues to indicate a speaker is ready to relinquish the floor to another speaker are different between hearing and sign language users.

Hearing people use a variety of verbal and non-verbal signals such as eye gaze, asking a question of another person, and head turns to manage turn-taking (Preece et al., 2002) in a group environment. All of these signals are very subtle and learned and participants are generally unaware of when, where, how and the speed with which such tactics are used. Sign language users tend to use more obvious hand gestures such as pointing, and waving their hands to gain attention and fewer non-verbal cues.

In an interpreted setting, the flow of communication tends to be slower due to the translation process. In addition, the sign language user's visual attention is with the interpreter and not with others in the meeting. As such, they cannot attend to subtle turn-taking gestures, such as shifts in eye gaze employed by hearing individuals, in order to know that the speaking floor is available. Turn-taking must therefore be slowed down and made more obvious or formal so that sign language users have a chance to keep up and participate.

Other difficulties that arise in meetings between deaf and hearing participants include difficulties maintaining a common level of understanding because of the use of two

different languages to discuss common subjects, and difficulties with access to private or "whispered" conversations. These types of difficulties are not that different from those experienced during meetings between participants using two different spoken languages. However, the role of the interpreter can be very different. The sign language interpreter often must interject cultural and emotional interpretations, request clarification, and interrupt the meeting flow to allow the deaf person a chance to speak.

The role of the meeting chair in these kinds of interpreted settings is very important as management of the meeting is ultimately his responsibility. The meeting chair must be aware of the differences and needs of all meeting participants and take extra steps to ensure that all participants are included and involved.

1.3.1.2 Video remote interpreting

Video remote interpreting in general is identified by interpreting service providers as an enhancement to the existing service and requires specialised training and different terms of use. For example, the Association of International Conference Interpreters suggests that spoken language remote interpreters should only work for three hours per day and that video interpreting is significantly more fatiguing over a 30-minute turn than conventional face-to-face interpreting (Moser-Mercer, 2003). These restrictions and issues apply to sign language video remote interpreters and will likely be amplified because of the physical nature of sign languages.

Video remote interpreting is considered a specialization within the sign language interpreting field. It is defined as the use of video conferencing technology to provide interpreter services where a participant or the sign language interpreter is located at a geographically different location. Many of the difficulties evident in face-to-face meetings are amplified for video remote interpreting and new ones arise that reflect the weaknesses of video conferencing in general.

There are numerous organizations throughout the world that provide video remote interpreting services (My Video Interpreter, 2004; SignTalk, 2004; and Community Access Network, 2004 are three examples) but there is no standardized training protocol or guidelines to overcome some of the difficulties. In addition, there are few best practice examples that demonstrate ways to use the strengths of the technology and overcome some of the weaknesses.

1.3.1.3 Challenges of Video Remote Interpreting

Many challenges arise when video remote interpreting is employed. Some of these challenges relate directly to the quality of the camera hardware and the bandwidth of the video conferencing system. For example, remote interpreters must consciously adjust their natural signing space to accommodate the camera's field of view. They cannot sign outside of the area captured by the camera. Many high-end cameras have zoom controls that can adjust this field of view by zooming the lens either wider or closer. However, a wider field of view that shows more of an interpreter's natural signing space also captures more of the

background and surrounding scenery that can be distracting for the person who is deaf. Inexpensive webcams do not have an adjustable field of view and sign language users often must move farther away from the camera so that more of their signing space can be seen or they must restrict their signing to the area around their faces.

Fingerspelling tends to be very fast-paced and not well articulated in face-to-face situations. Only a very high bandwidth video conferencing system will not become pixilated and be effective for fast fingerspelling. Fingerspelling therefore must be slowed down and done closer to the interpreter's body. However, when fingerspelling slows down so does the rate of communication between deaf and hearing interlocutors. There is thus a significant impact on the potential for misunderstandings and for missed opportunities to turn take.

One important aspect of hardware technologies that has a large impact on the success of sign language use is the camera view angle or field of view. This is defined as the viewable area or scene that can be seen through the camera (Segal, 2004) and it is a function of the focal length of the camera lens. For example, a wide angle lens with a short focal length has a very large field of view or area of the scene that can be seen through the camera lens. Zooming in the camera increases the focal length and decreases the field of view to a much smaller area of the scene.

Remote interpreting removes the chance to develop rapport with consumers, and for that reason has been met with some resistance on the part of sign language interpreters.

1.3.1.4 Considerations for video remote interpreting

With video remote interpreting there can be three possible interpreter locations:

1) The interpreter is remote from both parties (hearing person and deaf person physically located together);
2) The interpreter is physically located with the person who is deaf and the hearing participant(s) are remote; or
3) The interpreter is physically located with the hearing participant(s) and the person is deaf is remote.

Each scenario requires unique considerations regarding the behaviour and perception of the interpreter/deaf person pair. However, regardless of scenarios, one aspect remains constant; the interpreter and deaf person must have constant eye contact and must be able to see each other's signs at all times. A breach of eye contact indicates that communication has been severed.
Video conferencing technology is designed to support communication between one or more remote users.

Eye contact/gaze
Chen et al (2003) have suggested that eye contact is very important in communication of any kind. They indicate that when a speaker is looking to the left, right or upward, the recipient believes that the message is not meant for him. If the eye gaze is slightly downward, although not preferable, the recipient believes that the communication is

intended for them. This could explain why television newscasters read from a teleprompter that is positioned slightly below the front view camera. Although the newscaster's gaze is slightly downward, viewers still believe that the newscaster is speaking directly to them and that the message is meant for them. The same is true in video-mediated communication.

Cameras are usually positioned above the main viewing screen (the screen that shows the video images of the remote interlocutors) meaning that eye gaze is slightly downward (people are looking at the viewing screen and not the camera). However, large viewing screens or small field of view cameras create a large gap between the camera and the positions of a person's gaze (while they are looking at the viewing screen). It appears that a person's gaze is significantly downwards (not slightly downwards) and can be very disconcerting particularly if the interpreter is remote from the person who is deaf. When the interpreter is remote the deaf person has no other connection or means of communication with the interpreter other than through the video conferencing system. Maintaining eye contact (even artificially) is crucial for deaf people using video conferencing in this situation.

The interpreter can adjust their position to the camera by sitting far enough back from the camera or zooming the camera out so as to appear to be having eye contact with the person who is deaf. However, doing so also increases the amount of background scenery that the person who is deaf must contend with and screen out particularly with low level or even lighting conditions. Spot lighting can be used to emphasize the interpreter and de-emphasize the scenery but this must be carefully planned and orchestrated; something that is not normally part of a video conference setup.

When the person who is deaf is physically located with the interpreter, maintaining eye contact between the interpreter and the person who is deaf is relatively straight forward. The interpreter can sit next to the video display so that the person who is deaf is always looking toward the monitor. However, the person who is deaf may still appear to the remote participants as though she is looking in another direction and may be disregarded by the other interlocutors because it seems as though she is not participating due to the mis-interpreted eye gaze cue. In addition, the interpreter cannot see the remote participants and may miss the non-verbal cues for turn-taking and other important meeting activities.

In face-to-face situations, interpreters know that if they make eye contact with the hearing speaker, the speaker assumes he is talking to the interpreter and loses his connection with the deaf participant. It is an automatic human behaviour that people tend to look at the person who is speaking (verbally) and thus make eye contact. Experienced interpreters usually avoid eye contact with the hearing person as a non-verbal reminder to that person that he should direct his remarks to the deaf person. Remote interpreting can interfere with this practice particularly when the person who is deaf is remote from the interpreter (interpreter is physically present with the hearing participants or remote to all participants).

When the interpreter is remote to all parties, the interpreter must look at the viewing screen to watch the person who is deaf. To all parties this seems as though the remote interpreter

is now looking more directly at them and the viewing screen (and hence the interpreter) becomes the centre of unwanted focus. In addition, the opportunity for the interpreter to use eye gaze as a non-verbal cue to indicate that hearing participants should relate to the person who is deaf is considerably reduced. Careful attention to seating plans is one way to alleviate some of these difficulties.

Seating

In a video conferencing setting, seating should always be an important consideration because the remote participant has considerably less presence and prominence than those at the local site. For remote interpreting situations much more thought must be given to the position of each participant, and whether the interpreter is sitting or standing (community interpreters may be more accustomed to standing while interpreting and thus may prefer to stand. However, in general it is preferable for the interpreter to be seated). Having tools such as notepads or laptops can also be useful for tracking what is being said or presented. Table 1 shows the suggested seating arrangements for the three different interpreter locations. Note for all situations, flowers, water bottles, computer screens and other items generally located on tables should be removed to reduce the visual clutter in the camera's field of view.

Location	Seating for deaf person	Seating for hearing person(s)	Seating for interpreter
Hearing person and deaf person at same site, interpreter is remote	Seated across from viewing screen showing interpreter and in front of camera.	Beside viewing screen so deaf person can see interpreter and hearing person(s) together.	In front of own viewing screen and camera. Will be able to see deaf person.
Hearing person and interpreter at same site, deaf person is remote.	Seated in front of own viewing screen and camera.	Beside interpreter so deaf person can see both parties. Interpreter should direct eye gaze towards deaf person at all times (while signing and voicing)	In front of viewing screen and camera.
Deaf person and interpreter at same site, hearing person is remote	Seated in front of own viewing screen and camera.	In front of own viewing screen and camera.	Beside viewing screen and visible to deaf person. May not be visible to hearing person.
All people are remote	Seated in front of own viewing screen and camera.	In front of own viewing screen and camera	In front of own viewing screen and camera

Table 1: Suggested seating arrangements for all participants.

Environmental and technical issues

There are environmental and technical solutions that can be optimised for people using sign language. When identifying the location(s) for video conferencing, considerations such as physical environment (e.g. room size, lighting, acoustics room setup and furniture) and uses of video conferencing in that environment are important to optimise and renovate if needed. Table 2 summarises some of the important technology considerations when hearing and deaf people are participating in a video conferencing together.

Technical or equipment solutions are also possible and in combination with environmental adjustments can greatly assist in optimising a video conference for people who are deaf and using interpretation. For example, video transmission frame rate of greater than 15 frames per second is critical. Having consistent, high quality image transmission rates available through dedicated high bandwidth networks such as ISDN or high speed IP-based networks can provide this.

When using video conferencing with people who are deaf, audio is less important (although it is still relatively important for the interpreter), and the need for camera controls (remote and local) becomes more important. A personal microphone such as a lavaliere or lapel microphone for the interpreter rather than a high-end room microphone can be used. In the situation where the interpreter is with the hearing participants a room microphone and a personal microphone may be required. This also means that intelligent audio signal processing (in the form of an intelligent hardware or software mixer) must be available to switch between the various audio sources (e.g., interpreter voicing and meeting participants).

Technology	Hearing People	Deaf People
Audio	• High quality audio is higher priority than high quality video.	• May not benefit from the audio. • May not understand the importance of having the microphone "muted" or "on" at their site. • When using voice-activated audio, the camera will focus on the interpreter voicing and not on the deaf person doing the signing.
Video	• Tolerate low quality video • May want to continue meeting even with poor video	• Cannot tolerate poor quality video. • Will notice more minute changes in frame rate and video quality. • Will want to cancel the meeting if video quality is unsatisfactory.
Placement of the microphone	• Microphone should be placed near person talking. • Most conference microphones are sensitive enough to capture all audio when placed in room center.	• *Microphone should be placed next to the interpreter who will be voicing for the deaf person.*
Lighting and	• www.effectivemeetings.c	• *Be aware of appropriate colours to*

Technology	Hearing People	Deaf People
Background	om provides recommendations for appropriate clothing • An office divider in a neutral colour makes an appropriate backdrop. • Avoid sitting in front of visually noisy scenery.	*wear that contrast with skin.* • An office divider in a neutral colour makes an appropriate backdrop. • Avoid sitting in front of visually noisy logos or murals.
The View of the Room	• Usually satisfied with a broad view of the room and rely on the audio to know who is talking • Camera presets are helpful but not critical.	• *May prefer a large view of the room to start, and then to zoom in when it is time to look at a specific person's signing (whether it be the interpreter or a deaf participant)* • *Use of presets more critical.*

Table 2: Summary of technology considerations for video conferences involved hearing and deaf participants.

The environment must have minimal "visual noise" such as windows, wall coverings, as any thing or person that moves that will distract users. These types of visual distractions can disrupt the whole flow of communication in a video communication session that includes people who are deaf. Camera controls such as zoom can be used to adjust the image to eliminate some of these distractions. However, adjusting the image may not be appropriate in all situations (e.g., in a many-to-many conference where the remote participant needs to see all of other participants). Cameras with controls tend to be more expensive, high end cameras.

Detailed Examples of Visual Noise

- Windows can cause significant visual noise. Outside activities seen through the window can be distracting, and lighting from windows can cause difficulties for cameras that automatically adjust for lighting conditions. Cameras pointed at users sitting in front of windows will be flooded with background light and the transmitted image of the user will appear only as a dark object in front of a well-lit window.
- Window coverings such as curtains that sway, or those that do not completely cover the window can be distracting.
- Objects typically found on tabletops during meetings, like water bottles, and laptops can also contribute to visual noise.
- Tables with highly glossed surfaces cause light to reflect off the table and into the camera. Cameras that automatically adjust brightness settings will then adjust for the camera to accommodate this reflected light and most other images in the surroundings, including the people will appear dark.

Other physical factors to consider

Tables: Tables with a matte finish are recommended in order to reduce additional glare. Depending on the size of the sessions, tables should be portable (eg: wheels on legs, or

detachable legs) to allow optimal set up. A large meeting could be accommodated by a series of tables and technologies set up as shown in Figure 1.

Objects on Table: Minimize the amount of items visible on the table. Flowers, water bottles, computers and other objects disrupt the field of vision and should be placed elsewhere.

Curtains: Solid curtains are recommended to allow the least amount of visual distraction. Vertical shades, however, are not recommended, as they allow sunlight into the room and cause difficulties for cameras with automatic brightness compensation.

Lights: Adequate room lighting ensures productive communication. The most optimal lighting is one that illuminates the users face and hands directly. However, this type of lighting is likely to cause discomfort to the user.
Also, bright overhead lighting minimizes shadows on the face and hands. Brightline Inc. (Brightline, 2002) provides recommendations and shows optimal lighting arrangements for video conferencing. Lighting and lighting placement are a function of room size, person location, wall and ceiling reflectance.

Chairs: The chairs should not be "squeaky" when rocked back and forth. Casters on casters are most appropriate for tiled floors to prevent scraping sounds when the chairs are moved. The ideal floor covering is carpet with under padding to minimize the chair moving sounds.

Room Colour: The walls in the video conferencing room should be painted a solid neutral colour (blue and greens are also acceptable). Walls with patterns or pictures are visually distracting.

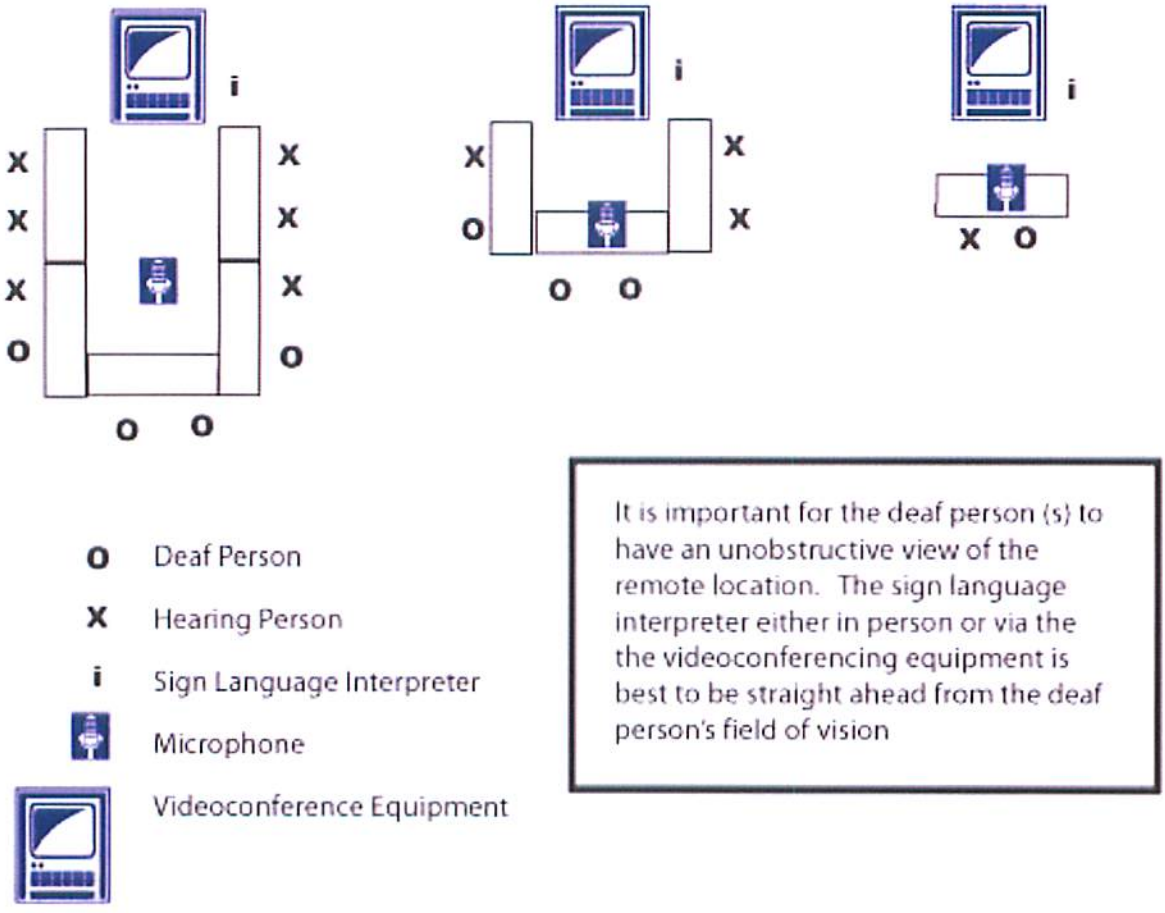

Figure 1: Different furniture and placement configurations.

Turn-taking

Another critically important consideration is that of turn-taking. Because of the difficulties in producing and understanding non-verbal cues during any video conference, turn taking becomes much more cumbersome in general. Interlocutors constantly miss turn-taking cues resulting in communication errors such as overlapping each other or interrupting, having long moments of silence, and taking control of the floor for lengthy periods of time. When someone who is deaf is added to the video conference these difficulties and errors become elevated.

It is often the role of the interpreter to mitigate turn-taking but it may be a much more difficult task for a remote interpreter because they too may miss the turn-taking cues. At the Canadian Hearing Society, attempts to solve this particular difficulty involve employing a conference manager at one site. This person is not the meeting chairperson and is only responsible for managing all of the technology as well as maintaining a formal speaker's list (by monitoring people's desire to speak). This approach is the most successful approach to date but it not the most cost-effective method because it requires another person to facilitate the meeting.

Fels et al. (2000) investigated the use of technology such as lights (flashing, spinning, etc), and a waving hand as a way of improving turn-taking for video conferencing. They found

that having a waving hand mechanism activated by a remote participant was very successful at gaining the attention of all participants. While this may be appropriate for classroom settings or even meeting settings, a waving hand may not be acceptable or appropriate in all situations. Further study of this type of approach may provide acceptable solutions.

A third solution to this problem is to use an electronic token to request a turn to speak. This is similar to a physical meeting token or formal speaker list that is commonly used to formalize turn-taking in face-to-face meetings. A user would request the token indicating that she wants a turn to speak, have her turn and then release the token when finished. There must be an override mechanism, perhaps controlled by the meeting chairperson, so that a person does not take complete control of the meeting or the floor. The electronic token can keep circulating until the communication session is complete. There has been little research on the effectiveness of this approach to formalised turn-taking and the acceptance by hearing and deaf people of such a method for video conferenced meetings.

Confidentiality

There are important and unique confidentiality and ownership issues arise with video conferencing. For example, questions such as whether recording a video conference violates confidentiality rules, who owns the archive, and who can access the archive remain unanswered. Similar to audio recording practices, permission to record the audio/visual proceedings should always be sought from participants. This permission should address the ownership and access issues. Legal advice is warranted if archiving video conferences is a normal procedure for an organisation.

Special Considerations for managing multipoint or multi-application conferencing

The user will have the opportunity to connect such equipment as a document projector and/or a scan converter that allow people to present paper-based visual materials through the video conferencing.

Video conferencing equipment such as Polycom allows the user to switch between different presentation technologies while in session. For example, the user can switch and allow the users at the remote locations to see a PowerPoint presentation or videotape on the full screen while presenting. For the hearing presenter/participant, there are no barriers as the hearing presenter can continue to speak and the users can see the PowerPoint presentation simultaneously. For deaf users deaf or hard of hearing users must read the PowerPoint presentation first and then return to the presenter or the interpreter being on the screen. This can cause disruptions (and hence delays) in the flow of the presentation and requires considerable mental effort on the part of the deaf participant who must then remember what was on the visual display.

The presenter should be aware of the difficulties of presenting additional visual materials simultaneously with discussion and provide visual materials to participants before the video conferencing or prepare the presentation to account for participant's needs to keep switching the view screen between the visual material and the interpreter or speaker. For example, the presenter should constantly repeat verbally points on visual material being discussed or allow time for participants to take notes or copy the material on the slides.

Displaying a PowerPoint presentation on the same image as the presenter is worse because it can be very difficult for the users at the remote locations to see the PowerPoint presentation (it is usually too small or the projection screen in the local location is poorly lit).

Other factors

The need to constantly monitor the auditory "goings-on" of the physical environment and then decide what is important to communicate to the person who is deaf is an important secondary task for the interpreter. For example, an interpreter might ignore a pencil that falls on the ground because it does not have any consequence for the communication transaction in a face-to-face meeting. However, when the interpreter is remote the physical context is limited by what can be viewed though the camera. It is difficult for the interpreter to determine whether an unseen audio event such as a door shutting outside the view of the camera is important or not. The interpreter must be hyper-vigilant and constantly assess the importance of non-speech and unseen audio events increasing the already high cognitive load and corresponding fatigue levels for the interpreter. Frequent breaks (e.g., every 30 minutes) or more than one interpreter may be required to accommodate these increased cognitive demands.

One final consideration for video conferencing situations is that they can include multiple applications. Many video conferencing technologies allow you to incorporate presentations (e.g. PowerPoint, videotapes (VCR, DVD), a drawing application to share work among all participants and other visual mediums) If only one viewing screen is available, the video conferencing software allocates the viewing priority to the application. The hearing participants can talk over the display and hear what is being said. However, in situations where the interpreter is located with the hearing participants or remote from all participants, the deaf person cannot participate because the interpreter's video is replaced by the application images. In this situation, the use of two viewing screens, one dedicated to the interpreter and the second one for other images is required, or the shared work must be paper-based. Users might have the opportunity to connect such equipment as "Elmo" and or a scan converter to allow user to use different technologies through the videoconferencing to provide more visual information.

Videoconferencing equipment such as that available through Polycom allows the user to switch between the mediums while a session is happening. For example, the user can switch and allow the users at the remote locations to see a PowerPoint presentation or videotape on the full screen while presenting. For the hearing presenter, this results in no barriers as the hearing presenter can continue to speak and the users can see the PowerPoint presentation. For the deaf users it requires more time as the presenter must allow the deaf or hard of hearing users to read the PowerPoint presentation and then go back to the presenter or the interpreter being on the screen. Using a PowerPoint presentation with the presenter through the videoconferencing camera results in less than optimal viewing because it is very difficult for the users at the remote locations to see the PowerPoint presentation. Ultimately the ideal setting would be allowing sufficient viewing times between the mediums to allow the users to read the content. Ideally it would be an excellent idea to send copies of your presentation (e.g. PowerPoint) to the remote users and

interpreters. Table 3 summarises the most common behavioural, etiquette and communication issues experienced by hearing and deaf people during video conference sessions.

Issue	Hearing People	Deaf People
Language choice of meetings and issues of language power	• Hearing people who know sign language still communicate in spoken language and use sign language interpreters.	• Culturally deaf people are still expected to be bilingual and follow written (English) documents shared in the meeting.
Introductions	• Often introduce themselves each time they speak as many female voices sound alike.	• It is obvious who is signing, but if deaf people announce themselves before signing, it will make their participation in the meeting equal to their hearing counterparts.
Eye Contact	• May tolerate the lack of eye contact with the people at the far site, provided there is good audio	• An important part of the visual language and severing eye contact means the communication has ceased. • Sitting back from the viewing screen (approximately 244 cm or 8' from a 32" monitor) simulates the most natural eye contact.
Chairperson (deaf or hearing)	• Must ensure that all people are included as equal participants	• Must ensure that all participants are included as equal participants
Use of peripherals	• Can keep talking while PowerPoint slides are being shown	• When interpreters and deaf people are showing PowerPoint slides in a videoconference, there must be pause between each slide and then interpreter can resume watching the signing. • Communication will not be accessible if the hearing person continues to talk over the PowerPoint slides.

Table 3: Behavioural, communication and etiquette issues.

1.3.1.5 Considerations for Remote Sign Language Interpreters

Preparation

An interpreter with many years of interpreting experience will be reasonably comfortable in most interpreting settings. However, the addition of remote interpreting makes every interpreting situation potentially new and anxiety provoking.

Some of the concerns that interpreters will have include:

1. Interpreters want assurances that the people at the remote site will understand their needs and be able to meet them.
2. Whether remote interpreting equipment will be placed in the correct position.
3. Whether people at the remote site will be familiar with how to use an interpreter and the particular dynamics of using a visual interpreter remotely?

To ease some of these concerns, remote interpreters require as much information as possible prior to the interpreting event. Information about the participants, the meeting purpose, agenda items for discussion, intended outcomes of the assignment, and any presentation materials should be provided at least one day ahead of the scheduled video conference.

During the video conference

If deaf people are meeting an interpreter face-to-face for the first time, they tend to ask personal questions such as whether the interpreter's parents are deaf, or where and why they learned sign language to establish a rapport with the interpreter. A remote interpreter may not have this same opportunity to interact with the deaf consumers before the interpreting session, and may be unable to develop that important rapport with those deaf consumers.

In addition, there can be regional differences in sign language that may cause communication difficulties or misunderstandings. For example, a Canadian deaf person may be assigned an American remote interpreter who will use subtle differences in sign language vocabulary. The may cause difficulties for the deaf person in understanding what is being said or expressing herself clearly. It is important to schedule introductory time between the remote interpreter and a deaf consumer ahead of the meeting (at least 10 minutes) to allow these individuals to establish some rapport, and acknowledge and accommodate for regional differences.

The interpreter's role is to facilitate communication between the hearing and deaf participants. During the session, the interpreter might ask for the participants to clarify what is being said because he/she did not hear the content or under the meaning of the content being said.

Processing in public

While the interpreter is voicing for the deaf consumer in a face-to-face situation, it is assumed that the other participants are focused on the deaf speaker and the hearing people are only listening to the interpreter. In a video conference the remote interpreting may be the centre of attention because the remote interpreter is seen on the viewing screen. The interpreter must perform the complex cognitive task of interpreting while being in the

unusual position of being the centre of attention. This potentially adds discomfort and cognitive load to the already considerable cognitive load from interpreting for a remote sign language interpreter.

Lag Time

During any interpreting assignment there is a lag, or delay, from the time the source message from the deaf participant is presented, to when the interpreter understands the message and presents it in the target language. This lag may be longer when videoconferencing technology is used due to the delay introduced by the technology. The ability of the deaf participant to participate on an equal level is restricted. Participants need to know to expect these delays and account for them meetings. Section 3.4.1.6 provides some suggested solutions to assist in managing the turn-taking difficulties imposed by the increased lag time. In addition, we suggest that a set of guidelines should be presented to all participants before the conference begins in order to educate people on the communication differences and the procedures put in place to accommodate these differences. The meeting chair or the access manager should be responsible for disseminating these guidelines.

Interpreters, deaf people and hearing people at several sites

Where there are several deaf people and interpreters for one video conference, the arrangement of cameras, viewing screens and seating becomes more complex. If several deaf people are participating in a multi-point call, they may have interpreters present with them at their site. In that case, the interpreter at that site voices and the information is re-signed by the interpreter at the other sites. The deaf people then have the choice of watching the deaf participant directly, or watching the "shadowed" version provided by the interpreter in person at their site. In a multi-point or continuous presence call, the frame speed of each square is reduced enough so as to increase the difficulty of the interpreting task. Having deaf people provide an interpreter at their site reduces some of this difficulty.

Interrupting the speaker (either deaf or hearing)

In person, there are opportunities for the interpreter and the deaf consumer to exchange brief signs that reinforce the accuracy of parts of the interpretation. For example, if a deaf person was talking about their family, an interpreter might check briefly, "Do you have FOUR brothers?" The deaf person could communicate the answer to the interpreter without necessarily stopping the natural flow of the communication. This checking of the accuracy of the initial interpretation might not be obvious to the audience listening to the voice interpretation. When interpreting remotely, it can be difficult for the interpreter to "check in" with the deaf consumer and interrupting becomes more complicated. The interpreter needs regular access to the consumers and the meeting chairperson so she can easily stop the proceedings in order to get clarification when needed. However, even if this occurs, the subtle accuracy "checking" becomes more conspicuous to the other participants and may cause disruption.

Preparation materials provided to the interpreter ahead of time can significantly offset this need for interrupting the speaker. As long as the interpreter has the proper background materials ahead of time, the need for interrupting the flow of the communication can be minimized.

Reduced Signing Space

An additional challenge to remote interpreters is they must adjust their natural signing space to accommodate the field of view of the camera. They cannot sign outside of a prescribed area that falls within the camera's visual field otherwise the deaf participant cannot see what is being said. Reducing the natural signing space can cause additional cognitive load and fatigue for the interpreter. More frequent breaks or team interpreting may be required to relieve this additional strain on the interpreter.

Auditory Referencing

Interpreters who are at the same location as their deaf and hearing consumers have the luxury of looking at exactly what is being referenced in the communication. Interpreters cannot sign the spatial relationship if they cannot see what is being referenced. For example, if a speaker says, "You put this over here," the interpreter will be at a loss as to how to describe what is being discussed. It is more effective for deaf and hearing participants to be explicit in what they are referencing such as, "Your name goes in the blue box in the right-hand corner of the first page."

Team Interpreting

Team interpreting is difficult to successfully carry out remotely without audio headsets that allow the interpreters to communicate together without disrupting the rest of the viewing audience. It is hard for the interpreters to confer on best linguistic choices (either for sign language or English) without individual headsets and microphones. If one of the team interpreters is at a remote setting, their audio is transmitted as soon as they offer linguistic suggestion. It is likely to be perceived as an auditory or visual distraction to the other participants.

Deaf Interpreter

The Certified Deaf Interpreter (CDI) is an individual who is deaf or hard of hearing. In addition to proficient communication skill and general interpreter training, the CDI has specialized training and/or experience in the use of gesture, mime, props, drawings and other tools to enhance communication. The CDI has knowledge and understanding of deafness, the Deaf community, and Deaf culture. The CDI possesses native or near-native fluency in American Sign Language (Registry of Deaf Interpreters, 2004).

There are some unique considerations for video remote interpretations that are applicable to Deaf interpreters. These include:

a. Negotiate with consumer(s) to create working conditions that will facilitate the most accurate and comfortable delivery of interpreting services
b. Inform consumers (hearing and deaf) of any problems the video conferencing session and make efforts to correct them. In this situation, the deaf interpreter may require more time to facilitate communication between the deaf person and the sign language interpreter. Depending on the communication needs of the consumer, the amount of time needed for effective communication may actually double.

c. Communicate with team member(s), particularly at the beginning of the video conference, to assess effectiveness of the interpreting.
d. At the completion of the assignment, it is critical that the deaf interpreter inform the consumers (hearing and deaf) about the clarity of the assignment.

1.3.1.6 Skills Needed for Remote Interpreters

There are very few documents describing specific interpreter skills required for successful remote interpreting. However, where there is mention of remote interpreting, there is agreement that remote interpreters must have considerable experience as face-to-face interpreters. Novices or new graduates of interpreter training programs may find remote interpreting extremely difficult. The types of skills that are learned through experience that are particularly transferable to remote interpreting are:

1. ***Closure skills*** – Interpreters must have the vocabulary, in English and in Sign Language, to appropriately complete sentences. An example of this might be a deaf person telling a story about going to an office to drop off their resume and having to leave it with a receptionist. The interpreter might miss the actual fingerspelling of the word "r-e-c-e-p-t-i-o-n-i-s-t" due to the time lag or pixelation caused by the video conferencing system but can still use their interpolation and closure skills to make a meaningful sentence.
2. ***Assertiveness*** – The remote interpreter must be willing to interrupt proceedings that are preventing participation by the deaf person for whatever reason, particularly if the chairperson is unable to manage the turn-taking and time lag issues. However, this is an added task for the interpreter and is not ideal. The interpreter may want to have a discussion with the chair person regarding some of the issues and solutions to turn-taking and accommodating the time delay to ensure equal access by the deaf person. Better yet, the interpreter can carry a set of guidelines such as the ones included in this document to provide to inexperienced meeting chairs.
3. ***Memory*** – The interpreter must track new, incoming information as well as the gist of what has just been interpreted. This is required because there are often ambiguous references made to previous utterance (such as to a previous PowerPoint slide that is no longer on screen) or location indicators such as "I put that document over here". In addition, remote interpreting tends to have more communication mis-understandings than face-to-face interpreting so the interpreter must have an idea of where the communication breakdown may have occurred, and where to go back to amend or correct the interpretation.
4. ***Lexical choices*** –The interpreter must have several lexical choices for the same concept, as some signs will be more conducive to a 2-dimensional medium than others. Experienced interpreters will have gained sufficient alternative expressions to accommodate and made lexical adjustments to accommodate this situation.
5. ***Varied Experiences*** – Interpreters with various kinds of community interpreting experiences will have the ability to interpret for a wide variety of consumers (both deaf and hearing). This is particularly important for remote interpreting

because the likelihood of interpreting for people outside of the interpreters' regular community is high. For example, an interpreter from Canada may be interpreting remotely for someone in the southern US.

Other factors to consider

1. The optimal background colour is a solid blue or black.
2. The interpreter's attire needs to be a solid blue or black colour as well.
3. Excessive movement is sometimes difficult for the camera to capture. It is best if the interpreter stays in one place.
4. A highly skilled interpreter is preferable, but he should be able to adjust his signing rate to account for less optimal camera frame rates.
5. The interpreter should arrive at least 15 minutes prior to the meeting. If it is an interpreter's first exposure to video conferencing (after training), it is recommended that the interpreter arrive at least 30 minutes early. The deaf person should also arrive 15 minutes prior to the meeting.

1.4 Illustrative cases and personal accounts highlighting issues

This section provides a short description of several cases and personal accounts illustrating the common issues using video conferencing for people with disabilities. Emphasis on experiences of deaf consumers is made due to the complications of language translation and the importance of high quality video.

The first case is of a family with a hearing father and deaf mother gathered to discuss parenting strategies with the hearing staff of a child protection agency in order to determine whether the child could stay in the home. The interpreter was connected remotely through a video conferencing system and all other participants were face-to-face. There were no remote camera controls so that the interpreter could not control the camera in the meeting room.

The mother was very upset and crying. As a result, she could not pay attention to the viewing screen, and the interpreter had difficulties gaining the attention of the other meeting members to assert the mother's needs. Also, the staff was seated with their backs to the viewing screen and facing the father, so that they could not see the interpreter's attempts to gain their attention. The interpreter was trying to accurately and intelligently represent the mother's communication but because the mother was so upset there was considerable delay in processing the mother's communication. This only added to the delay imposed by the technology. In addition, the hearing people continued to give new information and talk while the mother was trying to communicate and the interpreter was trying to interpret that communication and intervene on behalf of the mother. While having to process language as well as assert the deaf person's needs are normal responsibilities of the interpreter, the seating arrangement, the lack of support for and recognition of the mother in the physical setting, the lack of turn-taking structures and the lack of acknowledgement of the interpreter's importance resulted in a failed meeting. Many of these difficulties arose because the interpreter was remote and had difficulty gaining attention and recognition.

While this was a difficult situation even for a face-to-face meeting, the situation was exacerbated by the difficulties resulting from the remote video interpretation issues. To overcome some of these difficulties, there are a number of possible solutions. A formal attention-getting mechanism such as a flashing light with audio would have likely aided in allowing the interpreter and deaf mother to have more presence in the meeting. The hearing staff needed to be seated in such a way as to see the interpreter's eye gaze and turn-taking indicators. In addition, the staff did not have much experience with video conferencing technology, and did inadvertent things such as placing coffee cups down near the microphone causing audio spikes that were very disconcerting for the interpreter. Camera controls or properly setup camera view angles that suited the needs of the interpreter were required. An access manager would have greatly assisted in helping facilitate appropriate setup and use of the technology, and remove some of the barriers to successful communication.

The next three cases are first-person accounts from three individuals directly involved in providing video conferencing services at CHS; two are remote video interpreters, and one is a technical support person at CHS.

1.4.1 Personal Account: My First Impressions of Videoconferencing
By Video Remote Interpreter 1

Question: **What was your first impression of video conferencing? As a consumer?**

Answer: *"The first time I ever interpreted remotely, the deaf consumer copied everything I was signing as if he was watching a teleprompter. How many times does your television ever talk to you? It's a difficult concept for people to get their heads around. Those consumers whom I had met before seemed to pick up the concept faster. If the deaf consumer has never met the interpreter they may not know that the person signing to them on the television screen is actually expecting a response; that the process is interactive."*

Question: **What were your first experiences as a remote video interpreter?**

Answer: *"Sign Language Interpreters work hard at improving their English and Sign Language skills and be recognized as competent professionals. To impose technology that makes the interpretation feel more difficult and stilted feels like a step backward. Will people know that I'm not "new"? Will they see me as an interpreter with experience? As a "seasoned interpreter," why should I put myself in a position to feel inadequate when they are many easier assignments readily available?"*

1.4.2 Personal Account: My First Impressions of Videoconferencing
By Video Remote Interpreter 2

Question: **What was your first impression of video conferencing? As a consumer?**

Answer: *"The first experience I ever had using videoconferencing was two years ago for a job interview. I knew two of the people at the far site, but I was convinced they were angry with me. The camera had zoomed out in order to fit the three far-site people in the picture at the same time. I couldn't see their facial expressions very well and I felt as if my*

personality was really coming across like a lead balloon. Although it was a very clear connection (384 kbps and 30 fps) there was a slight delay in the amount of time it took for them to understand my questions and respond. The experience made me think that I might not want a job doing a lot of videoconferencing if this is what is was all about. I figured it wasn't much different (or better) than a teleconference call. I had a person with me that ran the remote control, but he wanted to leave for another commitment. I was terrified at the prospect of being left alone with the equipment (particularly in a job interview where you want to appear competent at what you're doing)."

Question: **What were your first experiences of remote video interpreting? Difficulties experienced?**

Answer: *"My first experience interpreting by video conference was for a deaf consumer that I have known both personally and professionally for many years. I thought this would make it easier, but in fact it "upped the ante" and made me more fearful of making a mistake. I thought if I made a mistake, people would question my interpreting skills and think, "Boy, we thought she'd do a great job with Susan seeing that they've known each other for years!" It provided an extra pressure on top of the already difficult interpreting task. The situation was further complicated by well-intentioned individuals (who knew sign language) who noticed me struggling and yelled out either background context that I was missing, or yelled out the fingerspelling that I had missed, in order to help me. I had to get the deaf person to fingerspell very slowly and to change the orientation of some of the signs she was producing. Although the deaf person was quite willing to accommodate my needs, I felt like I was giving her an extra task to do. She was already concentrating on her thoughts, and then had to remember my needs. Interpreters are used to blending into the background so that the deaf person and hearing person communicate directly with each other. Having to interrupt either the hearing person or the deaf person more often made me feel more conspicuous in the interpreting event than I was accustomed to being."*

1.4.3 Personal Account: Web Applications Specialist

Question: **What was your first impression of video conferencing? As a consumer?**

Answer: *"IT'S ABOUT TIME! Back in 1991 I was very interested in videoconferencing and how we can use this to communicate visually. The equipment back then was using six telephone lines to communicate and the setting up of this was complex. We now have come to modern day videoconferencing using IP or IDSN. The quality of the visual information has gone up considerably, but there is still room for improvement.*

It a new way of communicating and requires new set of rules. The complexity of providing meetings with various communication needs is a challenge. I find myself in a group of deaf individuals who sign only is fine and the only problem is getting people's attention at the other location. Often we forget the person at the other end. There needs to be a way electronically or through human interactions to improve "attention getting" cues in this medium."

Question: What were your first experiences of providing video conferencing services at CHS?

Answer: *"Given the implementation of IP videoconferencing at The Canadian Hearing Society, it has provided us new ways of providing services. We have many deaf, deafened and hard of hearing people in the north who does not have access to a sign language interpreter. By providing the interpreter through videoconferencing, it's breaking down the barrier and at the same time saving costs. I know of individuals in Timmins who are in need of interpreters and we can provide this service from Toronto through videoconferencing. Literacy classes, sign language classes and counseling are other kinds of events that are taking place via videoconferencing. With the videoconferencing, we are breaking down the geographical barriers and being able to provide information in a visual medium."*

These three accounts provide some insight (need for training, pre-conference planning, technology improvements, ways to improve and acknowledge presence of remote person and but that the geographical a significant barriers that can be mediated by vc).

1.5 User Environment Scenarios:

In an effort to better understand and elucidate the issues inherent in different uses of video communication technologies, the following section will examine three key user group environments: health, education, and business, and common tasks used in these environments. For each user group environment, the challenges and issues connected with its unique requirements will be explored, and possible remedies will also be presented.

The scenarios discussed mainly involve one-to-one and small groups. Even though there are many different scenarios and combinations, our recommendations will be based on the most popular scenarios that are commonly presented on daily basis when video remote interpreting is used.

1.5.1 Health care Environments

Health care environment tend to involve limited sets of personnel with limited tasks to be achieved. However, it is very important that people have equal access to the health care environment and are able to successfully communicate. Telemedicine is becoming a much more common approach for providing access to medical services, particularly specialist services, for people in remote communities. It is important to consider the needs of people with disabilities.

1.5.1.1 Tasks

Common tasks that video conference participants may want to carry out in this setting are:

Consultation – question and answer session regarding particular health needs or issues.
Examination – inspection of physical, or mental state of patient.
Prescription – discussion of a particular course of treatment, intervention or action.

1.5.1.2 Physical scenarios

A deaf patient would like to consult with medical personnel (e.g., a doctor, nurse, psychiatrists, or medical technician) through an interpreter via video conferencing. The following list includes possible scenarios of remote interpreter/deaf consumer combination.

- The interpreter is in a remote location and patient and doctor, hospital staff or health-care providers at the local location.
- The interpreter is with the deaf person and the doctor, hospital staff or health-care providers are remote.
- Interpreter can be at one location, deaf person at another and doctor, hospital staff or health-care providers at yet another location.

1.5.1.3 Issues unique to health care settings

Physical Positioning

The National Council on Interpreting in Health Care (NCIHC) has produced guidelines for the role of verbal language interpreters working face-to-face in health care settings. In these settings, they recommend that interpreters be positioned near the patient's head with their backs to the patient giving the patient as much privacy as possible. However, sign language interpreters must always have eye contact with the patient for communication to be understood so they must stand in such a place as to see the patient's facial expressions. NCIHC also recommends that interpreters stand between the patient and health care provider so as to appear as unbiased participants.

A sign language interpreter working remotely cannot be guaranteed that busy health care providers in emergency settings will understand the interpreters' positioning preferences or be able to accommodate them at a bedside with limited room to maneuver the required medical equipment.

Sign language production

The ill deaf person lying in bed will not have the same clear sign language production as that of the interpreter, nor will they necessarily maintain a small enough signing space to fit within the camera's field of view. This can be particularly problematic when the interpreter is remote from the deaf person.

One recommendation is to use technical solutions such as zooming out the camera lens to capture their whole signing space and environment. However, the interpreter risks losing critical facial expressions that are achieved by having the camera closer to the deaf person's face. There can be a constant conflict between wanted to see a larger view of the room, and the need to go close to the deaf person to see nuances in the facial expression.

Socio/Political

When remote video interpretation is the method of service delivery, deaf participants may mistrust the interpreter because they have no working relationship with the interpreter and no common cultural context. They may withhold some of their communication. This may also work to the benefit of the deaf person. In a sensitive health care setting, deaf people

may say more because they do not know the interpreter personally and chances are will not run into that same interpreter out in the community.

Socio/political factors emerge as some of the most important factors for successful video conferencing and remote interpreting. Failure to account for these factors can result in a failed conference and service to the deaf person. These factors include psychological aspects such as an interpreter's ability to cope with the stress of a remote interpreting assignment, or a deaf person's ability to cope with the stress of having medical needs and the confidence to express these needs via a video conferencing system and/or remote interpreter; having to rely on a screen to derive the visual support information necessary for carrying out the interpreting task; motivation; processing information from multiple sources; social isolation; and operating multiple controls while effectively communicating. For example, in personal statements it has been reported by interpreters and deaf people that the lack of proximity between a deaf person and her interpreter can create a feeling of alienation that may results in lack of motivation, a decrease in interpreting quality, and a decrease in the deaf person's involvement and participation in the video conference.

The deaf person may be at significant disadvantage because of these socio/political factors. In addition, they may feel intimidated by a lack of medical knowledge and and by not having a physical presence at the consultation, meeting or evaluation. This may result in an unbalanced power relationship between medical personnel and the deaf patient that can, in turn, cause withdrawl by the deaf participant, the need for the interpreter to take on a strong advocacy role, and errors made by the medical team by unconfirmed or incorrect assumptions. Awareness, experience and perhaps a patient advocate who is physically present with the medical team may be ways in which some of these difficulties can be mediated.

1.5.1.4 Guidelines and Protocols specific to Health Scenarios

- Follow general guidelines listed in Section 3.0.
- It is recommended that a system with "picture-in-picture" capabilities be used and that deaf consumers and interpreters be instructed to monitor themselves in the "Picture in Picture" screen to ensure that their signing stays within the camera's view. Individuals may need to adjust their signing space to accommodate small camera field of views.
- The deaf consumer at the remote end should have access to the camera controls so that they can ensure that the signs being transmitted by the interpreter. One important consideration is that the deaf person must also have training and a comfort level with the technology in order to manage camera controls, sign adequately and communicate his/her needs in an environment where the deaf person may be feeling sick or enjoy little power in the relationship.
- Video conferencing calls should be recorded for future reference or for legal needs.
- There can be a general need for a mobile video conferencing facility if people do not have the mobility to move to a "special video conferencing room". The recommendations in this document would apply to this type of portable system as well.

- A pre-conference meeting (using the video conferencing system) is recommended to alleviate some of the cultural and technical difficulties that might interfere with the success of the actual conference, and to provide new users with some practice.
- The technology should be tested and adjusted prior to the meeting to ensure that connection numbers, cameras, microphones and displays are working correctly. This also avoids time being spent on audio and video checks during the meeting.
- The interpreter should always remain in direct eye contact with the person who is deaf regardless of the position of equipment or other people.
- Be cognizant of the psychological stress imposed by medical situations and increased potential for the deaf participant to be alienated due to a reduced ability to communicate while ill and over a video conferencing system. It may be too easy for the medical practitioners to inadvertently ignore the deaf person's needs.

1.5.2 Education Environments

Distance learning has become more popular and gained wider acceptance as an effective instructional tool (Gowan & Downs, 1994; Benford et. al., 1998).
Students of all types have begun to take advantage of this services institution are offering. Video mediated communication is a valuable educational resource because it provides access to live instructors or teaching assistants; it can be more motivating than students working on their own, and can help students improve communication skills (Knight, 1998).

When a deaf student is registered at a post-secondary institution, whether it is through distance learning or face-to-face classes, she is often provided with an interpreter. As interpreting services can be difficult to obtain particularly for students at institutions in more remote locations (e.g., University of the Cariboo in northern British Columbia), the possibility of using remote interpretation is very real. Interpretation would be provided by interpreters in major centres that can often be quite a distance from the student.

1.5.2.1 Typical tasks

Common tasks that students (remote or local) may want to carry out in this setting are:

- Listening/pay attention to instructor for extended periods of time (e.g., one hour).
- Interacting with instructor with question/answer or discussion styles of interaction.
- Interacting with peers in formal group meetings, or in side conversations.
- Interrupting instructor to ask question.
- Formal presentation of academic material or point of view for entire class.
- Viewing class material (e.g., PowerPoint presentations, overheads, videos, music, blackboard/whiteboard markings, and images, websites, etc.)

1.5.2.2 Physical scenarios

There are a number of possible physical scenarios in which video conferencing is used to serve deaf students. These apply whether the video conferencing is used in a distanced education or a face-to-face teaching situation.

In the first scenario, the deaf student and her interpreter are in the same location. The interpreter would be signing the material being delivered by the instructor and voicing questions from the deaf student. This scenario is the most straight-forward as the interpreter can remain outside of the field of view of the camera and the viewing screen in the classroom only shows the deaf student. The image in the student's location shows the instructor and/or the classroom depending on the controls provided with the video conferencing system.
A second scenario is where the interpreter and instructor are in the same location and the deaf student is in the remote location. The interpreter is video remote interpreting the material being taught by the instructor while having a physical presence in the classroom. While the deaf student will always appear on the viewing screen, the interpreter potentially will have a stronger presence in the classroom particularly when voicing the deaf student's communication. Maintaining focus on the deaf student is a difficult task for the interpreter particularly when there are many other people in the classroom. The viewing screen is often located at the front of the classroom for the simple reason of access to electrical power. The deaf student is not an integrated part of the class but rather stands out at the front and may believe that everyone is always "watching" him. In addition, the eye gaze position of the deaf student due to the camera location may seem as though the deaf student is otherwise occupied or not paying attention. This may cause the student to take a passive stance and not participate in discussions or queries.

PEBBLES (Weiss & Fels, 2001) is one example of a video conferencing system that allows a remote student to be placed anywhere in a classroom. It is a video conferencing robot designed to allow students in hospital to attend school. Remote students have control over what they can view in their classroom and what others can see of them. Studies with PEBBLES (Fels, 2003) indicate that students using PEBBLES become integrated into the classroom quickly and that they do not receive more attention than other students after an initial novelty period. Placing the video conferencing unit at a normal "seat" in the classroom may remove some of the unwanted focus on the deaf student at the front of the class.

The third scenario would occur when the deaf student is physically attending a course in a classroom and the interpreter is remote. The video conferencing system would be setup in the classroom and transmit a live image and voice of the interpreter (the interpreter would sign what the instructor was saying and voice comments, questions, discussion points signed by the student).

Similar to the second scenario, the video conferencing system would usually be placed at the front of the classroom and potentially become the focus of attention particularly when the interpreter is voicing the deaf student's comments. The interpreter would have very

little influence over where people are looking as the interpreter's eye gaze would seem to be towards all people in the classroom. Using a personal video conferencing system in the classroom that can be located close to the deaf student may potentially alleviate some of these problems including focusing the attention on the deaf student when he wants the floor.

1.5.2.3 Issues unique to education settings

Turn-taking

In classroom situations, turn-taking tends to be more formalized where students are expected to raise their hands to indicate they want the floor. Integrating a turn-taking indicator such as a hand or an audible light may be an appropriate method for the deaf student to also indicate she wants the floor. However, using only a light or flashing light has been shown to be ineffective in classroom settings (Weiss et al, 2001).

Shared applications

Where PowerPoint presentations or other applications must be shared, dual monitors must be used to ensure that the interpreter can always be seen by the deaf student. If captioning is available for audio material such as videos and films that have sound or music, it should be activated to ease some of the burden on the interpreter. If no captions are available for video or music material, the education delivery unit should consider producing them. This is important for live access to this material during use for the class but it is also important to allow students access to the material after class when an interpreter is not available.

Other important factors

Finally, constant attention to a video screen is fatiguing for deaf students as they rely exclusively on their visual system to acquire communication messages. Hearing students can take small visual breaks by using their auditory system during class. More frequent formal breaks, at least once per hour, are required to allow the deaf student to rest.

1.5.2.4 Guidelines and Recommendations specific to education

- Follow general guidelines for listed in Section 3.0
- It is recommended that a system with "picture-in-picture" capabilities be used and that deaf consumers and interpreters be instructed to monitor themselves in the "Picture in Picture" screen to ensure that their signing stays within the camera's view. Individuals may need to adjust their signing space to accommodate small camera field of views.
- The deaf consumer at the remote end should have access to the camera controls so that they can ensure that the signs being transmitted by the interpreter. One important consideration is that the deaf person must also have training and a comfort level with the technology in order to manage camera controls, sign and communicate adequately.
- As the instructor usually is responsible for managing class activities, pre-conference training is highly recommended. The instructor must be made aware of the unique communication and turn-taking needs of the deaf person/interpreter pair, and given strategies for ensuring that these needs are met.
- The technology should be tested and adjusted prior to the first class to ensure that connection numbers, cameras, microphones and displays are working correctly. This

also avoids time being spent on audio and video checks during the class and possible missed information from the instructor.

- The interpreter should always remain in direct eye contact with the person who is deaf regardless of the position of the instructor, other people or equipment in the classroom.
- Employ a formal turn-taking mechanism such as a remote hand that allows the deaf person to overtly gain the attention of the instructor or class peers.
- All class materials should be available to the deaf person and the instructor before the class begins.
- Any video or music material used in class should be captioned, and the captions turned on during viewing of the material in class.

1.5.3 Business Environments

One of the most common applications of video conferencing with deaf participants is a business meeting. These can take several forms including one-on-one, small groups of less than fifteen individuals, and large meeting with many people (e.g., annual general meeting). In each setting, there are unique issues that must be addressed so that the deaf person can enjoy equal participation and the interpreter is optimally positioned to facilitate this participation.

1.5.3.1 Tasks

Common tasks that video conference participants may want to carry out in this setting are:

- Participate in the discussion, contributing comments and listening to what others contribute. This can be accomplished using formal, agenda-driven rules for turn-taking and meeting progress (e.g., Robert's rules of order) or much more informal processes where people raise hands to request the floor or use non-verbal cues to take a turn when the opportunity arises. Large group meetings tend to be much more formal with set agendas and speakers, formal question/answer or discussion periods and formal turn-taking structures.
- Proposing or seconding motions.
- Presenting information or materials where participant has formal and exclusive control of the floor.
- Asking/answering questions/gaining attention
- Chairing meeting

1.5.3.2 Scenarios

The following three scenarios of deaf/interpreter pairs are possible

One to One Meetings

- The deaf person and the interpreter are in the remote location and the hearing person is at the local location or vice-versa.
- The deaf person and the hearing person are in the local location while the interpreter is at the remote location.

Small Group Meeting

- The group of deaf people and interpreter are at the local location while the hearing person/people are at the remote location.
- The deaf person is at the remote location and the hearing people and interpreter is at the local location.
- Deaf and hearing people at local location and the interpreter is at remote location.

Large meetings

- Group of deaf and hearing people are at the local location while the interpreter is at the remote location.
- Group of deaf and hearing people as well as the interpreter is at the local location while at the remote location there would be a small group of hearing and/or deaf people.

1.5.3.3 Issues unique to meeting settings

Turn-taking

Turn-taking issues are likely the more important issue to consider in meeting with deaf people. Equal participation in video conferenced meetings often involves equal access and particular sensitivity to turn-taking issues. Many of the issues discussed in Section 3.1.4.6 apply in business meeting scenarios.

It is very important that turn-taking mechanisms be explicitly addressed and formalised in meetings with deaf participants to ensure that people are not isolated from discussions and can contribute equally. This is the responsibility of the meeting chair and remote interpreter (and/or the access manager) even when technological solutions are provided (e.g., a turn-taking indicator is used).

Visual materials

Business meetings like education scenarios often involve the use of visual presentation materials. As discussed in section 5.2.3.2 and 3.1.4.8, there are particular difficulties in using visual materials and speaking about those materials simultaneously. Large group meetings are often planned well in advance of the meeting. Providing visual materials to participants ahead of the meeting is the usual practice. One-on-one meetings often do not involve the use of other visual materials.

Small group meetings are often most affected by use of ad hoc or undistributed visual materials. In order to best manage the needs of deaf users for access to the visual materials and the interpreter through a single view screen, the following suggestions are made:

1) Use a fax, internet connection or file transfer capabilities on the video conferencing system to supply the deaf participant and the interpreter with visual materials during the meeting. The meeting may need to pause while this is carried out but can it can then resume at a faster pace once all people have access to the visual materials.
2) For a pre-planned meeting, the meeting organizer should request visual materials be made available prior to the meeting or suggest that they not be used.

3) The presenter should repeat/read each point verbally before discussing it as well as explicitly announce when a page/slide should be turned to the next one. This will be useful for blind and deaf participants.

Socio/political

The social/political issues that arise with for the health care environment are also potential issues in business meetings. Section 5.1.3.3 under Socio/political health provides details of those issues.

Technology alternatives

- Desktop computer videoconferencing equipment can be used for one to one videoconferencing.
- Small groups require boardroom style set up utilizing videoconferencing equipment that allows camera movement via the remote control.
- Small groups require boardroom style set up utilizing videoconferencing equipment that allows camera movement via the remote control.

1.5.3.4 Guidelines and Recommendations specific to meetings

- Deaf consumers and interpreters need to watch themselves in the "My Video" or "Picture in Picture" screen to be sure that they are signing within the camera's view. Deaf people might have to sign in a smaller space than they normally do, so they are not signing off screen.
- The deaf consumer at the other end should have the control to zoom in/out, up/down to be able to get the signs being transmitted by the interpreter.
- For large and small group meetings, a meeting chair should be assigned. The chair is responsible for ensuring that participants with disabilities and interpreters are explicitly included and meeting procedures address their specific access needs. Planning this prior to the meeting ensures that there are no meeting delays because these issues have not been addressed.
- It is ideal to have a separate access manager from the meeting chair who is responsible for the operation of the technology and for ensuring that access needs are met.
- Video conferencing calls should be recorded and archived for future references and as video/audio notes. Confidentiality issues should be taken into account.
- Visual materials should be made available to deaf participants and interpreters at least one day prior to the meeting.
- Turn-taking procedures should follow formal turn-taking rules. The meeting chair must be responsible for the management of turn-taking.
- Training sessions for video conferencing should include training and suggestions to address access issues.

1.6 Live Captioning: An Overview

Real-time or live captioning is a technique that is not currently available in video conferencing technologies and that could provide many benefits to users with disabilities.

Real-time captioning involves the translation of dialog or spoken information into text as it is occurring similar using court stenographic procedures (court stenographer and technology). A verbatim text transcript is provided to conference participants as participant dialog is being produced. Not only does this allow participation by hard of hearing participants and some deaf participants who use spoken language, but also it allows a complete text archive of the meeting to be produced while the meeting is in progress. The text stream could be displayed along with the camera images on the view screen or it could be displayed over parallel technologies such as through a website.
Services already exist that provide real-time captioning through remote connections. The real-time captionist does not need to physically attend the meeting or class but can use a remote audio/video connection to "listen" to the meeting, and produce and display the real-time captions for meeting participants.

Some of the difficulties with real-time captioning relate to accuracy levels (or error rates during to typing inaccuracies, poor audio fidelity, and mis-hearing words), interpreter's ability to physically and cognitively cope with speed of conversation, interpreter fatigue, and ways to easily provide emotive or speaker identification information. Many of these difficulties remain unresolved and additional research and development is required to address them.

1.7 Recommendations and Guidelines – Summary

- *Recommended minimum bandwidth is 384kbps for a typical business quality videoconference.*
- Good quality videoconference requires 30 frames per second video transmission.
- Data rate higher than or equal to 384 kbps will support a video screen update of 30 frames per second, equal to VCR playback quality television.
- *Data rate lower than 384 kbps will support video screen update of 15 frames per second or less, which is usable, but can seem jerky under rapid motion.*
- Video transmission frame rate greater than 15 frames per second is critical.
- Audio is less important (it is still important for the interpreter), than video, so need for camera controls (remote and local) is very critical.
- Personal microphone such as a lavaliere or lapel microphone for the interpreter rather than a high-end room microphone can be used.
- If interpreter is with the hearing participants, a room microphone and a personal microphone may be required.
- Intelligent audio signal processing (in the form of intelligent hardware or software mixer) must be available to switch between the various audio sources (e.g., interpreter voicing and meeting participants).
- Microphone should be placed next to interpreter voicing for deaf person.
- Remote interpreters should only work for three hours per day, since video interpreting is more fatiguing than face-to-face interpreting.
- Maintaining eye contact is crucial for deaf people in video conferencing.
- Sitting back from the viewing screen (approximately 244 cm or 8' from a 32" monitor) simulates the most natural eye contact.

- Interpreter should position herself on camera by sitting far enough back or by zooming out to appear to have eye contact with the deaf person .
- The interpreter should always remain in direct eye contact with the person who is deaf regardless of the position of equipment or other people.
- Interpreters should avoid eye contact with a hearing person as a non-verbal reminder that he should direct his remarks to the deaf person.
- If interpreter is remote to all parties, he must view screen to watch the person who is deaf.
- To eliminate "visual clutter" in the camera's field of view, minimize visible items on the table such as flowers, water bottles, computer screens,
- Table 1 suggests appropriate seating arrangements for all participants.
- An office divider in a neutral colour makes an appropriate backdrop.
- Walls in the video conferencing room should be painted a solid neutral colour (blue and green are also acceptable).
- The environment must have minimal "visual noise" such as windows, wall coverings, logos, murals or any thing or person that can distract users.
- The optimal background colour is a solid blue or black.
- The interpreter's attire needs to be a solid blue or black colour as well and should contrast with the skin colour.
- Excessive movement is sometimes difficult for the camera to capture. It is best if the interpreter stays in one place.
- Tables with a matte finish are recommended to reduce additional glare.
- Depending on the size of the sessions, tables should be portable (eg: wheels on legs, or detachable legs) to allow optimal set up.
- Curtains are recommended to allow the least amount of visual distraction.
- Chairs should not be "squeaky" when rocked back and forth. Casters on casters are most appropriate for tiled floors to prevent scraping sounds when the chairs are moved. The ideal floor covering is carpet with under padding to minimize the chair moving sounds.
- Adequate room lighting ensures productive communication. Optimal lighting should illuminate the user's face and hands directly and minimizes shadows on face and hands.
- The interpreter must be hyper-vigilant and constantly assess the importance of non-speech and unseen audio events
- If a presentation is incorporated in video conferencing one viewing screen should be for the interpreter and a second one for the other images.
- Chairperson must ensure that all participants are included equally.
- When interpreters and deaf people are using PowerPoint in video conferencing, there must be a pause between each slide and then interpreter can resume watching the signing. Communication will not be accessible if the hearing person continues to talk over the PowerPoint.
- If deaf participants announce themselves before signing; it will make their participation in the meeting more equal to their hearing counterparts.

- Information about participants, meeting purpose, agenda for discussion, intended outcomes of assignment, and any other materials should be provided at least one day ahead of the scheduled video conference.
- Scheduled introductory time between remote interpreter and deaf consumer ahead of the meeting (at least 10 minutes) is needed to allow these individuals to establish rapport, and acknowledge and accommodate for regional differences.
- Arrival of interpreter should be at least 15 minutes prior to the meeting, but if it's a first time it should be ½ hour earlier. The client (deaf person) should arrive 15 minutes prior to the meeting as well.
- A set of guidelines should be presented to all participants before the conference to educate them on the communication differences and the procedures of video remote interpreting.
- The interpreter requires regular access to consumers and meeting chairperson to easily stop the proceedings to get clarification if needed.
- Remote interpreters should be experienced face-to-face interpreters.
- Interpreters must have the vocabulary, in English and in Sign Language, to appropriately complete sentences.
- Remote interpreter must be willing to interrupt proceedings that are preventing participation by deaf person for any reason, particularly if the chairperson is unable to manage the turn-taking and time lag issues.
- Interpreters must track incoming information as well as the gist of what has just been interpreted.
- The interpreter must have several lexical choices for the same concept, as some signs will be more conducive to a 2-dimensional medium.
- Interpreters with diverse community interpreting experiences will have the ability to interpret for a wide variety of consumers (both deaf and hearing).
- The interpreter should be able to accommodate signing slower.
- To process language as well as assert the deaf person's needs are normal responsibilities of the interpreter
- System with "picture-in-picture" capabilities should be used and deaf consumers and interpreters be instructed to monitor themselves on the "picture-in-picture" screen to ensure their signing is within camera's view.
- The deaf consumer at the remote end should have access to the camera controls to better view the signs being transmitted by the interpreter.
- Consider a general need for a mobile video conferencing facility if people do not have the mobility to move to a "special video conferencing room".
- A pre-conference meeting (using video conferencing system) can ease cultural and technical difficulties that might interfere with actual conference, and provide new users with practice.
- The technology should be tested and adjusted prior to meeting to ensure connection numbers, cameras, microphones and displays are in order. This also avoids time spent on audio and video checks during meeting.
- Medical situations can impose Psychological stress and increase potential for deaf participant to be alienated due to a reduced ability to communicate while ill and

over a video conferencing system. The medical practitioners may inadvertently ignore the deaf person's needs.

- Interpreters should stand between the patient and health care provider to appear as unbiased participants.
- Pre-conference training is highly recommended for a classroom instructor and he must be made aware of the unique communication and turn-taking needs of the deaf person/interpreter pair, and given strategies for ensuring that these needs are met.
- Employ a formal turn-taking mechanism such as a remote hand that allows deaf person to overtly gain attention of the instructor or class peers.
- All class materials should be available to the deaf person and the instructor before the class begins.
- Any video or music material used in class should be captioned, and the captions turned on during viewing of the material in class.
- Desktop computer videoconferencing equipment can be used for one to one videoconferencing.
- Small groups require boardroom style set up utilizing videoconferencing equipment that allows camera movement via the remote control.
- The deaf consumer at the other end should have the ability to zoom in/out, up/down to get the signs being transmitted by the interpreter.
- Video conferencing calls can be recorded for any future legal issues as well as being able to go through notes in case he/she feels that they have missed something.
- Instructors are required to allow deaf student to rest at least once a hour.
- A traveling "Road Show" that would show the videoconferencing equipment to deaf individuals and explain its impact on service delivery. Deaf people in remote areas will not know that it is possible for the television to communicate with them. More education and exposure to this technology will encourage cultural acceptance.
- Agencies that do a lot of remote interpreting should invest in "studio quality" resources: the proper videoconferencing furniture, backdrop colours and lighting.
- A separate certification process for remote video interpreters should be investigated so that deaf and hearing consumers will have faith in the professionals providing service to them in this medium.
- Headsets, laptops should be considered natural parts of the remote interpreting process and should have resources designated to that purpose only.

1.8 Glossary of terms

Frames per second (fps): number of frames that pass by per second. NTSC (north American) Broadcast quality video is 29.95 fps

H.323 The ITU standard for videoconferencing over packet switched networks

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4 Remote Real-Time ASL Interpretation

4.1 Introduction

Video communication or video conferencing is becoming a much more commonly used and effective means of interpersonal communication (Finn, Sellen & Wilbur, 1997) such as for distance learning, business meetings and social communication. As hardware becomes more available and less expensive, and software, signal processing and compression technologies become more stable and efficient, there is an increasing interest and experimentation with the technology by the general public and by business.

Video communication technology is designed to support real-time communication between one or more users when long distances separate them. Video-mediated communications, as well as other forms of remote interpersonal communication (e.g., traditional telephony, email, and audio-only communication) are distinctive by the nature of the medium from which they are constituted (Olson, Olson & Meader, 1997). Each form of communication has particular strengths and weaknesses. The goal in using a particular communication medium is not to replicate identically that which can be easily achieved when interlocutors are face-to-face. Rather, it is to find ways to provide participants with a means to achieve all the interactions that are necessary to complete the defined task in a productive and efficient manner. We need to understand the strengths and weaknesses of each medium of communication in order optimize its use and find ways in which to overcome their weaknesses.

One of the strengths of video conferencing technology is the opportunity it offers people with disabilities to communicate with each other, with service providers and with business associates without having to travel. One important benefit relates to sign language users, who can communicate in their own language (using their own cultural expressions and dynamics) with each other and with people who are hearing and at a distance.

ASL speakers living in remote communities can now have access to and participate in Deaf culture where Deaf cultural events are often limited to urban settings with a large population of ASL speakers. Other telecommunications technologies such as the telephone, TTY devices and synchronous chat use text and so do not allow sign language users to communicate in their first language. For people who use sign as their primary language, text based expressions of a spoken language like English should be a viewed as second language and as such is a significantly less expressive and intuitive language for sign language users. Through video communication technology, sign language users can now have access to a more equitable means of communication. Sign language users have been experimenting with video mediated communication for some time and many lessons have been learned to mitigate some difficulties encountered with video conferencing technologies.

In order to ensure that people with disabilities are adequately served by video conferencing technologies and remote meeting procedures we must ensure that the technology and procedures are inclusive and accessible. Guidelines that have been established for video conferencing situations may not be inclusive particularly for users who are deaf. Researchers at Gallaudet University have devised some guidelines to assist sign language users in experiencing more effective one-on-one video mediated signed communication (Williams, 2002) based on the findings and recommendations of the above research. However, these guidelines only apply in one-on-one situations with small field-of-view cameras; they have not been extrapolated to one-to-many situations with high end technology or where there is an interpretation need – a potentially common application.

While video conferencing technologies offer exciting opportunities to support people with disabilities, there is a dearth of research, case studies and best practice literature to support the procurement, installation, management and operation of inclusive video conferencing services. This report provides a set of guidelines and best practice statements that will assist organizations and individuals in establishing accessible video conferencing.

In this document, there is a focus on guidelines for users who are sign language users or who are hard of hearing. These two groups of people have the greatest variety of unique needs for video conferencing. Lack of accessibility therefore has the greatest impact on them. In this document, we provide an overview of the technology, a description of remote

sign language interpretation issues and requirements, small case studies and user reports. Specific access issues are identified and discussed followed by guidelines and recommendations to address these issues. Many of these recommendations are based on our experiences since 2003 using high-end video conferencing for remote interpretation.

4.2 Technology Overview

Before addressing the unique aspects of video communication for people with disabilities, we will provide a brief review of common video communication technologies. There is a standard and common set of hardware technologies and configurations for video conferencing regardless of how the system is used and who the users may be. First, video conferencing relies on having network connectivity so that video and audio signals can be transmitted in real-time over a distance (often over long distances).

There are two main types of network transmission technologies used for video conferencing, Integrated Services Digital Network (ISDN) and Internet Protocols (IP). ISDN, introduced in 1984, is designed to allow fast digital point-to-point connections over the public telephone network (Total Access Networks, 2004). Video communication signal processing and transmission are guided by the International Telecommunication's Union (ITU) H.320 video standards (Polycom, 2001). Guaranteed and consistent quality of service is provided by ISDN as the signal does not fluctuate with network availability because it is a continuous feed and direct connection. Common transmission speeds for ISDN used in video conferencing applications range from 128 kilobits per second (kbps) to 384 kbps. These transmission speeds allow audio-video signals to be consistently transmitted at near broadcast quality (broadcast quality video transmission is 29.95 frames per second (fps)). The cost of this service is based on a monthly line charge (e.g., for 128 kbps service, two 64 kbps lines are required) plus "on air" charges per minute. Video conferencing is "on-air" as soon as a connection is made and is only disconnected when the video conference is complete.

IP videoconferencing involves using Internet Protocols and technologies to process and transmit live video and audio signals. Video conferencing using IP protocols is governed by the ITU H.323 video standard (Polycom, 2001).

Internet protocols (IP) require that data signals are divided into small data packets and routed through various available networks rather than through the continuous feed, direct point-to-point connection available with ISDN. The IP video conferencing signals must share the network with all of the other Internet traffic resulting in inconsistent and fluctuating quality of the video and audio signals (ranging from 2 to 29.95 fps). As a result, high-speed Internet connectivity is required to have effective IP-based video conferencing. Much research and development effort has been placed in developing technical solutions for improving the quality of service for IP video conferencing. Some of this research that has met with some success includes better compression and signal processing techniques (Muresan, et al., 2002), and ways of assigning transmission priorities to video and audio signals (Babich & Vitez, 2000).

Gatekeeper technology is a network device that provides addressing service for H.323 (Internet-based) videoconference clients. It may also be configured to impose network bandwidth restrictions and to allow or disallow a call. Registration by the videoconference client usually takes place when the client is started; the address of the gatekeeper is put into the client's configuration. Use of a gatekeeper allows a videoconference device to "dial" another device using the videoconference address rather than an IP address (which could be changed by DHCP). Gatekeeper services might include bandwidth and call management. Bandwidth controls the number of H.323 terminals permitted simultaneous access to a LAN. Call Management maintains a list of active H.323 calls. This information indicates when a called terminal is busy, and provides information for the bandwidth management function. One or more gatekeepers may reside anywhere on the network, fully integrated into another networking device or operating as a standalone software application on a desktop computer.

Costs for IP-based video conferencing can be significantly lower than ISDN and are mostly related to the speed or bandwidth of connectivity rather than the length of time the video conference is in session. Cable modem or Digital Subscriber Line (DSL) connectivity is generally available and relatively inexpensive, and would be considered as the minimum bandwidth required. Similar to ISDN cost structure, the cost of this service is also based on a monthly rate plus "on-air" per minute charge for use. However, these costs are considerably less than ISDN because of the shared nature of IP-based networks. High-speed networks, and/or fibre-based Ethernets only improve the quality and reliability of video conferencing but costs are significantly increased.

A multipoint videoconference allows more than one site to connect at the same time. A multipoint videoconference involving 3 or more sites is possible through the use of a bridge or multipoint control unit (MCU). Some pre-configured systems such as the Polycom FX have built-in bridges which allow you to connect to multiple sites. Third party services such as Bell Canada bridge services can be rented on an hourly basis.

The video communication system itself consists of two subsystems, one at each end of the network connection. Each subsystem is composed of at least one video camera with optional zoom controls, microphones (desktop or wireless), speakers, a small preview screen (picture-in-picture capability), and monitors or large screen televisions. These subsystems can be PC-based such as iVisit and Netmeeting setups or can be dedicated hardware such as a PolyCom™ ViaVideo® II. Many sources are available to describe the characteristics of the various hardware/software options (e.g., Video Development Initiative's Video Conferencing Cookbook, (VIDe, 2004) is a good source for general detailed information about video conferencing hardware).

There are many different types of subsystem hardware that range in quality and cost. The simplest and least costly hardware is a webcam (at $50.00) and PC-microphone. Often this type of hardware is "plug and play" technology that is

directly accepted by the computer. As a result this type of setup can be installed directly and used immediately with software such as NetMeeting or iVisit. However, this type of hardware has few controls and adjustments. For example, a simple webcam may be limited to focus control (there are not lighting, motion or zoom controls).

The audio system for video conferencing consists of some combination of audio headset, telephone handset, microphones, speakers, and digitising devices (hardware and software). One of the most traditional microphones in video conferencing is the lavaliere microphone, which is a miniature microphone that you clip onto the clothing of the person speaking. Wearing a lavaliere microphone reduces the feedback noise that is picked up by the other type of microphones. A second common type of microphone is the room microphone, which is a unidirectional boundary microphone. These microphones lie on the surface of a conference table or desk. They detect speech with a clear, natural sound. This type of microphone is specially designed to filter out room acoustics – much more so than a conventional microphone on a desk stand. A third microphone type that is often used with desktop video conferencing is the stick microphone or microphone built into the camera. Such microphones lack good audio quality and can effectively shut down a video conferencing. These types of microphones are the least expensive audio solutions but they are also the lowest quality. There is no adjustment in the echo or gain features for these microphones.

As the quality of the camera and microphone setup increases there is a corresponding increase in functionality, controls and the cost of the hardware. For example, a top of the line camera may cost $2,500 but will have a considerable number of functions such as zoom, pan and tilt controls, back light, and automatic tracking. In addition, the optics system in these types of cameras is of a much higher quality than typical webcams. These types of cameras are typically used with systems that allow remote control of camera functions so that the remote participant can control the zoom, pan and tilt functions of the remote camera.

4.2.1 Connecting IP technologies with ISDN

IP video conferencing systems and ISDN systems can be connected together using a gateway communication system. A gateway offers the most flexible link between ISDN (H.320) and IP (H.323) videoconferencing standards and delivers full interoperability between ISDN and IP endpoints. The Gateway integrates seamlessly to provide H.323 management and to control network capacity. For instance, you can conduct conference calls seamlessly from any endpoint to any other endpoint – regardless of system type or network configuration.

4.2.2 Bandwidth recommendations

Videoconferencing requires a large amount of data to be transmitted in a short amount of time. The recommended minimum amount of bandwidth is 384kbps for a typical business quality videoconference.

The main consideration for any video conference is how many frames per second are being transmitted. A good quality video conference requires 30 frames per second video transmission.

Any data rate higher than or equal to 384 kbps will support a video screen update of 30 frames per second, equivalent to VCR playback quality television.

Any data rate lower than 384 kbps will support a video screen update of 15 frames per second or less, which is still usable, but will appear slightly jerky under rapid motion.

4.2.3 Applications

A typical video conferencing interface is based on a telephone metaphor where remote participants are connected using telephone or telephone-like (IP address) numbers. Terminology such as dialing, hanging up, answer, busy, and address book is used to refer to the connecting tasks accomplished by users with the system. Unique aspects of the interface include video displays (local and remote windows) where the local window often appears as a picture-in-picture window in the main video window. Settings menus are often available to customise the look and placement of the video windows, and to adjust various technical properties such as compression quality or levels, video and audio settings and controls, and file management. On the high-end video conference interfaces there are also specialized camera settings for remote and local camera controls and automatic speaker detection.

Video conferencing can involve more than just the real-time transmission of audio and video images. Applications such as file and application sharing, logging audio and video, capturing and sending of static images, simultaneous text chat can be incorporated into video conferencing software. While all of these applications can be very useful in supporting work group needs, they can also interfere with communication strategies. In addition, appropriate access to all of these applications must be included for people with disabilities.

4.2.4 Physical space/Room technologies

Although the number of hardware providers of high end video conferencing equipment is relatively small and system configurations are limited, it is important to carry out a needs and task analysis, (i.e. what is the purpose of the video conferencing system in the organization and for what tasks will it be used) and an environmental survey. These surveys are useful in determining the system requirements, the human resources required to manage the system and an appropriate room or room modifications that might be required. The results of these analyses will have cost, management and timeline implications. For example, if lighting renovations are required the project budget will

increase.

4.2.5 Environmental Considerations

In order to have effective video communication, the hardware must be properly configured and housed in an appropriate environment. There are numerous technical guidelines published to assist organizations and individuals in proper environmental assessments and setup for various configurations of video conferencing hardware (see Polycom, 2004; McAteer, 2000; and Brightline, 2002 to name a few) but few of these guidelines address the special considerations required to accommodate people with special needs, particularly sign language users and remote interpreters.

4.2.6 Future Considerations

Some industry pundits (Lee, T., 200X) suggest that instant messaging and mobile cell phone technologies will assist in the acceptance of personal video conferencing. Already, cell phones incorporate instant messaging capability with image processing and video capabilities. As the next generation enters the workforce they will already be exposed and using instant messaging and video conferencing., "These kids are ready for video conferencing because they were brought up in front of cameras their whole life." (Brandofino, M. Glowpoint Inc. page #.)

4.3 Technology issues related to accessibility

Video conferencing technology mostly involves audio and video communication mediated through computing and network systems. There is some, although considerable less, interaction with computer software required to carry out a video conference. Accessibility by people with disabilities involves access to communication. For people who have no communication disabilities, video conferencing remains accessible. For example, for people who are blind or have low vision, the video conference becomes an audio-only conference. All of the standard audio conference issues such as, ensuring software applications are accessible to screenreaders, and the need to have visual materials made available prior to the conference and readable by a person who is blind are relevant here. However, none of these issues is unique to video conferencing and guidelines for inclusive audio conferencing, and access to images and other visual materials are available from other sources. An example of web guidelines are the Web Accessibility Guidelines of the W3C, (W3C, 2004).

For people who are keyboard users, there are also very few issues related to video conferencing applications that are different from other software applications. One unique issue is the accessibility of camera controls and pre-set buttons. These controls are often available through a remote control or button panels and/or software buttons. Remote control settings may need to loaded into specialized assistive technologies such as an environmental control unit in order to this person to access the camera controls. Where controls are provided through software, keyboard access is required to allow use of these controls.

The people with the highest need for access solutions to video conferencing then are people who are deaf or hard of hearing and who are non-speaking. The remainder of this report will focus on access issues and guidelines to ensure that there is access to audio and video communication for people who are deaf or hard of hearing.

4.3.1 Video conferencing and use with sign language interpreters for people who are deaf.

One exciting opportunity offered by video conferencing technology is that of supporting people who are sign language users in accessing sign language interpreter services; services that can be particularly difficult to obtain in geographically remote locations. Sign language interpretation is required to mediate communication between deaf and hearing people. When sign language users are in geographically remote locations, it is now feasible for them to have access to interpreter services using video mediated communication technologies. However, there are important considerations and differences to address. In this section, we discuss the unique issues that arise when remote interpretation is required and provide amendments to technical and use guidelines to account for these special needs. These recommendations are based on our experiences since 2003 using high-end video conferencing for remote interpretation.

We will also provide a brief introduction to sign language interpretation and video remote interpreting as a sub-specialty within sign language interpreting.

4.3.1.1 Sign Language Interpretation

Sign language interpretation is required when people who are deaf must interact with people who are hearing such as in business meetings, for court, and for accessing social and medical services. It is essential for providing equal access to these activities and services for people who are deaf, and in many western countries it is required through legislative initiatives (for example, see the Americans with Disabilities Act, US Department of Justice, 2003).

American Sign Language (ASL) is the most prevalent sign language used in North America although it is not the only one (e.g., in Quebec, Canada Langue des Signes Québécoise is used). ASL, like other sign languages, is a visual-spatial language without much grammatical similarity to English (Stokeo, 2001). It is considered a linguistically complete, natural language system where the elements of the language are not equivalent to vowels and consonants of written languages, and it is not a translation of English. Vocabulary and meaning of concepts in ASL are expressed using a series of hand gestures, facial gestures such as eyebrow motion and lip-mouth movements, and body movements that

change in time and space. This series of gestures cannot easily be represented by a single written or spoken word. Fingerspelling is used to spell out a word in alphabetic characters that has no sign. For example, there is no unique sign for email and it is therefore represented as the hand gestures for an "e", an "m", an "a", an "i" and an "l" separately.

In order for communication with hearing people to be effective in any situation, the person who is deaf must be able to completely express herself, and must also have complete access to the meeting and communication activities. Interpreters are required to provide a translation of what is said as well as broker any linguistic clarification required and cultural differences experienced between the two parties (Avery, 2001). In face-to-face situations with inexperienced participants, communication can be awkward and difficult. Common practices of turn-taking, participation, maintaining a common understanding and access are noticeably different from meetings that occur between all hearing participants or all sign language participants. For example, common cues to indicate a speaker is ready to relinquish the floor to another speaker are different between hearing and sign language users.

Hearing people use a variety of verbal and non-verbal signals such as eye gaze, asking a question of another person, and head turns to manage turn-taking (Preece et al., 2002) in a group environment. All of these signals are very subtle and learned and participants are generally unaware of when, where, how and the speed with which such tactics are used. Sign language users tend to use more obvious hand gestures such as pointing, and waving their hands to gain attention and fewer non-verbal cues.

In an interpreted setting, the flow of communication tends to be slower due to the translation process. In addition, the sign language user's visual attention is with the interpreter and not with others in the meeting. As such, they cannot attend to subtle turn-taking gestures, such as shifts in eye gaze employed by hearing individuals, in order to know that the speaking floor is available. Turn-taking must therefore be slowed down and made more obvious or formal so that sign language users have a chance to keep up and participate.

Other difficulties that arise in meetings between deaf and hearing participants include difficulties maintaining a common level of understanding because of the use of two different languages to discuss common subjects, and difficulties with access to private or "whispered" conversations. These types of difficulties are not that different from those experienced during meetings between participants using two different spoken languages. However, the role of the interpreter can be very different. The sign language interpreter often must interject cultural and emotional interpretations, request clarification, and interrupt the meeting flow to allow the deaf person a chance to speak.

The role of the meeting chair in these kinds of interpreted settings is very important as management of the meeting is ultimately his responsibility. The meeting chair must be aware of the differences and needs of all meeting participants and take extra steps to ensure that all participants are included and involved.

4.3.1.2 Video remote interpreting

Video remote interpreting in general is identified by interpreting service providers as an enhancement to the existing service and requires specialised training and different terms of use. For example, the Association of International Conference Interpreters suggests that spoken language remote interpreters should only work for three hours per day and that video interpreting is significantly more fatiguing over a 30-minute turn than conventional face-to-face interpreting (Moser-Mercer, 2003). These restrictions and issues apply to sign language video remote interpreters and will likely be amplified because of the physical nature of sign languages.

Video remote interpreting is considered a specialization within the sign language interpreting field. It is defined as the use of video conferencing technology to provide interpreter services where a participant or the sign language interpreter is located at a geographically different location. Many of the difficulties evident in face-to-face meetings are amplified for video remote interpreting and new ones arise that reflect the weaknesses of video conferencing in general.

There are numerous organizations throughout the world that provide video remote interpreting services (My Video Interpreter, 2004; SignTalk, 2004; and Community Access Network, 2004 are three examples) but there is no standardized training protocol or guidelines to overcome some of the difficulties. In addition, there are few best practice examples that demonstrate ways to use the strengths of the technology and overcome some of the weaknesses.

4.3.1.3 Challenges of Video Remote Interpreting

Many challenges arise when video remote interpreting is employed. Some of these challenges relate directly to the quality of the camera hardware and the bandwidth of the video conferencing system. For example, remote interpreters must consciously adjust their natural signing space to accommodate the camera's field of view. They cannot sign outside of the area captured by the camera. Many high-end cameras have zoom controls that can adjust this field of view by zooming the lens either wider or closer. However, a wider field of view that shows more of an interpreter's natural signing space also captures more of the background and surrounding scenery that can be distracting for the person who is deaf. Inexpensive webcams do not have an adjustable field of view and sign language users often must move farther away from the camera so that more of their signing space can be seen or they must restrict their signing to the area around their faces.

Fingerspelling tends to be very fast-paced and not well articulated in face-to-face situations. Only a very high bandwidth video conferencing system will not become pixilated and be effective for fast fingerspelling. Fingerspelling therefore must be slowed down and done closer to the interpreter's body. However, when fingerspelling slows down so does the rate of communication between deaf and hearing interlocutors. There is thus a significant impact on the potential for

misunderstandings and for missed opportunities to turn take.

One important aspect of hardware technologies that has a large impact on the success of sign language use is the camera view angle or field of view. This is defined as the viewable area or scene that can be seen through the camera (Segal, 2004) and it is a function of the focal length of the camera lens. For example, a wide angle lens with a short focal length has a very large field of view or area of the scene that can be seen through the camera lens. Zooming in the camera increases the focal length and decreases the field of view to a much smaller area of the scene.

Remote interpreting removes the chance to develop rapport with consumers, and for that reason has been met with some resistance on the part of sign language interpreters.

4.3.1.4 Considerations for video remote interpreting

With video remote interpreting there can be three possible interpreter locations:

1. The interpreter is remote from both parties (hearing person and deaf person physically located together);
2. The interpreter is physically located with the person who is deaf and the hearing participant(s) are remote; or
3. The interpreter is physically located with the hearing participant(s) and the person is deaf is remote.

Each scenario requires unique considerations regarding the behaviour and perception of the interpreter/deaf person pair. However, regardless of scenarios, one aspect remains constant; the interpreter and deaf person must have constant eye contact and must be able to see each other's signs at all times. A breach of eye contact indicates that communication has been severed.

Video conferencing technology is designed to support communication between one or more remote users.

Eye contact/gaze

Chen et al (2003) have suggested that eye contact is very important in communication of any kind. They indicate that when a speaker is looking to the left, right or upward, the recipient believes that the message is not meant for him. If the eye gaze is slightly downward, although not preferable, the recipient believes that the communication is intended for them. This could explain why television newscasters read from a teleprompter that is positioned slightly below the front view camera. Although the newscaster's gaze is slightly downward, viewers still believe that the newscaster is speaking directly to them and that the message is meant for them. The same is true in video-mediated communication.

Cameras are usually positioned above the main viewing screen (the screen that shows the video images of the remote interlocutors) meaning that eye gaze is slightly downward (people are looking at the viewing screen and not the camera). However, large viewing screens or small field of view cameras create a large gap between the camera and the positions of a person's gaze (while they are looking at the viewing screen). It appears that a person's gaze is significantly downwards (not slightly downwards) and can be very disconcerting particularly if the interpreter is remote from the person who is deaf. When the interpreter is remote the deaf person has no other connection or means of communication with the interpreter other than through the video conferencing system. Maintaining eye contact (even artificially) is crucial for deaf people using video conferencing in this situation.

The interpreter can adjust their position to the camera by sitting far enough back from the camera or zooming the camera out so as to appear to be having eye contact with the person who is deaf. However, doing so also increases the amount of background scenery that the person who is deaf must contend with and screen out particularly with low level or even lighting conditions. Spot lighting can be used to emphasize the interpreter and de-emphasize the scenery but this must be carefully planned and orchestrated; something that is not normally part of a video conference setup.

When the person who is deaf is physically located with the interpreter, maintaining eye contact between the interpreter and the person who is deaf is relatively straight forward. The interpreter can sit next to the video display so that the person who is deaf is always looking toward the monitor. However, the person who is deaf may still appear to the remote participants as though she is looking in another direction and may be disregarded by the other interlocutors because it seems as though she is not participating due to the mis-interpreted eye gaze cue. In addition, the interpreter cannot see the remote participants and may miss the non-verbal cues for turn-taking and other important meeting activities.

In face-to-face situations, interpreters know that if they make eye contact with the hearing speaker, the speaker assumes he is talking to the interpreter and loses his connection with the deaf participant. It is an automatic human behaviour that people tend to look at the person who is speaking (verbally) and thus make eye contact. Experienced interpreters usually avoid eye contact with the hearing person as a non-verbal reminder to that person that he should direct his remarks to the deaf person. Remote interpreting can interfere with this practice particularly when the person who is deaf is remote from the interpreter (interpreter is physically present with the hearing participants or remote to all participants).

When the interpreter is remote to all parties, the interpreter must look at the viewing screen to watch the person who is deaf. To all parties this seems as though the remote interpreter is now looking more directly at them and the viewing screen (and hence the interpreter) becomes the centre of unwanted focus. In addition, the opportunity for the interpreter to use eye gaze as a non-verbal cue to indicate that hearing participants should relate to the person who is deaf is considerably reduced. Careful attention to seating plans is one way to alleviate some of these difficulties.

Seating

In a video conferencing setting, seating should always be an important consideration because the remote participant has considerably less presence and prominence than those at the local site. For remote interpreting situations much more thought must be given to the position of each participant, and whether the interpreter is sitting or standing (community interpreters may be more accustomed to standing while interpreting and thus may prefer to stand. However, in general it is preferable for the interpreter to be seated). Having tools such as notepads or laptops can also be useful for tracking what is being said or presented. Table 2 shows the suggested seating arrangements for the three different interpreter locations. Note for all situations, flowers, water bottles, computer screens and other items generally located on tables should be removed to reduce the visual clutter in the camera's field of view.

Location	Seating for deaf person	Seating for hearing person(s)	Seating for interpreter
Hearing person and deaf person at same site, interpreter is remote	Seated across from viewing screen showing interpreter and in front of camera.	Beside viewing screen so deaf person can see interpreter and hearing person(s) together.	In front of own viewing screen and camera. Will be able to see deaf person.
Hearing person and interpreter at same site, deaf person is remote.	Seated in front of own viewing screen and camera.	Beside interpreter so deaf person can see both parties. Interpreter should direct eye gaze towards deaf person at all times (while signing and voicing)	In front of viewing screen and camera.
Deaf person and interpreter at same site, hearing person is remote	Seated in front of own viewing screen and camera.	In front of own viewing screen and camera.	Beside viewing screen and visible to deaf person. May not be visible to hearing person.
All people are remote	Seated in front of own viewing screen and camera.	In front of own viewing screen and camera	In front of own viewing screen and camera

Table 2: Suggested seating arrangements for all participants.

Environmental and technical issues

There are environmental and technical solutions that can be optimised for people using sign language. When identifying the location(s) for video conferencing, considerations such as physical environment (e.g. room size, lighting, acoustics room setup and furniture) and uses of video conferencing in that environment are important to optimise and renovate if needed. Table 2 summarises some of the important technology considerations when hearing and deaf people are participating in a video conferencing together.

Technical or equipment solutions are also possible and in combination with environmental adjustments can greatly assist in optimising a video conference for people who are deaf and using interpretation. For example, video transmission frame rate of greater than 15 frames per second is critical. Having consistent, high quality image transmission rates available through dedicated high bandwidth networks such as ISDN or high speed IP-based networks can provide this.

When using video conferencing with people who are deaf, audio is less important (although it is still relatively important for the interpreter), and the need for camera controls (remote and local) becomes more important. A personal microphone such as a lavaliere or lapel microphone for the interpreter rather than a high-end room microphone can be used. In the situation where the interpreter is with the hearing participants a room microphone and a personal microphone may be required. This also means that intelligent audio signal processing (in the form of an intelligent hardware or software mixer) must be available to switch between the various audio sources (e.g., interpreter voicing and meeting participants).

Technology	Hearing People	Deaf People
Audio	• High quality audio is higher priority than high quality video.	• May not benefit from the audio. • May not understand the importance of having the microphone "muted" or "on" at their site. • When using voice-activated audio, the camera will focus on the interpreter voicing and not on the deaf person doing the signing.
		• Cannot tolerate poor quality video. • Will notice more

Video	• Tolerate low quality video • May want to continue meeting even with poor video	minute changes in frame rate and video quality. • Will want to cancel the meeting if video quality is unsatisfactory.
Placement of the microphone	• Microphone should be placed near person talking. • Most conference microphones are sensitive enough to capture all audio when placed in room center.	• *Microphone should be placed next to the interpreter who will be voicing for the deaf person.*
Lighting and Background	**www.effectivemeetings.com** • provides recommendations for appropriate clothing • An office divider in a neutral colour makes an appropriate backdrop. • Avoid sitting in front of visually noisy scenery.	• *Be aware of appropriate colours to wear that contrast with skin.* • An office divider in a neutral colour makes an appropriate backdrop. • Avoid sitting in front of visually noisy logos or murals.
The View of the Room	• Usually satisfied with a broad view of the room and rely on the audio to know who is talking • Camera presets are helpful but not critical.	• *May prefer a large view of the room to start, and then to zoom in when it is time to look at a specific person's signing (whether it be the interpreter or a deaf participant)* • *Use of presets more critical.*

Table 3: Summary of technology considerations for video conferences involved hearing and deaf participants.

The environment must have minimal "visual noise" such as windows, wall coverings, as any thing or person that moves that will distract users. These types of visual distractions can disrupt the whole flow of communication in a video communication session that includes people who are deaf. Camera controls such as zoom can be used to adjust the image to eliminate some of these distractions. However, adjusting the image may not be appropriate in all situations (e.g., in a many-to-many conference where the remote participant needs to see all of other participants). Cameras with controls tend to be more expensive, high end cameras.

Detailed Examples of Visual Noise

- Windows can cause significant visual noise. Outside activities seen through the window can be distracting, and lighting from windows can cause difficulties for cameras that automatically adjust for lighting conditions. Cameras pointed at users sitting in front of windows will be flooded with background light and the transmitted image of the user will appear only as a dark object in front of a well-lit window.
- Window coverings such as curtains that sway, or those that do not completely cover the window can be distracting.
- Objects typically found on tabletops during meetings, like water bottles, and laptops can also contribute to visual noise.
- Tables with highly glossed surfaces cause light to reflect off the table and into the camera. Cameras that automatically adjust brightness settings will then adjust for the camera to accommodate this reflected light and most other images in the surroundings, including the people will appear dark.

Other physical factors to consider

Tables: Tables with a matte finish are recommended in order to reduce additional glare. Depending on the size of the sessions, tables should be portable (eg: wheels on legs, or detachable legs) to allow optimal set up. A large meeting could be accommodated by a series of tables and technologies set up as shown in **Figure 21**.

Objects on Table: Minimize the amount of items visible on the table. Flowers, water bottles, computers and other objects disrupt the field of vision and should be placed elsewhere.

Curtains: Solid curtains are recommended to allow the least amount of visual distraction. Vertical shades, however, are not recommended, as they allow sunlight into the room and cause difficulties for cameras with automatic brightness compensation.

Lights: Adequate room lighting ensures productive communication. The most optimal lighting is one that illuminates the users face and hands directly. However, this type of lighting is likely to cause discomfort to the user.
Also, bright overhead lighting minimizes shadows on the face and hands. Brightline Inc. (Brightline, 2002) provides recommendations and shows optimal lighting arrangements for video conferencing. Lighting and lighting placement are a function of room size, person location, wall and ceiling reflectance.

Chairs: The chairs should not be "squeaky" when rocked back and forth. Casters on casters are most appropriate for tiled floors to prevent scraping sounds when the chairs are moved. The ideal floor covering is carpet with under padding to minimize the chair moving sounds.

Room Colour: The walls in the video conferencing room should be painted a solid neutral colour (blue and greens are also acceptable). Walls with patterns or pictures are visually distracting.

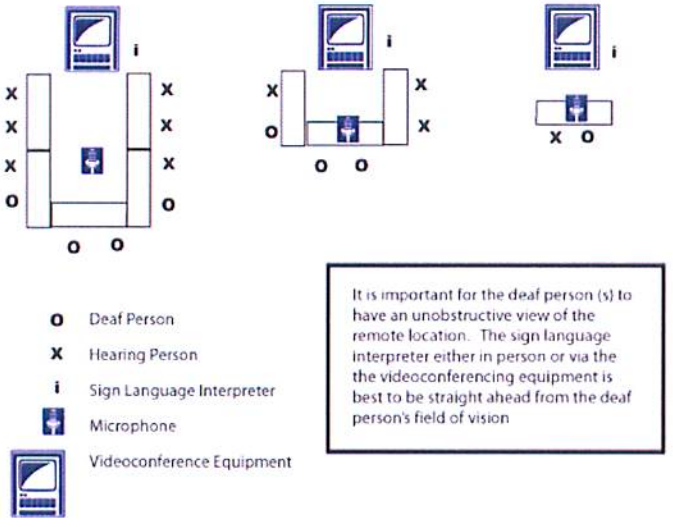

Figure 21: Different furniture and placement configurations.

Turn-taking

Another critically important consideration is that of turn-taking. Because of the difficulties in producing and understanding non-verbal cues during any video conference, turn taking becomes much more cumbersome in general. Interlocutors constantly miss turn-taking cues resulting in communication errors such as overlapping each other or interrupting, having long moments of silence, and taking control of the floor for lengthy periods of time. When someone who is deaf is added to the video conference these difficulties and errors become elevated.

It is often the role of the interpreter to mitigate turn-taking but it may be a much more difficult task for a remote interpreter because they too may miss the turn-taking cues. At the Canadian Hearing Society, attempts to solve this particular difficulty involve employing a conference manager at one site. This person is not the meeting chairperson and is only responsible for managing all of the technology as well as maintaining a formal speaker's list (by monitoring people's desire to speak). This approach is the most successful approach to date but it not the most cost-effective method because it requires another person to facilitate the meeting.

Fels et al. (2000) investigated the use of technology such as lights (flashing, spinning, etc), and a waving hand as a way of improving turn-taking for video conferencing. They found that having a waving hand mechanism activated by a remote participant was very successful at gaining the attention of all participants. While this may be appropriate for classroom settings or even meeting settings, a waving hand may not be acceptable or appropriate in all situations. Further study of this type of approach may provide acceptable solutions.

A third solution to this problem is to use an electronic token to request a turn to speak. This is similar to a physical meeting token or formal speaker list that is commonly used to formalize turn-taking in face-to-face meetings. A user would request the token indicating that she wants a turn to speak, have her turn and then release the token when finished. There must be an override mechanism, perhaps controlled by the meeting chairperson, so that a person does not take complete control of the meeting or the floor. The electronic token can keep circulating until the communication session is complete. There has been little research on the effectiveness of this approach to formalised turn-taking and the acceptance by hearing and deaf people of such a method for video conferenced meetings.

Confidentiality

There are important and unique confidentiality and ownership issues arise with video conferencing. For example, questions such as whether recording a video conference violates confidentiality rules, who owns the archive, and who can access the archive remain unanswered. Similar to audio recording practices, permission to record the audio/visual proceedings should always be sought from participants. This permission should address the ownership and access issues. Legal advice is warranted if archiving video conferences is a normal procedure for an organisation.

Special Considerations for managing multipoint or multi-application conferencing

The user will have the opportunity to connect such equipment as a document projector and/or a scan converter that allow people to present paper-based visual materials through the video conferencing.

Video conferencing equipment such as Polycom allows the user to switch between different presentation technologies while in session. For example, the user can switch and allow the users at the remote locations to see a PowerPoint presentation or videotape on the full screen while presenting. For the hearing presenter/participant, there are no barriers as the hearing presenter can continue to speak and the users can see the PowerPoint presentation simultaneously. For deaf users deaf or hard of hearing users must read the PowerPoint presentation first and then return to the presenter or the interpreter being on the screen. This can cause disruptions (and hence delays) in the flow of the presentation and requires considerable mental effort on the part of the deaf participant who must then remember what was on the visual display.

The presenter should be aware of the difficulties of presenting additional visual materials simultaneously with discussion and provide visual materials to participants before the video conferencing or prepare the presentation to account for participant's needs to keep switching the view screen between the visual material and the interpreter or speaker. For example, the presenter should constantly repeat verbally points on visual material being discussed or allow time for participants to take notes or copy the material on the slides.

Displaying a PowerPoint presentation on the same image as the presenter is worse because it can be very difficult for the users at the remote locations to see the PowerPoint presentation (it is usually too small or the projection screen in the local location is poorly lit).

Other factors

The need to constantly monitor the auditory "goings-on" of the physical environment and then decide what is important to communicate to the person who is deaf is an important secondary task for the interpreter. For example, an interpreter might ignore a pencil that falls on the ground because it does not have any consequence for the communication transaction in a face-to-face meeting. However, when the interpreter is remote the physical context is limited by what can be viewed though the camera. It is difficult for the interpreter to determine whether an unseen audio event such as a door shutting outside the view of the camera is important or not. The interpreter must be hyper-vigilant and constantly assess the importance of non-speech and unseen audio events increasing the already high cognitive load and corresponding fatigue levels for the interpreter. Frequent breaks (e.g., every 30 minutes) or more than one interpreter may be required to accommodate these increased cognitive demands.

One final consideration for video conferencing situations is that they can include multiple applications. Many video conferencing technologies allow you to incorporate presentations (e.g. PowerPoint, videotapes (VCR, DVD), a drawing application to share work among all participants and other visual mediums) If only one viewing screen is available, the video conferencing software allocates the viewing priority to the application. The hearing participants can talk over the display and hear what is being said. However, in situations where the interpreter is located with the hearing participants or remote from all participants, the deaf person cannot participate because the interpreter's video is replaced by the application images. In this situation, the use of two viewing screens, one dedicated to the interpreter and the second one for other images is required, or the shared work must be paper-based. Users might have the opportunity to connect such equipment as "Elmo" and or a scan converter to allow user to use different technologies through the videoconferencing to provide more visual information.

Videoconferencing equipment such as that available through Polycom allows the user to switch between the mediums while a session is happening. For example, the user can switch and allow the users at the remote locations to see a PowerPoint presentation or videotape on the full screen while presenting. For the hearing presenter, this results in no barriers as the hearing presenter can continue to speak and the users can see the PowerPoint presentation. For the deaf users it requires more time as the presenter must allow the deaf or hard of hearing users to read the PowerPoint presentation and then go back to the presenter or the interpreter being on the screen. Using a PowerPoint presentation with the presenter through the videoconferencing camera results in less than optimal viewing because it is very difficult for the users at the remote locations to see the PowerPoint presentation. Ultimately the ideal setting would be allowing sufficient viewing times between the mediums to allow the users to read the content. Ideally it would be an excellent idea to send copies of your presentation (e.g. PowerPoint) to the remote users and interpreters. Table 3 summarises the most common behavioural, etiquette and communication issues experienced by hearing and deaf people during video conference sessions.

Issue	Hearing People	Deaf People
Language choice of meetings and	• Hearing people who know sign language still communicate in	• Culturally deaf people are still expected to be bilingual and follow

issues of language power	spoken language and use sign language interpreters.	written (English) documents shared in the meeting.
Introductions	• Often introduce themselves each time they speak as many female voices sound alike.	• It is obvious who is signing, but if deaf people announce themselves before signing, it will make their participation in the meeting equal to their hearing counterparts.
Eye Contact	• May tolerate the lack of eye contact with the people at the far site, provided there is good audio	• An important part of the visual language and severing eye contact means the communication has ceased. • Sitting back from the viewing screen (approximately 244 cm or 8Ō from a 32" monitor) simulates the most natural eye contact.
(deaf or hearing)	• Must ensure that all people are included as equal participants	• Must ensure that all participants are included as equal participants
Use of peripherals	• Can keep talking while PowerPoint slides are being shown	• When interpreters and deaf people are showing PowerPoint slides in a videoconference, there must be pause between each slide and then interpreter can resume watching the signing. • Communication will not be accessible if the hearing person continues to talk over the PowerPoint slides.

Table 4: Behavioural, communication and etiquette issues.

4.3.1.5 Considerations for Remote Sign Language Interpreters

Preparation

An interpreter with many years of interpreting experience will be reasonably comfortable in most interpreting settings. However, the addition of remote interpreting makes every interpreting situation potentially new and anxiety provoking.

Some of the concerns that interpreters will have include:

1. Interpreters want assurances that the people at the remote site will understand their needs and be able to meet them.
2. Whether remote interpreting equipment will be placed in the correct position.
3. Whether people at the remote site will be familiar with how to use an interpreter and the particular dynamics of using a visual interpreter remotely?

To ease some of these concerns, remote interpreters require as much information as possible prior to the interpreting event. Information about the participants, the meeting purpose, agenda items for discussion, intended outcomes of the assignment, and any presentation materials should be provided at least one day ahead of the scheduled video conference.

During the video conference

If deaf people are meeting an interpreter face-to-face for the first time, they tend to ask personal questions such as whether the interpreter's parents are deaf, or where and why they learned sign language to establish a rapport with the interpreter. A remote interpreter may not have this same opportunity to interact with the deaf consumers before the interpreting session, and may be unable to develop that important rapport with those deaf consumers.

In addition, there can be regional differences in sign language that may cause communication difficulties or misunderstandings. For example, a Canadian deaf person may be assigned an American remote interpreter who will use subtle differences in sign language vocabulary. The may cause difficulties for the deaf person in understanding what is being said or expressing herself clearly. It is important to schedule introductory time between the remote interpreter and a deaf consumer ahead of the meeting (at least 10 minutes) to allow these individuals to establish some rapport, and acknowledge and accommodate for regional differences.

The interpreter's role is to facilitate communication between the hearing and deaf participants. During the session, the interpreter might ask for the participants to clarify what is being said because he/she did not hear the content or under the meaning of the content being said.

Processing in public

While the interpreter is voicing for the deaf consumer in a face-to-face situation, it is assumed that the other participants are focused on the deaf speaker and the hearing people are only listening to the interpreter. In a video conference the remote interpreting may be the centre of attention because the remote interpreter is seen on the viewing screen. The interpreter must perform the complex cognitive task of interpreting while being in the unusual position of being the centre of attention. This potentially adds discomfort and cognitive load to the already considerable cognitive load from interpreting for a remote sign language interpreter.

Lag Time

During any interpreting assignment there is a lag, or delay, from the time the source message from the deaf participant is presented, to when the interpreter understands the message and presents it in the target language. This lag may be longer when videoconferencing technology is used due to the delay introduced by the technology. The ability of the deaf participant to participate on an equal level is restricted. Participants need to know to expect these delays and account for them meetings. **Section 3.4.1.6** provides some suggested solutions to assist in managing the turn-taking difficulties imposed by the increased lag time. In addition, we suggest that a set of guidelines should be presented to all participants before the conference begins in order to educate people on the communication differences and the procedures put in place to accommodate these differences. The meeting chair or the access manager should be responsible for disseminating these guidelines.

Interpreters, deaf people and hearing people at several sites

Where there are several deaf people and interpreters for one video conference, the arrangement of cameras, viewing screens and seating becomes more complex. If several deaf people are participating in a multi-point call, they may have interpreters present with them at their site. In that case, the interpreter at that site voices and the information is re-signed by the interpreter at the other sites. The deaf people then have the choice of watching the deaf participant directly, or watching the "shadowed" version provided by the interpreter in person at their site. In a multi-point or continuous presence call, the frame speed of each square is reduced enough so as to increase the difficulty of the interpreting task. Having deaf people provide an interpreter at their site reduces some of this difficulty.

Interrupting the speaker (either deaf or hearing)

In person, there are opportunities for the interpreter and the deaf consumer to exchange brief signs that reinforce the accuracy of parts of the interpretation. For example, if a deaf person was talking about their family, an interpreter might check briefly, "Do you have FOUR brothers?" The deaf person could communicate the answer to the interpreter without necessarily stopping the natural flow of the communication. This checking of the accuracy of the initial interpretation might not be obvious to the audience listening to the voice interpretation. When interpreting remotely, it can be difficult for the interpreter to "check in" with the deaf consumer and interrupting becomes more complicated. The interpreter needs regular access to the consumers and the meeting chairperson so she can easily stop the proceedings in order to get clarification when needed. However, even if this occurs, the subtle accuracy "checking" becomes more conspicuous to the other participants and may cause disruption.

Preparation materials provided to the interpreter ahead of time can significantly offset this need for interrupting the speaker. As long as the interpreter has the proper background materials ahead of time, the need for interrupting the flow of the communication can be minimized.

Reduced Signing Space

An additional challenge to remote interpreters is they must adjust their natural signing space to accommodate the field of view of the camera. They cannot sign outside of a prescribed area that falls within the camera's visual field otherwise the deaf participant cannot see what is being said. Reducing the natural signing space can cause additional cognitive load and fatigue for the interpreter. More frequent breaks or team interpreting may be required to relieve this additional strain on the interpreter.

Auditory Referencing

Interpreters who are at the same location as their deaf and hearing consumers have the luxury of looking at exactly what is being referenced in the communication. Interpreters cannot sign the spatial relationship if they cannot see what is being referenced. For example, if a speaker says, "You put this over here," the interpreter will be at a loss as to how to describe what is being discussed. It is more effective for deaf and hearing participants to be explicit in what they are

referencing such as, "Your name goes in the blue box in the right-hand corner of the first page."

Team Interpreting

Team interpreting is difficult to successfully carry out remotely without audio headsets that allow the interpreters to communicate together without disrupting the rest of the viewing audience. It is hard for the interpreters to confer on best linguistic choices (either for sign language or English) without individual headsets and microphones. If one of the team interpreters is at a remote setting, their audio is transmitted as soon as they offer linguistic suggestion. It is likely to be perceived as an auditory or visual distraction to the other participants.

Deaf Interpreter

The Certified Deaf Interpreter (CDI) is an individual who is deaf or hard of hearing. In addition to proficient communication skill and general interpreter training, the CDI has specialized training and/or experience in the use of gesture, mime, props, drawings and other tools to enhance communication. The CDI has knowledge and understanding of deafness, the Deaf community, and Deaf culture. The CDI possesses native or near-native fluency in American Sign Language (Registry of Deaf Interpreters, 2004).

There are some unique considerations for video remote interpretations that are applicable to Deaf interpreters. These include:

a. Negotiate with consumer(s) to create working conditions that will facilitate the most accurate and comfortable delivery of interpreting services
b. Inform consumers (hearing and deaf) of any problems the video conferencing session and make efforts to correct them. In this situation, the deaf interpreter may require more time to facilitate communication between the deaf person and the sign language interpreter. Depending on the communication needs of the consumer, the amount of time needed for effective communication may actually double.
c. Communicate with team member(s), particularly at the beginning of the video conference, to assess effectiveness of the interpreting.
d. At the completion of the assignment, it is critical that the deaf interpreter inform the consumers (hearing and deaf) about the clarity of the assignment.

4.3.1.6 Skills Needed for Remote Interpreters

There are very few documents describing specific interpreter skills required for successful remote interpreting. However, where there is mention of remote interpreting, there is agreement that remote interpreters must have considerable experience as face-to-face interpreters. Novices or new graduates of interpreter training programs may find remote interpreting extremely difficult. The types of skills that are learned through experience that are particularly transferable to remote interpreting are:

1. Closure skills – Interpreters must have the vocabulary, in English and in Sign Language, to appropriately complete sentences. An example of this might be a deaf person telling a story about going to an office to drop off their resume and having to leave it with a receptionist. The interpreter might miss the actual fingerspelling of the word "r-e-c-e-p-t-i-o-n-i-s-t" due to the time lag or pixelation caused by the video conferencing system but can still use their interpolation and closure skills to make a meaningful sentence.
2. Assertiveness – The remote interpreter must be willing to interrupt proceedings that are preventing participation by the deaf person for whatever reason, particularly if the chairperson is unable to manage the turn-taking and time lag issues. However, this is an added task for the interpreter and is not ideal. The interpreter may want to have a discussion with the chair person regarding some of the issues and solutions to turn-taking and accommodating the time delay to ensure equal access by the deaf person. Better yet, the interpreter can carry a set of guidelines such as the ones included in this document to provide to inexperienced meeting chairs.
3. Memory – The interpreter must track new, incoming information as well as the gist of what has just been interpreted. This is required because there are often ambiguous references made to previous utterance (such as to a previous PowerPoint slide that is no longer on screen) or location indicators such as "I put that document over here". In addition, remote interpreting tends to have more communication mis-understandings than face-to-face interpreting so the interpreter must have an idea of where the communication breakdown may have occurred, and where to go back to amend or correct the interpretation.
4. Lexical choices –The interpreter must have several lexical choices for the same concept, as some signs will be more conducive to a 2-dimensional medium than others. Experienced interpreters will have gained sufficient alternative expressions to accommodate and made lexical adjustments to accommodate this situation.
5. Varied Experiences – Interpreters with various kinds of community interpreting experiences will have the ability to interpret for a wide variety of consumers (both deaf and hearing). This is particularly important for remote interpreting because the likelihood of interpreting for people outside of the interpreters' regular community is high. For example, an interpreter from Canada may be interpreting remotely for someone in the southern US.

Other factors to consider

1. The optimal background colour is a solid blue or black.
2. The interpreter's attire needs to be a solid blue or black colour as well.
3. Excessive movement is sometimes difficult for the camera to capture. It is best if the interpreter stays in one place.
4. A highly skilled interpreter is preferable, but he should be able to adjust his signing rate to account for less optimal camera frame rates.

5. The interpreter should arrive at least 15 minutes prior to the meeting. If it is an interpreter's first exposure to video conferencing (after training), it is recommended that the interpreter arrive at least 30 minutes early. The deaf person should also arrive 15 minutes prior to the meeting.

4.4 Illustrative cases and personal accounts highlighting issues

This section provides a short description of several cases and personal accounts illustrating the common issues using video conferencing for people with disabilities. Emphasis on experiences of deaf consumers is made due to the complications of language translation and the importance of high quality video.

The first case is of a family with a hearing father and deaf mother gathered to discuss parenting strategies with the hearing staff of a child protection agency in order to determine whether the child could stay in the home. The interpreter was connected remotely through a video conferencing system and all other participants were face-to-face. There were no remote camera controls so that the interpreter could not control the camera in the meeting room.

The mother was very upset and crying. As a result, she could not pay attention to the viewing screen, and the interpreter had difficulties gaining the attention of the other meeting members to assert the mother's needs. Also, the staff was seated with their backs to the viewing screen and facing the father, so that they could not see the interpreter's attempts to gain their attention. The interpreter was trying to accurately and intelligently represent the mother's communication but because the mother was so upset there was considerable delay in processing the mother's communication. This only added to the delay imposed by the technology. In addition, the hearing people continued to give new information and talk while the mother was trying to communicate and the interpreter was trying to interpret that communication and intervene on behalf of the mother. While having to process language as well as assert the deaf person's needs are normal responsibilities of the interpreter, the seating arrangement, the lack of support for and recognition of the mother in the physical setting, the lack of turn-taking structures and the lack of acknowledgement of the interpreter's importance resulted in a failed meeting. Many of these difficulties arose because the interpreter was remote and had difficulty gaining attention and recognition.

While this was a difficult situation even for a face-to-face meeting, the situation was exacerbated by the difficulties resulting from the remote video interpretation issues. To overcome some of these difficulties, there are a number of possible solutions. A formal attention-getting mechanism such as a flashing light with audio would have likely aided in allowing the interpreter and deaf mother to have more presence in the meeting. The hearing staff needed to be seated in such a way as to see the interpreter's eye gaze and turn-taking indicators. In addition, the staff did not have much experience with video conferencing technology, and did inadvertent things such as placing coffee cups down near the microphone causing audio spikes that were very disconcerting for the interpreter. Camera controls or properly setup camera view angles that suited the needs of the interpreter were required. An access manager would have greatly assisted in helping facilitate appropriate setup and use of the technology, and remove some of the barriers to successful communication.

The next three cases are first-person accounts from three individuals directly involved in providing video conferencing services at CHS; two are remote video interpreters, and one is a technical support person at CHS.

4.4.1 Personal Account: My First Impressions of Videoconferencing By Video Remote Interpreter 1

Question: **What was your first impression of video conferencing? As a consumer?**

Answer: *"The first time I ever interpreted remotely, the deaf consumer copied everything I was signing as if he was watching a teleprompter. How many times does your television ever talk to you? It's a difficult concept for people to get their heads around. Those consumers whom I had met before seemed to pick up the concept faster. If the deaf consumer has never met the interpreter they may not know that the person signing to them on the television screen is actually expecting a response; that the process is interactive."*

Question: What were your first experiences as a remote video interpreter?

Answer: *"Sign Language Interpreters work hard at improving their English and Sign Language skills and be recognized as competent professionals. To impose technology that makes the interpretation feel more difficult and stilted feels like a step backward. Will people know that I'm not "new"? Will they see me as an interpreter with experience? As a "seasoned interpreter," why should I put myself in a position to feel inadequate when they are many easier assignments readily available?"*

4.4.2 Personal Account: My First Impressions of Videoconferencing By Video Remote Interpreter 2

Question: *What was your first impression of video conferencing? As a consumer?*

Answer: *"The first experience I ever had using videoconferencing was two years ago for a job interview. I knew two of the people at the far site, but I was convinced they were angry with me. The camera had zoomed out in order to fit the three far-site people in the picture at the same time. I couldn't see their facial expressions very well and I felt as if my*

personality was really coming across like a lead balloon. Although it was a very clear connection (384 kbps and 30 fps) there was a slight delay in the amount of time it took for them to understand my questions and respond. The experience made me think that I might not want a job doing a lot of videoconferencing if this is what is was all about. I figured it wasn't much different (or better) than a teleconference call. I had a person with me that ran the remote control, but he wanted to leave for another commitment. I was terrified at the prospect of being left alone with the equipment (particularly in a job interview where you want to appear competent at what you're doing)."

Question: What were your first experiences of remote video interpreting? Difficulties experienced?

Answer: *"My first experience interpreting by video conference was for a deaf consumer that I have known both personally and professionally for many years. I thought this would make it easier, but in fact it "upped the ante" and made me more fearful of making a mistake. I thought if I made a mistake, people would question my interpreting skills and think, "Boy, we thought she'd do a great job with Susan seeing that they've known each other for years!" It provided an extra pressure on top of the already difficult interpreting task. The situation was further complicated by well-intentioned individuals (who knew sign language) who noticed me struggling and yelled out either background context that I was missing, or yelled out the fingerspelling that I had missed, in order to help me. I had to get the deaf person to fingerspell very slowly and to change the orientation of some of the signs she was producing. Although the deaf person was quite willing to accommodate my needs, I felt like I was giving her an extra task to do. She was already concentrating on her thoughts, and then had to remember my needs. Interpreters are used to blending into the background so that the deaf person and hearing person communicate directly with each other. Having to interrupt either the hearing person or the deaf person more often made me feel more conspicuous in the interpreting event than I was accustomed to being."*

4.4.3 Personal Account: Web Applications Specialist

Question: What was your first impression of video conferencing? As a consumer?

Answer: *"IT'S ABOUT TIME! Back in 1991 I was very interested in videoconferencing and how we can use this to communicate visually. The equipment back then was using six telephone lines to communicate and the setting up of this was complex. We now have come to modern day videoconferencing using IP or IDSN. The quality of the visual information has gone up considerably, but there is still room for improvement.*

It a new way of communicating and requires new set of rules. The complexity of providing meetings with various communication needs is a challenge. I find myself in a group of deaf individuals who sign only is fine and the only problem is getting people's attention at the other location. Often we forget the person at the other end. There needs to be a way electronically or through human interactions to improve "attention getting" cues in this medium."

Question: What were your first experiences of providing video conferencing services at CHS?

Answer: *"Given the implementation of IP videoconferencing at The Canadian Hearing Society, it has provided us new ways of providing services. We have many deaf, deafened and hard of hearing people in the north who does not have access to a sign language interpreter. By providing the interpreter through videoconferencing, it's breaking down the barrier and at the same time saving costs. I know of individuals in Timmins who are in need of interpreters and we can provide this service from Toronto through videoconferencing. Literacy classes, sign language classes and counseling are other kinds of events that are taking place via videoconferencing. With the videoconferencing, we are breaking down the geographical barriers and being able to provide information in a visual medium."*

These three accounts provide some insight (need for training, pre-conference planning, technology improvements, ways to improve and acknowledge presence of remote person and but that the geographical a significant barriers that can be mediated by vc).

4.5 User Environment Scenarios:

In an effort to better understand and elucidate the issues inherent in different uses of video communication technologies, the following section will examine three key user group environments: health, education, and business, and common tasks used in these environments. For each user group environment, the challenges and issues connected with its unique requirements will be explored, and possible remedies will also be presented.

The scenarios discussed mainly involve one-to-one and small groups. Even though there are many different scenarios and combinations, our recommendations will be based on the most popular scenarios that are commonly presented on daily basis when video remote interpreting is used.

4.5.1 Health care Environments

Health care environment tend to involve limited sets of personnel with limited tasks to be achieved. However, it is very important that people have equal access to the health care environment and are able to successfully communicate. Telemedicine is becoming a much more common approach for providing access to medical services, particularly specialist services, for people in remote communities. It is important to consider the needs of people with disabilities.

4.5.1.1 Tasks

Common tasks that video conference participants may want to carry out in this setting are:

Consultation – question and answer session regarding particular health needs or issues.
Examination – inspection of physical, or mental state of patient.
Prescription – discussion of a particular course of treatment, intervention or action.

4.5.1.2 Physical scenarios

A deaf patient would like to consult with medical personnel (e.g., a doctor, nurse, psychiatrists, or medical technician) through an interpreter via video conferencing. The following list includes possible scenarios of remote interpreter/deaf consumer combination.

- The interpreter is in a remote location and patient and doctor, hospital staff or health-care providers at the local location.
- The interpreter is with the deaf person and the doctor, hospital staff or health-care providers are remote.
- Interpreter can be at one location, deaf person at another and doctor, hospital staff or health-care providers at yet another location.

4.5.1.3 Issues unique to health care settings

Physical Positioning

The National Council on Interpreting in Health Care (NCIHC) has produced guidelines for the role of verbal language interpreters working face-to-face in health care settings. In these settings, they recommend that interpreters be positioned near the patient's head with their backs to the patient giving the patient as much privacy as possible. However, sign language interpreters must always have eye contact with the patient for communication to be understood so they must stand in such a place as to see the patient's facial expressions. NCIHC also recommends that interpreters stand between the patient and health care provider so as to appear as unbiased participants.

A sign language interpreter working remotely cannot be guaranteed that busy health care providers in emergency settings will understand the interpreters' positioning preferences or be able to accommodate them at a bedside with limited room to maneuver the required medical equipment.

Sign language production

The ill deaf person lying in bed will not have the same clear sign language production as that of the interpreter, nor will they necessarily maintain a small enough signing space to fit within the camera's field of view. This can be particularly problematic when the interpreter is remote from the deaf person.

One recommendation is to use technical solutions such as zooming out the camera lens to capture their whole signing space and environment. However, the interpreter risks losing critical facial expressions that are achieved by having the camera closer to the deaf person's face. There can be a constant conflict between wanted to see a larger view of the room, and the need to go close to the deaf person to see nuances in the facial expression.

Socio/Political

When remote video interpretation is the method of service delivery, deaf participants may mistrust the interpreter because they have no working relationship with the interpreter and no common cultural context. They may withhold some of their communication. This may also work to the benefit of the deaf person. In a sensitive health care setting, deaf people may say more because they do not know the interpreter personally and chances are will not run into that same interpreter out in the community.

Socio/political factors emerge as some of the most important factors for successful video conferencing and remote interpreting. Failure to account for these factors can result in a failed conference and service to the deaf person. These factors include psychological aspects such as an interpreter's ability to cope with the stress of a remote interpreting assignment, or a deaf person's ability to cope with the stress of having medical needs and the confidence to express these needs via a video conferencing system and/or remote interpreter; having to rely on a screen to derive the visual support information necessary for carrying out the interpreting task; motivation; processing information from multiple sources; social isolation; and operating multiple controls while effectively communicating. For example, in personal statements it has been reported by interpreters and deaf people that the lack of proximity between a deaf person and her interpreter can create a feeling of alienation that may results in lack of motivation, a decrease in interpreting quality, and a decrease in the deaf person's involvement and participation in the video conference.

The deaf person may be at significant disadvantage because of these socio/political factors. In addition, they may feel intimidated by a lack of medical knowledge and and by not having a physical presence at the consultation, meeting or evaluation. This may result in an unbalanced power relationship between medical personnel and the deaf patient that can, in turn, cause withdrawl by the deaf participant, the need for the interpreter to take on a strong advocacy role, and errors made by the medical team by unconfirmed or incorrect assumptions. Awareness, experience and perhaps a patient advocate who is physically present with the medical team may be ways in which some of these difficulties can be

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mediated.

4.5.1.4 Guidelines and Protocols specific to Health Scenarios

- Follow general guidelines listed in **Section 3.0**.
- It is recommended that a system with "picture-in-picture" capabilities be used and that deaf consumers and interpreters be instructed to monitor themselves in the "Picture in Picture" screen to ensure that their signing stays within the camera's view. Individuals may need to adjust their signing space to accommodate small camera field of views.
- The deaf consumer at the remote end should have access to the camera controls so that they can ensure that the signs being transmitted by the interpreter. One important consideration is that the deaf person must also have training and a comfort level with the technology in order to manage camera controls, sign adequately and communicate his/her needs in an environment where the deaf person may be feeling sick or enjoy little power in the relationship.
- Video conferencing calls should be recorded for future reference or for legal needs.
- There can be a general need for a mobile video conferencing facility if people do not have the mobility to move to a "special video conferencing room". The recommendations in this document would apply to this type of portable system as well.
- A pre-conference meeting (using the video conferencing system) is recommended to alleviate some of the cultural and technical difficulties that might interfere with the success of the actual conference, and to provide new users with some practice.
- The technology should be tested and adjusted prior to the meeting to ensure that connection numbers, cameras, microphones and displays are working correctly. This also avoids time being spent on audio and video checks during the meeting.
- The interpreter should always remain in direct eye contact with the person who is deaf regardless of the position of equipment or other people.
- Be cognizant of the psychological stress imposed by medical situations and increased potential for the deaf participant to be alienated due to a reduced ability to communicate while ill and over a video conferencing system. It may be too easy for the medical practitioners to inadvertently ignore the deaf person's needs.

4.5.2 Education Environments

Distance learning has become more popular and gained wider acceptance as an effective instructional tool (Gowan & Downs, 1994; Benford et. al., 1998).
Students of all types have begun to take advantage of this services institution are offering. Video mediated communication is a valuable educational resource because it provides access to live instructors or teaching assistants; it can be more motivating than students working on their own, and can help students improve communication skills (Knight, 1998).

When a deaf student is registered at a post-secondary institution, whether it is through distance learning or face-to-face classes, she is often provided with an interpreter. As interpreting services can be difficult to obtain particularly for students at institutions in more remote locations (e.g., University of the Cariboo in northern British Columbia), the possibility of using remote interpretation is very real. Interpretation would be provided by interpreters in major centres that can often be quite a distance from the student.

4.5.2.1 Typical tasks

Common tasks that students (remote or local) may want to carry out in this setting are:

- Listening/pay attention to instructor for extended periods of time (e.g., one hour).
- Interacting with instructor with question/answer or discussion styles of interaction.
- Interacting with peers in formal group meetings, or in side conversations.
- Interrupting instructor to ask question.
- Formal presentation of academic material or point of view for entire class.
- Viewing class material (e.g., PowerPoint presentations, overheads, videos, music, blackboard/whiteboard markings, and images, websites, etc.)

4.5.2.2 Physical scenarios

There are a number of possible physical scenarios in which video conferencing is used to serve deaf students. These apply whether the video conferencing is used in a distanced education or a face-to-face teaching situation.

In the first scenario, the deaf student and her interpreter are in the same location. The interpreter would be signing the material being delivered by the instructor and voicing questions from the deaf student. This scenario is the most straight-forward as the interpreter can remain outside of the field of view of the camera and the viewing screen in the classroom only shows the deaf student. The image in the student's location shows the instructor and/or the classroom depending on the controls provided with the video conferencing system.
A second scenario is where the interpreter and instructor are in the same location and the deaf student is in the remote location. The interpreter is video remote interpreting the material being taught by the instructor while having a physical presence in the classroom. While the deaf student will always appear on the viewing screen, the interpreter potentially will have a stronger presence in the classroom particularly when voicing the deaf student's communication. Maintaining focus on the deaf student is a difficult task for the interpreter particularly when there are many other people in the

classroom. The viewing screen is often located at the front of the classroom for the simple reason of access to electrical power. The deaf student is not an integrated part of the class but rather stands out at the front and may believe that everyone is always "watching" him. In addition, the eye gaze position of the deaf student due to the camera location may seem as though the deaf student is otherwise occupied or not paying attention. This may cause the student to take a passive stance and not participate in discussions or queries.

PEBBLES (Weiss & Fels, 2001) is one example of a video conferencing system that allows a remote student to be placed anywhere in a classroom. It is a video conferencing robot designed to allow students in hospital to attend school. Remote students have control over what they can view in their classroom and what others can see of them. Studies with PEBBLES (Fels, 2003) indicate that students using PEBBLES become integrated into the classroom quickly and that they do not receive more attention than other students after an initial novelty period. Placing the video conferencing unit at a normal "seat" in the classroom may remove some of the unwanted focus on the deaf student at the front of the class.

The third scenario would occur when the deaf student is physically attending a course in a classroom and the interpreter is remote. The video conferencing system would be setup in the classroom and transmit a live image and voice of the interpreter (the interpreter would sign what the instructor was saying and voice comments, questions, discussion points signed by the student).

Similar to the second scenario, the video conferencing system would usually be placed at the front of the classroom and potentially become the focus of attention particularly when the interpreter is voicing the deaf student's comments. The interpreter would have very little influence over where people are looking as the interpreter's eye gaze would seem to be towards all people in the classroom. Using a personal video conferencing system in the classroom that can be located close to the deaf student may potentially alleviate some of these problems including focusing the attention on the deaf student when he wants the floor.

4.5.2.3 Issues unique to education settings

Turn-taking

In classroom situations, turn-taking tends to be more formalized where students are expected to raise their hands to indicate they want the floor. Integrating a turn-taking indicator such as a hand or an audible light may be an appropriate method for the deaf student to also indicate she wants the floor. However, using only a light or flashing light has been shown to be ineffective in classroom settings (Weiss et al, 2001).

Shared applications

Where PowerPoint presentations or other applications must be shared, dual monitors must be used to ensure that the interpreter can always be seen by the deaf student. If captioning is available for audio material such as videos and films that have sound or music, it should be activated to ease some of the burden on the interpreter. If no captions are available for video or music material, the education delivery unit should consider producing them. This is important for live access to this material during use for the class but it is also important to allow students access to the material after class when an interpreter is not available.

Other important factors

Finally, constant attention to a video screen is fatiguing for deaf students as they rely exclusively on their visual system to acquire communication messages. Hearing students can take small visual breaks by using their auditory system during class. More frequent formal breaks, at least once per hour, are required to allow the deaf student to rest.

4.5.2.4 Guidelines and Recommendations specific to education

- Follow general guidelines for listed in **Section 3.0**
- It is recommended that a system with "picture-in-picture" capabilities be used and that deaf consumers and interpreters be instructed to monitor themselves in the "Picture in Picture" screen to ensure that their signing stays within the camera's view. Individuals may need to adjust their signing space to accommodate small camera field of views.
- The deaf consumer at the remote end should have access to the camera controls so that they can ensure that the signs being transmitted by the interpreter. One important consideration is that the deaf person must also have training and a comfort level with the technology in order to manage camera controls, sign and communicate adequately.
- As the instructor usually is responsible for managing class activities, pre-conference training is highly recommended. The instructor must be made aware of the unique communication and turn-taking needs of the deaf person/interpreter pair, and given strategies for ensuring that these needs are met.
- The technology should be tested and adjusted prior to the first class to ensure that connection numbers, cameras, microphones and displays are working correctly. This also avoids time being spent on audio and video checks during the class and possible missed information from the instructor.
- The interpreter should always remain in direct eye contact with the person who is deaf regardless of the position of the instructor, other people or equipment in the classroom.
- Employ a formal turn-taking mechanism such as a remote hand that allows the deaf person to overtly gain the attention of the instructor or class peers.
- All class materials should be available to the deaf person and the instructor before the class begins.
- Any video or music material used in class should be captioned, and the captions turned on during viewing of the material in class.

4.5.3 Business Environments

One of the most common applications of video conferencing with deaf participants is a business meeting. These can take several forms including one-on-one, small groups of less than fifteen individuals, and large meeting with many people (e.g., annual general meeting). In each setting, there are unique issues that must be addressed so that the deaf person can enjoy equal participation and the interpreter is optimally positioned to facilitate this participation.

4.5.3.1 Tasks

Common tasks that video conference participants may want to carry out in this setting are:

- Participate in the discussion, contributing comments and listening to what others contribute. This can be accomplished using formal, agenda-driven rules for turn-taking and meeting progress (e.g., Robert's rules of order) or much more informal processes where people raise hands to request the floor or use non-verbal cues to take a turn when the opportunity arises. Large group meetings tend to be much more formal with set agendas and speakers, formal question/answer or discussion periods and formal turn-taking structures.
- Proposing or seconding motions.
- Presenting information or materials where participant has formal and exclusive control of the floor.
- Asking/answering questions/gaining attention
- Chairing meeting

4.5.3.2 Scenarios

The following three scenarios of deaf/interpreter pairs are possible

One to One Meetings

- The deaf person and the interpreter are in the remote location and the hearing person is at the local location or vice-versa.
- The deaf person and the hearing person are in the local location while the interpreter is at the remote location.

Small Group Meeting

- The group of deaf people and interpreter are at the local location while the hearing person/people are at the remote location.
- The deaf person is at the remote location and the hearing people and interpreter is at the local location.
- Deaf and hearing people at local location and the interpreter is at remote location.

Large meetings

- Group of deaf and hearing people are at the local location while the interpreter is at the remote location.
- Group of deaf and hearing people as well as the interpreter is at the local location while at the remote location there would be a small group of hearing and/or deaf people.

4.5.3.3 Issues unique to meeting settings

Turn-taking

Turn-taking issues are likely the more important issue to consider in meeting with deaf people. Equal participation in video conferenced meetings often involves equal access and particular sensitivity to turn-taking issues. Many of the issues discussed in **Section 3.1.4.6** apply in business meeting scenarios.

It is very important that turn-taking mechanisms be explicitly addressed and formalised in meetings with deaf participants to ensure that people are not isolated from discussions and can contribute equally. This is the responsibility of the meeting chair and remote interpreter (and/or the access manager) even when technological solutions are provided (e.g., a turn-taking indicator is used).

Visual materials

Business meetings like education scenarios often involve the use of visual presentation materials. As discussed in section **5.2.3.2** and **3.1.4.8**, there are particular difficulties in using visual materials and speaking about those materials simultaneously. Large group meetings are often planned well in advance of the meeting. Providing visual materials to participants ahead of the meeting is the usual practice. One-on-one meetings often do not involve the use of other visual materials.

Small group meetings are often most affected by use of ad hoc or undistributed visual materials. In order to best manage the needs of deaf users for access to the visual materials and the interpreter through a single view screen, the following suggestions are made:

1. Use a fax, internet connection or file transfer capabilities on the video conferencing system to supply the deaf participant and the interpreter with visual materials during the meeting. The meeting may need to pause while this is

carried out but can it can then resume at a faster pace once all people have access to the visual materials.
2. For a pre-planned meeting, the meeting organizer should request visual materials be made available prior to the meeting or suggest that they not be used.
3. The presenter should repeat/read each point verbally before discussing it as well as explicitly announce when a page/slide should be turned to the next one. This will be useful for blind and deaf participants.

Socio/political

The social/political issues that arise with for the health care environment are also potential issues in business meetings. **Section 5.1.3.3** under Socio/political health provides details of those issues.

Technology alternatives

- Desktop computer videoconferencing equipment can be used for one to one videoconferencing.
- Small groups require boardroom style set up utilizing videoconferencing equipment that allows camera movement via the remote control.
- Small groups require boardroom style set up utilizing videoconferencing equipment that allows camera movement via the remote control.

4.5.3.4 Guidelines and Recommendations specific to meetings

- Deaf consumers and interpreters need to watch themselves in the "My Video" or "Picture in Picture" screen to be sure that they are signing within the camera's view. Deaf people might have to sign in a smaller space than they normally do, so they are not signing off screen.
- The deaf consumer at the other end should have the control to zoom in/out, up/down to be able to get the signs being transmitted by the interpreter.
- For large and small group meetings, a meeting chair should be assigned. The chair is responsible for ensuring that participants with disabilities and interpreters are explicitly included and meeting procedures address their specific access needs. Planning this prior to the meeting ensures that there are no meeting delays because these issues have not been addressed.
- It is ideal to have a separate access manager from the meeting chair who is responsible for the operation of the technology and for ensuring that access needs are met.
- Video conferencing calls should be recorded and archived for future references and as video/audio notes. Confidentiality issues should be taken into account.
- Visual materials should be made available to deaf participants and interpreters at least one day prior to the meeting.
- Turn-taking procedures should follow formal turn-taking rules. The meeting chair must be responsible for the management of turn-taking.
- Training sessions for video conferencing should include training and suggestions to address access issues.

4.6 Live Captioning: An Overview

Real-time or live captioning is a technique that is not currently available in video conferencing technologies and that could provide many benefits to users with disabilities. Real-time captioning involves the translation of dialog or spoken information into text as it is occurring similar using court stenographic procedures (court stenographer and technology). A verbatim text transcript is provided to conference participants as participant dialog is being produced. Not only does this allow participation by hard of hearing participants and some deaf participants who use spoken language, but also it allows a complete text archive of the meeting to be produced while the meeting is in progress. The text stream could be displayed along with the camera images on the view screen or it could be displayed over parallel technologies such as through a website.
Services already exist that provide real-time captioning through remote connections. The real-time captionist does not need to physically attend the meeting or class but can use a remote audio/video connection to "listen" to the meeting, and produce and display the real-time captions for meeting participants.

Some of the difficulties with real-time captioning relate to accuracy levels (or error rates during to typing inaccuracies, poor audio fidelity, and mis-hearing words), interpreter's ability to physically and cognitively cope with speed of conversation, interpreter fatigue, and ways to easily provide emotive or speaker identification information. Many of these difficulties remain unresolved and additional research and development is required to address them.

4.7 Recommendations and Guidelines – Summary

- Recommended minimum bandwidth is 384kbps for a typical business quality videoconference.
- Good quality videoconference requires 30 frames per second video transmission.
- Data rate higher than or equal to 384 kbps will support a video screen update of 30 frames per second, equal to VCR playback quality television.
- Data rate lower than 384 kbps will support video screen update of 15 frames per second or less, which is usable, but can seem jerky under rapid motion.
- Video transmission frame rate greater than 15 frames per second is critical.
- Audio is less important (it is still important for the interpreter), than video, so need for camera controls (remote and

local) is very critical.

- Personal microphone such as a lavaliere or lapel microphone for the interpreter rather than a high-end room microphone can be used.
- If interpreter is with the hearing participants, a room microphone and a personal microphone may be required.
- Intelligent audio signal processing (in the form of intelligent hardware or software mixer) must be available to switch between the various audio sources (e.g., interpreter voicing and meeting participants).
- Microphone should be placed next to interpreter voicing for deaf person.
- Remote interpreters should only work for three hours per day, since video interpreting is more fatiguing than face-to-face interpreting.
- Maintaining eye contact is crucial for deaf people in video conferencing.
- Sitting back from the viewing screen (approximately 244 cm or 8' from a 32" monitor) simulates the most natural eye contact.
- Interpreter should position herself on camera by sitting far enough back or by zooming out to appear to have eye contact with the deaf person .
- The interpreter should always remain in direct eye contact with the person who is deaf regardless of the position of equipment or other people.
- Interpreters should avoid eye contact with a hearing person as a non-verbal reminder that he should direct his remarks to the deaf person.
- If interpreter is remote to all parties, he must view screen to watch the person who is deaf.
- To eliminate "visual clutter" in the camera's field of view, minimize visible items on the table such as flowers, water bottles, computer screens,
- Table 1 suggests appropriate seating arrangements for all participants.
- An office divider in a neutral colour makes an appropriate backdrop.
- Walls in the video conferencing room should be painted a solid neutral colour (blue and green are also acceptable).
- The environment must have minimal "visual noise" such as windows, wall coverings, logos, murals or any thing or person that can distract users.
- The optimal background colour is a solid blue or black.
- The interpreter's attire needs to be a solid blue or black colour as well and should contrast with the skin colour.
- Excessive movement is sometimes difficult for the camera to capture. It is best if the interpreter stays in one place.
- Tables with a matte finish are recommended to reduce additional glare.
- Depending on the size of the sessions, tables should be portable (eg: wheels on legs, or detachable legs) to allow optimal set up.
- Curtains are recommended to allow the least amount of visual distraction.
- Chairs should not be "squeaky" when rocked back and forth. Casters on casters are most appropriate for tiled floors to prevent scraping sounds when the chairs are moved. The ideal floor covering is carpet with under padding to minimize the chair moving sounds.
- Adequate room lighting ensures productive communication. Optimal lighting should illuminate the user's face and hands directly and minimizes shadows on face and hands.
- The interpreter must be hyper-vigilant and constantly assess the importance of non-speech and unseen audio events
- If a presentation is incorporated in video conferencing one viewing screen should be for the interpreter and a second one for the other images.
- Chairperson must ensure that all participants are included equally.
- When interpreters and deaf people are using PowerPoint in video conferencing, there must be a pause between each slide and then interpreter can resume watching the signing. Communication will not be accessible if the hearing person continues to talk over the PowerPoint.
- If deaf participants announce themselves before signing; it will make their participation in the meeting more equal to their hearing counterparts.
- Information about participants, meeting purpose, agenda for discussion, intended outcomes of assignment, and any other materials should be provided at least one day ahead of the scheduled video conference.
- Scheduled introductory time between remote interpreter and deaf consumer ahead of the meeting (at least 10 minutes) is needed to allow these individuals to establish rapport, and acknowledge and accommodate for regional differences.
- Arrival of interpreter should be at least 15 minutes prior to the meeting, but if it's a first time it should be _ hour earlier. The client (deaf person) should arrive 15 minutes prior to the meeting as well.
- A set of guidelines should be presented to all participants before the conference to educate them on the communication differences and the procedures of video remote interpreting.
- The interpreter requires regular access to consumers and meeting chairperson to easily stop the proceedings to get clarification if needed.
- Remote interpreters should be experienced face-to-face interpreters.
- Interpreters must have the vocabulary, in English and in Sign Language, to appropriately complete sentences.
- Remote interpreter must be willing to interrupt proceedings that are preventing participation by deaf person for any reason, particularly if the chairperson is unable to manage the turn-taking and time lag issues.
- Interpreters must track incoming information as well as the gist of what has just been interpreted.
- The interpreter must have several lexical choices for the same concept, as some signs will be more conducive to a 2-dimensional medium.
- Interpreters with diverse community interpreting experiences will have the ability to interpret for a wide variety of consumers (both deaf and hearing).
- The interpreter should be able to accommodate signing slower.
- To process language as well as assert the deaf person's needs are normal responsibilities of the interpreter
- System with "picture-in-picture" capabilities should be used and deaf consumers and interpreters be instructed to monitor themselves on the "picture-in-picture" screen to ensure their signing is within camera's view.
- The deaf consumer at the remote end should have access to the camera controls to better view the signs being transmitted by the interpreter.

- Consider a general need for a mobile video conferencing facility if people do not have the mobility to move to a "special video conferencing room".
- A pre-conference meeting (using video conferencing system) can ease cultural and technical difficulties that might interfere with actual conference, and provide new users with practice.
- The technology should be tested and adjusted prior to meeting to ensure connection numbers, cameras, microphones and displays are in order. This also avoids time spent on audio and video checks during meeting.
- Medical situations can impose Psychological stress and increase potential for deaf participant to be alienated due to a reduced ability to communicate while ill and over a video conferencing system. The medical practitioners may inadvertently ignore the deaf person's needs.
- Interpreters should stand between the patient and health care provider to appear as unbiased participants.
- Pre-conference training is highly recommended for a classroom instructor and he must be made aware of the unique communication and turn-taking needs of the deaf person/interpreter pair, and given strategies for ensuring that these needs are met.
- Employ a formal turn-taking mechanism such as a remote hand that allows deaf person to overtly gain attention of the instructor or class peers.
- All class materials should be available to the deaf person and the instructor before the class begins.
- Any video or music material used in class should be captioned, and the captions turned on during viewing of the material in class.
- Desktop computer videoconferencing equipment can be used for one to one videoconferencing.
- Small groups require boardroom style set up utilizing videoconferencing equipment that allows camera movement via the remote control.
- The deaf consumer at the other end should have the ability to zoom in/out, up/down to get the signs being transmitted by the interpreter.
- Video conferencing calls can be recorded for any future legal issues as well as being able to go through notes in case he/she feels that they have missed something.
- Instructors are required to allow deaf student to rest at least once a hour.
- A traveling "Road Show" that would show the videoconferencing equipment to deaf individuals and explain its impact on service delivery. Deaf people in remote areas will not know that it is possible for the television to communicate with them. More education and exposure to this technology will encourage cultural acceptance.
- Agencies that do a lot of remote interpreting should invest in "studio quality" resources: the proper videoconferencing furniture, backdrop colours and lighting.
- A separate certification process for remote video interpreters should be investigated so that deaf and hearing consumers will have faith in the professionals providing service to them in this medium.
- Headsets, laptops should be considered natural parts of the remote interpreting process and should have resources designated to that purpose only.

4.8 Glossary of terms

Frames per second (fps): number of frames that pass by per second. NTSC (north American) Broadcast quality video is 29.95 fps

H.323 The ITU standard for videoconferencing over packet switched networks

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Editor's Note: This is a comprehensive and well documented study regarding distance learning for deaf populations. Videoconferencing designed especially for Deaf elementary and high school students facilitates visual communication and American Sign Language (ASL). College and career-age students with language proficiency – whether English or ASL - prefer to receive information first-hand. A wide range of programs and strategies can be employed with positive results for Deaf students and the instructors and interpreters that serve them.

Distance Education Brings Deaf Students, Instructors, and Interpreters Closer Together: A Review of Prevailing Practices, Projects, and Perceptions

Becky Sue Parton

Abstract

Distance education is becoming increasingly common in the general population – a trend that is mirrored in programs for students and professionals involved in Deaf education. A review of the literature reveals three distinctive target groups within Deaf education for which distance education serves to advance learning agendas: Deaf students, instructors, and interpreters. This paper will first endeavor to identify and describe the ways in which distance education is positively contributing to Deaf education and training. As a secondary goal, the special considerations and modifications necessary for successful implementation of a distance-learning module targeted toward Deaf students will be discussed. Videoconferencing designed especially for Deaf elementary and high school students, appears to be the most common and successful form of distance education currently since it accommodates American Sign Language communication.

Keywords: deaf, hard-of-hearing, distance education, video conferencing, American Sign Language, interpreters, distance learning, computer technology, special populations, deaf education teachers, captions, instructional technology.

Introduction

Distance education is becoming increasingly common in the general population – a trend that is mirrored in programs for students and professionals involved in Deaf education. Hubbard (1999) extols the virtues of this medium, "Education of the deaf can benefit from distance

learning fully as much, if not more, as education of the hearing" (p.6). Distance education can be defined as technology-aided instruction occurring when teachers and students are physically separated (Eilers-Crandall, 2000). A review of the literature reveals three distinctive target groups within Deaf education for which distance education serves to advance learning agendas: Deaf students, instructors, and interpreters. Each of these groups has experienced successful instruction through a variety of distance techniques including videoconferencing and web-based initiatives. The purpose of this paper is to review prevailing practices, projects, and perceptions regarding distance education in the realm of Deaf education. It will first endeavor to identify and describe the ways in which distance education is positively contributing to Deaf education and training. As a secondary goal, this paper will discuss the special considerations and modifications necessary for successful implementation of a distance-learning model targeted toward Deaf students. By gaining a broad understanding of these issues, the interested reader will be better prepared to conduct investigations into specific areas of interest within this discipline.

Target Groups and Projects Identified

Deaf Students

Deaf students from elementary age to college age are experiencing the additional opportunities that distance education affords them. Many projects and approaches are underway. Researchers agree that, in particular, videoconferencing is beneficial for Deaf students due to its visual nature (e.g., Hazelwood, n.d.; Juhas, 2001). At the Texas School for the Deaf (TSD), videoconferencing grants students the opportunity to explore via virtual fieldtrips to museums, zoos, and other sites. Students can collaborate with peers in their native language, American Sign Language (ASL) versus exchanging comments through written English (Hazelwood, n.d.). Additionally, Deaf children and teenagers are exposed to Deaf adults. These role models may serve as mentors or experts to assist in job interview role-playing or to depict the art of ASL poetry for example. Students at TSD share presentations, present ASL stories, and debate all at a distance. They can receive instruction on a wide-variety of topics, even the study of other languages, such as Spanish, by using the document camera to display a written representation of the foreign language (Hazelwood, n.d.). At the Colorado School for the Deaf and Blind (CSDB), Deaf students use videoconferencing to connect with Deaf adults who answer questions about life in the 'real-world' including relationships and employment (Rose, 1999). Although many of the activities permissible through videoconferencing at these and other schools are not unique to Deaf students, it is the dramatic improvement to communication that is noteworthy. Text-telephones (TTYs) and email rely on written English, but Eilers-Crandall (2000) states, "Videoconferencing provides remote participants with face-to-face familiarity that comes with physical presence, including facial expressions, body language, and eye contact" (p.10). The National Technical Institute for the Deaf (NTID) – a school within the Rochester Institute of Technology (RIT) in New York - arranged a panel discussion between students, Gallaudet University, and the Greater Los Angeles Council on Deafness (GLAD). NTID also participated in a joint venture with the Rochester School for the Deaf (RSD) whereby high school

students at RSD took college-level science and math class from NTID through videoconferencing during the 2000-2001 school year (Robinson & Aidala, 2002). An initiative entitled the Shared Reading Video Outreach Project (SRVOP) was initially developed by Gallaudet University and has subsequently been adapted by states such as Washington to fit the needs of the community. SRVOP is a reading enhancement program that promotes literacy by presenting stories from children's books to Deaf students. These families, who live in remote areas of the state, might otherwise not have the chance to meet and participate with Deaf adult storytellers (SRVOP, 2003).

Videoconferencing is but one method of implementing distance learning. Web-based is another approach that is gaining popularity. The familiarity of the Internet to most students makes it a comfortable medium (Eilers-Crandall, 2000). At NTID, some programming courses are now offered on-line and were specifically designed for Deaf students. They integrate captions and signed videotaped lectures (NTID, 2003). In the broader community of RIT however, Deaf students often elect to take courses for which an interpreter traditionally translated the discourse. When the format of some of the aforementioned classes became web-based, they were made accessible to the Deaf students through text-based dialogue. A recently conducted survey posed questions regarding Deaf students embracement of this approach. Hearing and Deaf students did equally well statistically and rated many contributing factors to success similarly. Long (2003) reflects:

> *. . . most deaf and hard of hearing respondents felt that the on-line learning format provided important communication-related advantages. Compared to a more traditional class, students were less dependent on interpreters to capture the important concepts in class and then present them in sign, in a way that was comprehensible to the students (p.397).*

It is worth noting that the Deaf students did not necessarily indicate that they preferred text material over ASL, but rather that they preferred first-hand information over messages filtered through interpreters. One student summarized the essence of this concept by saying, "Now through distance learning I get the exact same material presented in the exact same way as everyone else in the class" (Long, 2003, p.398). This statement would support the notion of leveling the playing field - an inquiry of the research project – at least among students with an excellent command of written English. Another strategic advantage of the web-based courses was the flexible pace at which students could address course discussions and content. Ninety percent of the students enjoyed being able to read, review, and process material prior to participating in on-line meetings. Students also had the option of seeking live tutoring from professors or peers – a service that Deaf learners valued more than did their hearing classmates (Long, 2003).

Conversations with the lead researcher, led this author to hypothesize that the derived benefit from these live tutoring sessions was explanations given in ASL. A similar, but somewhat different approach by DeSales University is to modify, primarily through captioning, their current MBA on-line program to accommodate Deaf students (Mangan, 2001). Gallaudet University, the world's only liberal arts college for the

Deaf, is also at the forefront of distance education delivery. Their online learning system is called the Gallaudet Dynamic Online Collaboration (GDOC) and encompasses tools, such as Blackboard, to offer web-enhanced and web-based courses. Seventy percent of the students and forty three percent of the faculty are using this system (King, 2002).

For schools not accustomed or attuned to the needs of Deaf students, however, the tendency may be to produce inaccessible on-line courses. Kessler (1999) writes, "The ADA [Americans with Disabilities Act] does not mandate that distance-learning programs be provided, but where they are offered, the accessibility requirements are no less stringent than for standard educational programs" (p.44). Therefore, the National Center for Accessible Media (NCAM) and the Massachusetts Institute of Technology (MIT) have teamed up for a three-year project involving "Access to PIVoT" (Physics Interactive Video Tutor). The research team will, ". . . issue a set of guidelines recommending procedures for creating Web-based educational resources" (Freed, 2001, p.3).

Other educational entities have either combined, expanded, or taken a different approach to educating their Deaf students through distance learning. SOAR-High (Science, Observing, and Reporting-High School) ". . . is a web-based earth systems science course involving collaborating teachers and deaf students at high schools in California, Washington DC, and Indiana" (Barman & Stockton, 2002, p.5). In this hybrid environment, students continue to meet in person with their own teacher and classmates, but the course materials and activities are web-based. By its very nature and design, SOAR-High increased students' exposure not only to the science content but also to technology. The students learned to use digital cameras, scanners, videoconferencing, web search mechanisms, web page development tools, and on-line courseware for discussions, quizzes, and research exchanges (Barman & Stockton, 2002; Ellsworth, 2001). Barman & Stockton (2002) find, "All of the ISD students seemed to feel that they had learned to be more independent as a result of the SOAR-High project" (p. 8). These skills will endow a broader range of students to be more successful in mainstream on-line courses in the future (Ellsworth, 2001).

Although low-ability English readers had difficulty with some of the units, studies have shown that students are motivated by the technology and will attempt reading tasks on a computer that they would find daunting in a text book (Juhas, 2001). At the post-secondary level, NTID has a variety of distance learning approaches. They adopted a hybrid approach including videotape-supplemented instruction, in sign language, as far back as the 1960s. The disadvantages of this medium include the requirement to physically keep track of the tape, the lack of uniformity between video players around the world, and the inability to index the material (Mallory, 2001). Recently, instructors have experimented with a new approach – video streamed instruction delivered via the web. Video streaming can be defined as the progressive download of a video file that is either live or prerecorded. Mallory (2001) forecasts, "Although streaming video with captioning is not quite perfected and is not yet widely used on the web yet as a stand-alone instructional tool for the deaf and heard of hearing audience, it will be soon" (p. 6). NTID hopes to entice working adults in remote areas to receive training in this manner. Video streaming is becoming more viable in part due to friendlier editing

software, inexpensive digital camcorders, and high-speed Internet connection. Having separate streams for the signing instructor, the audio, the captions, and the computer displays is preferred due to limited bandwidth considerations (Mallory, 2001). Still there are disadvantages such as the cost and complexity of production and the clarity required for readability of sign language. Mallory (2001) summarizes, "There is a trade off between what file size is adequate to be able to understand sign language and the instruction when it is streamed to the user's desktop and what is a practical file size to store and stream video over a broadband connection" (p. 5).

Outside the United States, a recent study was conducted at the Open University in the United Kingdom to compare the perceptions of academic quality of a distance education program between hearing students and students with a hearing loss (Richardson and Woodley, 2001). The distance-learning courses were distributed primarily through broadcast television. Although both groups rated the quality of those classes high, the group with a hearing loss was not reflective of a typical Deaf student in that only three percent listed signing as their preferred language. The diversity of the various distance education projects discussed thus far is impacting schools around the nation and around the world. When implemented correctly, Deaf children and adults appear to benefit from these scenarios.

Instructors

Just as Deaf students themselves are participating in distance learning ventures, so are their current and prospective teachers. Teacher preparation programs and in-service initiatives have interwoven the distance-learning dimension into their agendas previously, but only recently on a large scale. In 1992, a survey was issued to remote graduate Deaf education students taking courses via videoconferencing (a.k.a. interactive video) from the University of Kansas (Luetke-Stahlman, 1994). Of the thirteen students, twelve were hearing *and* one was Deaf. Luetke-Stahlman (1994) finds:

> *Subjects generally agreed that the camera and monitor were not distracting,*
> *that being on "TV" did not make them feel self-conscious, that it wasn't hard*
> *to ask questions during class, that the professor didn't spend too much time attending to the "other" group, that the audiovisual materials were presented adequately, and that they didn't find it difficult to concentrate (p.100).*

Thus the program was a successful experience for these teachers-in-training and a preferred alternative to correspondence study due to the live interaction. This study did not address the communication method of the one Deaf student.

To gain a sense of the current state of distance teacher training and professional development, two nationwide, influential projects will be examined. The need for said initiatives is established by the declaration, "The primary problem in Deaf Education is not a lack of information,

innovation or effort, but rather a persistent and growing problem in achieving critical mass of individuals, knowledge and resources" (Join Together, n.d., ¶ C). The PT3 Deaf Education Catalyst grant was subsequently awarded to the Association of College Educators – Deaf/Hard-of-Hearing (ACE-D/HH) and links the nation's 70 Deaf education teacher preparation programs through the Internet. The overall goal of the grant is to: "Establish a seamless on-line community of learners that collaboratively share information, resources, and opportunities for the common purpose of recognizing excellence and enhancing performance within the field of Deaf Education." (Join Together, n.d., ¶ B). Membership enrollment at www.deafed.net is over 4,300 and includes pre-service teachers, mentor teachers, college professors, and parents. A typical exchange of knowledge between "Cyber Mentors" might consist of a teacher in the field sharing 'real-life' anecdotes and in return receiving contemporary literature on a topic from a pre-service teacher (Join Together, n.d.). Additionally, the grant has begun investigating the potential use of Internet based videoconferencing including its ability to render signed conversation adequately. At a bandwidth of 384 kbs, the technology is capable of performing the required tasks and will be used to connect expert teachers of the deaf with teacher preparation programs. Presently, 54 Polycom ViaVideo systems are in place throughout 21 states with more to be added (Join Together, n.d.). A future hope of the project is the expansion of the community of learners to include state schools for the Deaf, large public schools with Deaf education programs, deafness related national organizations, and selected corporations. With additional funding, the Deaf Education Network could also facilitate the recruitment of individuals to become Deaf educators, setup a "Virtual Professional Network" for statistical tracking and mentorship, and create a "Virtual Learning Environment" for Deaf students and adults to broaden their learning and collaborating opportunities (Join Together, n.d.). In general, this network fulfills and facilities a previously untapped source of national networking opportunities.

A second project that spans multiple states and is impacting Deaf educators and students alike is the Star Schools Project. This five-year grant, which began in 1997, is one of seven from the United Star Distance Learning Consortium (USDLC). According to Rodgers (2003):

> *[It is] one of the most comprehensive, education-focused research and development projects in the history of deaf education . . . The ASL/English*
> *Bilingual Staff Development Project effectively applied engaged learning*
> *principles and a technology-based learning community approach to increase teacher and staff knowledge and skills related to bilingual approaches for*
> *deaf students (p. 3218).*

The primary school, the New Mexico School for the Deaf, along with eleven other residential schools for the Deaf and several university teacher-training programs have been impacted. The learning community that has developed out of this venture includes researchers, parents, dormitory personnel, mentors, and teachers. They share materials through web-based lessons, videotapes, CD-ROMS, videoconferencing,

and other avenues (Rodgers, 2003). Hubbard (1999) concurs, "Distance learning and videoconferencing are especially useful for making subject matter experts available to students and for enabling collaboration and staff development activities over distances" (p. 1). One example on the student side was the connection of Deaf youth and a panel of veterans who had served the country. During the course of the five years, distance learning took place in staff/mentor meetings, seminars, and classroom instruction and moved from a precursory use of the Internet for such tasks as email to an in-depth use of complex, broadcast technologies such as videoconferencing and online instruction (Rogers, 2003). The project, which also sparked international interest, has generated self-sustaining practices that can continue to develop even after the official grant comes to a close.

In the same spirit, other smaller-scaled initiatives have followed suit in the race to keep educators and support personnel connected and informed. In 1997, Gallaudet University initiated an in-service project called THREADS (Transformations for Humanistic and Responsive Education for all Deaf Students). Theories of multicultural education and constructivist methodology were presented live during a one-week summer course and subsequently reinforced throughout the school year via distance education (deGarcia, 1997). CSDB has used their videoconferencing capabilities not only for the student-centered activities discussed previously, but also for workshops on bilingual-bicultural pedagogy methods, conference planning, audiology meetings, sign class distribution, and more (Rose, 1999). At NTID, a new outreach effort under the auspice of the distance education department, is labeled "COMETS" (Clearinghouse on Mathematics, Engineering, Technology, and Science). It is an online educational resource and network for pre-service and in-service development programs aimed at both K-12 and college instructors (NTID, 2003). The project is funded by the National Science Foundation. NTID also uses their videoconferencing capabilities for staff development and recruitment efforts. Finally, SKI-HI (Sensory Kids Impaired Home Intervention) is:

> *a specialized in-service training model to prepare early interventionists, special education teachers, and related service personnel to provide family-centered programming to infants, toddlers, and preschoolers who are deaf or hard of hearing and their families. The in-service course was specifically designed for practicing professionals and paraprofessionals (SKIHI, n.d.,¶ Home).*

The distance education distribution methods for SKI-HI include two-way audio conferencing and videotape correspondence shared in three 10-week units. This paper suggests that the time has come for teachers to stop reinventing the wheel and start getting plugged into the ever-increasing community of distance collaborators that can propel Deaf education forward in terms of success and influence.

Interpreters

The last group of people involved in Deaf education that this paper will address is interpreters. The Distance Opportunities for Interpreter Training (DO IT) Center offers a three- year program, at a distance, for

sign language interpreters who work in K-12 classrooms (Johnson, 2001). Of the 70 interpreter training programs, only two offer specialization in educational interpreting. The rationale, therefore, for this program is that school districts, especially rural ones, often must hire individuals who are 'under-prepared' for the task. Thus, "Educational interpreters who have limited or no opportunities for professional growth are able to access state-of-the-art information via technology without compromising jobs or families" (Johnson, 2001, p. 9). The program, as of 2001, had over 200 students from twelve states with an expected increase in subsequent years. The learning approach by DO IT incorporates a wide variety of distance techniques. Courses in the fall and spring are typically six weeks long and are sent to students in a "Box" format that includes a study guide, video and audiotapes, readings, teacher insights, assignments, and other information. Seventy percent of the courses are actually based in WebCT, but students still receive the "Box" with initial material. Students then converse through email and web discussions with their instructors, reportedly creating more interaction than common in traditional classrooms. Most importantly, "Distance learners are not left in isolation to struggle alone with academic content" (Johnson, 2001, p. 11). During each course, there is usually one three-hour videoconference as well. "[These] synchronous presentations by instructional staff members can be made to enhance or clarify instructional content; panels can be recruited with members from various states to provide multiple perspectives on an issue; modeling of specific assignment expectations can be done", states Johnson (2001, p. 11). The videoconferencing session does require travel, sometimes of over a 100 miles, on the part of the student. Besides the academic content, there is a mentorship component of the program (comprised of master interpreters and Deaf individuals) that is delivered totally at a distance by exchange of videotapes through the postal system and of comments through electronic mail (Johnson, 2001). Finally, there is a three-week, mandatory, in-person summer session. Johnson (2001) finds:

The on-site segment proves that personal interaction adds a valuable dimension to the educational experience. Without it, the distance interactions might well remain more impersonal and less appealing; with them, both students and faculty look forward to the on-going distance interactions with little notice of the distance dimension (p. 13).

The DO IT Center has future plans to videoconference to home computers, add computer-assisted sign language enhancement to the courses, and provide an on-line resource for continuing education. In summary, "It [The Educational Interpreting Certificate Program] illustrates that distance education is an effective means of providing interpreter education. It is possible to teach interpreting at a distance" (Johnson, 2001, p.13).

A closely related group, students taking ASL as a foreign language, share a common goal with interpreters - to become proficient in signed communication; therefore, a brief look at programs addressing this subset is required. In 2001, at the University of Wisconsin-Milwaukee (UWM), ASL was delivered through the blended technologies of the Internet, videoconferencing, and streaming video (Lehman & Conceicao, 2001). The researchers asserted, "ASL is highly visual and interactive and, therefore, an excellent type of content for

videoconferencing." (Lehman & Conceicao, 2001, ¶ Implications). Similarly, the Baxter School for the Deaf employees a Deaf instructor to teach ASL to other high schools in Main (Kessler, 1999; Mara 1999). The course is distributed over a high-speed, asynchronous transfer mode (ATM) network at speeds of 45 megabits per second – the equivalent of 30 telephone lines. The exchanges are high quality and instantaneous. Mara (1999) explains, "ATM is especially good at carrying video, voice, and data simultaneously because it can prioritize different kinds of information and manage them efficiently. Other wide area technologies, like ISDN or T1 lines, don't have this capability" (¶ Infrastructure). The videoconferencing equipment and the ability to now offer courses such as ASL, is hoped to increase enrollment at the rural high school by enticing neighboring cities without high schools to choose Baxter for their students.

Implementation Considerations Identified

Having now reviewed the various projects for the students and staff involved in Deaf education, this paper's focus shifts to the practical strategies and suggestions for creating or modifying distance learning in this context. Johnson (2001) establishes, "Effective distance education requires a new perspective on learning and teaching, and new approaches to preparing teaching materials" (p.9). Eilers-Crandall (2000) concurs and asserts, "Educators of Deaf students have a definite advantage when it comes to distance education in that they already know how to adapt teaching for visual learning" (p. 14). Implementation considerations are broken down into two main categories – videoconferencing and Internet-based planning.

Videoconferencing

Hearing presenters must be instructed to not use 'voice-over' with their visuals. Deaf students cannot attend to the visual image and the interpreter at the same time; therefore, they must be allowed to look at it first and then pay attention to the discussion. Neither can Deaf students attend to a task, such as a web search, while listening to the presenter (Hazelwood, n.d.). However, "For Deaf participants, chromakey takes the place of 'voice-over'", continues Hazelwood (p. 10). In order to implement this technique, one needs a mixer with a chromakey generator and a background (typically a blue or green screen) so that the presenter can be superimposed over an image from the document camera or computer. A mixer is also critical because it allows an interpreter and hearing presenter to be spliced together to be displayed to the Deaf audience and recorded to tape for future viewing.

Juhas (2001) notes "Lack of visual clarity and latency or lag time can be problematic for hearing users but is an even greater disadvantage to deaf users" (p. 2). The lag time referenced above is due to technical limitations, but lag time, more accurately termed 'processing time', also manifests itself as a delay between original and translated language utterances. Thus it behooves the Deaf educator to explain to hearing presenters that students cannot, for example, answer questions immediately because both the equipment and the interpreter have to "catch-up" (Hazelwood, n.d.). Researchers have found that internet-based videoconferencing such as 'Cu-SeeMe' delivered through web cams

do not currently produce high enough quality output to have a normal ASL conversation (Eilers-Crandall, 2000; Hazelwood, n.d.). The recommendation, therefore, is to use a T1 or ISDN-based network with a minimum of 384kbps and a preferred 512kbps. Especially, at the former rate, signers must slow down their communications, especially fingerspelling (Hazelwood, n.d.). Regardless of the rate the deaf students have available, if the museum or other school is only wired at 128kps, the signing will not be clear; it may be jerky or blurry (Juhas, 2001; Rose, 1999). Hence, Juhas (2001) recommends:

> *Due to the lag time that is inherent with videoconferencing, and the fact that*
> *sign language is not smooth and natural at 128 kbps, it is essential that the interpreter be located with the deaf audience members and not in the*
> *customary place, which is a the side of the presenter (p. 3).*

However, even in the past couple years since much of this research began, there has been an increase in the speed and quality of connections consequently clearing the path for viable internet-based videoconferencing. For example, traditionally, Deaf and hearing persons have experienced phone conversations through a text relay process, but video relay interpreting (VRI) is growing in popularity. The logical progression to engaging remote interpreters even for in-person courses is one of the topics to be addressed by Gallaudet University and the University of Tennessee should they be awarded a new federal grant (Gallaudet University, 2002). The grant would also provide funds for creating a 'cookbook' of best practice guides and training for distance education.

Taking a more technical approach to combating the issues of transmission clarity, Muir & Richardson (2002) conducted a study to determine what portion of the signer a person looks at most. They found, "It may be possible to make better use of available transmission bandwidth by selective optimization of key features of the video sequence" (Muir & Richardson, 2002, p. 650). Through tacking of gaze point and eye movement data, the face was found to be the region of the image that was attended to most often and thus needed to be the sharpest quality. From a practitioner viewpoint, some more simplistic ideas to maximize readability include selecting appropriate contrasting colors for clothing and background and properly framing the shot (Lehman & Conceicao, 2001; Lightfoot, 2002). Establishing a few preset camera positions is best so that camera zooming is minimized as excessive visual movement is disorienting to Deaf audiences (Robinson & Aidala, 2002; Lehman & Conceicao, 2001). Finally, signers need to see themselves to ensure they stay in their sign space, but students often find it distracting to see their images so the protocol for videoconferencing may vary based on individual cases (Hazelwood, n.d.; Juhas, 2001). Juhas (2001) summarizes, "The value of these learning tools is dependent upon the strategies employed in planning and preparing for interactive and experiential learning" (p. 5).

Internet-based

Eilers-Crandall (2000) suggests that a transition time is necessary as

web-based distance education instruction is introduced to Deaf students since it signals both a change in technology dependence and a change from guided to more independent learning. A professor at DeSales University, states, "For most Deaf ... students, the language we're going to use – mostly text-based, supported with graphics – is a second language for them. We need to think of these students the same way we think of international students who have another first language" (Mangan, 2001, p.A39). Modification of content to include more visual components is thus a recommendation. At NTID, Dr. Mallory creates innovative web-based distance education programs and asserts, "My teaching style has been to take distance learning to a more personal level, trying to create the same atmosphere that I am able to create in the traditional classroom" (COMETS, n.d.). That personal level for some NTID courses, means adding streaming video to the web presentations so that instruction can be given in ASL. As mentioned earlier in this text, the tradeoff for clearer video is larger file size so both factors must be considered. A recent teleconference in February of 2003, distributed by PEPNet (The Postsecondary Education Programs Network), detailed some of the design considerations and technical issues pertinent to on-line learning involving Deaf students that have been addressed in this paper (PEPnet, n.d.).

Conclusion

"Research studies clearly demonstrate that, properly executed, distance learning is, at least, as effective as traditional pedagogical approaches," reflects Johnson (2001, p. 9). 'Properly executed' is the key word in that statement and the focal point for much of the contemporary research regarding Deaf studies. But is there one right answer? This paper takes the position that Deaf learners are a heterogeneous group comprised of individuals with unique backgrounds and skill sets necessitating different distant instructional approaches. Videoconferencing designed especially for Deaf elementary and high school students, appears to be the most common and successful form of distance education currently since it accommodates ASL communication. In examining college and career age students, however, the issues are more dynamic. As long as students have a certain level of proficiency in the language of the instructor – whether that be English or ASL - they appear to prefer to receive the information first-hand. Future research should address how to determine the pivotal point in terms of age, grade level, or language skill at which students develop this preference for direct instruction over their preference for instruction in their native-language. It is the same type phenomena that occurs when a hearing person would rather watch a movie in the original foreign language than with English dubbing because the payoff of receiving the nuances of the original outweigh any deficiencies in comprehension of the secondary language. With this type of data, educational entities would be in a better position to make accommodating implementation decisions such as captions versus interpreters. It would be interesting to research the connection between students who prefer interpreters versus real-time captioning in traditional classrooms and students who prefer text-based web-courses versus interpreted videoconferencing. However, a majority of the available research is descriptive, focusing on individual projects, rather than empirical studies. It is evident from that body of literature that a wide range of programs and strategies can be employed with positive results

not only for Deaf students but also for the instructors and interpreters that serve them.

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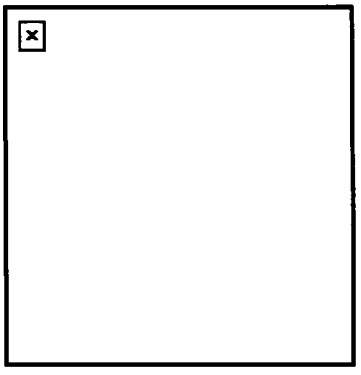
About the Author



Becky Sue Parton

Becky Sue Parton is a Ph.D. student at the University of North Texas. Her field of study is Educational Computing. Her research interest is technology as it relates to Deaf Education. She teaches an *Intro to Computers* class at a local two-year college and works as a programmer / database developer at the University of North Texas.

Becky Sue Parton
12825 Metz Rd., Sanger, TX 76266
W: 940-565-3889

Email: parton@cc.admin.unt.edu

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STANDARD PRACTICE PAPER

VIDEO RELAY SERVICE INTERPRETING

The Registry of Interpreters for the Deaf, Inc., (RID) Standard Practice Paper (SPP) provides a framework of basic, respectable standards for RID members' professional work and conduct with consumers. This paper also provides specific information about the practice setting. This document is intended to raise awareness, educate, guide and encourage sound basic methods of professional practice. The SPP should be considered by members in arriving at an appropriate course of action with respect to their practice and professional conduct.

It is hoped that the standards will promote commitment to the pursuit of excellence in the practice of interpreting and be used for public distribution and advocacy.

About Video Relay Service Interpreting

Video relay service (VRS) is a free telephone relay service using video technology to allow deaf and hard of hearing persons to make and receive phone calls using American Sign Language (ASL). VRS, as an industry, has grown exponentially since its inception in 2000 as an offshoot of traditional Telecommunications Relay Service (TRS) or text-based relay services. It is estimated that more than 4,000 sign language interpreters have worked in this setting. VRS companies provide millions of minutes of interpreting services per month, and given its current rate of growth, VRS will continue to be a viable employment setting for sign language interpreters into the future.

The basic requirements for using VRS are a monitor, a video camera device and a broadband (high-speed) internet connection.[i] Each VRS company has its own particular system that is required to be interoperable, allowing consumers to access any company's service no matter what equipment they have. There are likely to be additional applications, such as enhanced services for customers who are deaf-blind. Because technology is ever changing and rapidly improving, RID anticipates increases in the volume and desire for the service.

VRS services are regulated by the Federal Communications Commission (FCC)[ii]. The FCC is responsible for managing reimbursement rates from the Interstate TRS Fund, which is funded by interstate telephone companies throughout the United States. The FCC is responsible for setting standards that VRS companies and their interpreters must follow when handling calls. These regulations help to ensure that VRS calls are handled efficiently, appropriately and ethically. VRS providers must comply with the rules set forth by the FCC in order to be reimbursed for the calls they relay. The goal of TRS, and thus VRS, is to provide telecommunications access for deaf, hard of hearing and speech disabled individuals in a manner functionally equivalent to traditional voice telephone users.

The FCC puts forth the following provisions for VRS providers[iii]:

- General VRS telephone communication access 24 hours a day, 7 days a week is mandated;[iv]
- Speed of Answer Rule - by January 1, 2007, VRS providers must answer 80 percent of all VRS calls within 120 seconds, measured on a monthly basis;[v]
- The ability to place calls to 911 services. Currently, access to 911 is waived for VRS providers until 1/1/2008;[vi]
- If Spanish to ASL services are offered, they must be accessible 24 hours a day, 7 days a week;[vii]
- Video mail services, which are services similar to voice mail but in sign, are reimbursable. Video mail is not mandated by the FCC.[viii]

The FCC also limits use of this free system to phone calls and does not intend the service to be used to replace on-site interpreting for meetings.[ix] As such the FCC requires that all deaf and hearing participants be in separate locations.[x]

The Role of the Interpreter

VRS cannot function without skilled, capable interpreters. RID plays a leading role in establishing a national standard of quality for interpreters by providing education and certification through the National Testing System. The process of becoming a highly qualified interpreter starts with attaining credentials through certifications offered by RID and maintaining qualifications through continued skill development. RID believes that national certification must be the minimum standard for qualification of VRS interpreters. RID also encourages the use of Certified Deaf Interpreters (CDI) as team interpreters to assist with the demanding nature of the work involved with VRS interpreting.

Each VRS company employs sign language interpreters through direct employment as employees or independent contractors or through agreements with sign language interpreting agencies. VRS interpreters are currently working full time or part time shifts to assure VRS services are available 24 hours a day, 7 days a week.

VRS has attracted many interpreters who previously worked in community settings. While the advent of VRS interpreting has opened up new telecommunication options for the Deaf community, it has done so at some loss of adequate availability of interpreters in community settings. Recruitment of VRS interpreters has led to a supply-and-demand phenomenon that has meant higher salaries for not only video interpreters; the entire field has had to adjust to the rise in salary ranges to retain interpreters in community and educational settings. RID remains steadfast in its commitment to the needs of the community and to promoting a balanced approached to the provision of interpreting services in all arenas. Furthermore, RID remains committed to those practices and standards that will promote career longevity for interpreters so that the valued resources of qualified interpreters for this highly specialized arena will not be prematurely or unnecessarily depleted.

Never before, in the history of the interpreting profession, have interpreters worked in settings where the federal government and large corporations have played such an important role in the provision of interpreting services. The FCC has defined VRS interpreters as 'communication assistants' (CA), using language from TRS regulations. In accordance with the Americans with Disabilities Act (ADA) and later FCC regulations, interpreters working in the VRS setting must be "qualified." The FCC states that VRS interpreters must be able to "interpret effectively, accurately, and impartially, both receptively and expressively, using any necessary specialized vocabulary."[xi] The interpreter as a professional has the responsibility to assess the communication needs of consumers and render the message using the interpreting service model and interpreting techniques that are most appropriate for the communication needs of the consumers. In addition, interpreters working in the VRS arena must be readily prepared for working in an environment with diverse cultural groups including deaf and hearing people of color, hearing consumers with varying cultures and accents as well as colloquial differences found in different regions of the United States.

RID urges VRS providers and interpreters to work together to ensure quality interpreting services, professional standards and practices and a safe and healthy work environment. The following issues should be addressed when discussing best practices for working in the VRS setting:

Interpreter preparation: Industry standards and best practices suggest that interpreters are most successful when they are able to obtain information about the subject of an interpreted conversation in advance because interpreters exercise professional judgment and make decisions based, in part, on this information. While the FCC does not prohibit the gathering of such information by a VRS interpreter prior to placing a call, this is not a common policy among VRS providers.[xii] RID supports the practice of interpreters obtaining necessary information in order to process calls appropriately.

Teaming: The RID Standard Practice Paper on Team Interpreting explains factors involved in determining the need for a team interpreter. These factors include the length of the assignment, the complexity of the interpreted content, the dynamics of the setting and possible unique needs of the persons receiving the interpreting services.[xiii] In VRS settings, there are times when it is necessary to request a team interpreter for assistance. Additionally, RID supports the use of Certified Deaf Interpreters (CDIs) within call centers as another resource to ensure functional equivalency.[xiv]

Working Conditions: In VRS call centers, the following workplace concerns have been identified: repetitive movement injuries, eye strain, muscle strain, weight gain and physical and mental fatigue. Additionally, the intimate nature of VRS work can lead to emotional strain or vicarious trauma. RID recommends established policies for breaks in order to prevent or minimize the negative effects of the physical, mental and emotional demands of the VRS environment.

Training: Because of the complex and dynamic nature of VRS, ongoing training related to the technology as well as interpreting skill sets specific to the VRS setting is needed.

Cultural Competency: VRS interpreters work with consumers from different geographical and cultural backgrounds. Because culture is inextricably tied to language, interpreters must develop cultural competency as well as understanding of language variations for both signed and spoken languages. Variations can be seen in word meaning, accents and speed of production. Managing these differences skillfully can be challenging for interpreters.

The Role of RID

RID is the national professional organization for sign language interpreters in the United States and, as such, advocates for its members by promoting the profession and advocating for increased quality, qualification and quantity of interpreters through a triad of services.[xv]

- *National Testing System (NTS)* strives to maintain strict adherence to nationally recognized testing industry standards of validity, reliability, equity and legal defensibility.

- *Certification Maintenance Program (CMP)* is the avenue through which the continued skill development of certified interpreters/transliterators is monitored.

- *Ethical Practices System (EPS) and NAD-RID Code of Professional Conduct (CPC)* are two vehicles that provide guidance and enforcement of professionalism and conduct. The EPS provides an opportunity for consumers and colleagues to address concerns or file complaints regarding the quality of interpreter/transliterator services, and the CPC sets the standards to which all individuals holding RID certification are expected to adhere.

RID serves as a liaison between the interpreting community and stakeholders in VRS. Working in partnership with Deaf organizations, advisory groups and the FCC, issues relating to the provision of VRS services are addressed at the national level. RID's membership makes up the largest pool of interpreters working in the industry, and its members serve as the experts in the field in terms of working conditions, self-care and self-advocacy.

RID views the interpreters who work in the VRS setting as professionals with the rights and responsibilities necessary to assist in helping to steer the future course of video relay service provision. In addition, RID makes the following recommendations to those involved in the field of VRS interpreting.

Recommendations:

The primary recommendation is that VRS providers hire RID certified interpreters.[xvi] High levels of skill, experience and professionalism are necessary for the volume of work and the wide variety and unpredictable nature of call content. RID certification is a measure of qualifications of sign language interpreters. RID recommends that VRS providers develop hiring practices that ensure the highest quality interpreting services.

Other recommendations are as follows:

Ergonomics: VRS providers should assure that all steps are taken to provide a safe and healthy environment for interpreters, especially considering the physical and mental demands of VRS work.

Breaks: Frequent breaks during a shift should be encouraged to ensure quality of interpreting services. Research on spoken language interpreters has shown that an interpreter's performance declines after 15 minutes in video-based settings.[xvii] Because the mental processes for spoken and signed language interpreting is parallel, this research has implications for interpreting in VRS settings.

Teaming opportunities: A team should be available for support when deemed necessary by the interpreter.

CDIs: Certified Deaf Interpreters/qualified Deaf interpreters should be available for needed teaming and/or assistance with idiosyncratic language.

Diversity: VRS providers should promote the hiring of a diverse body of interpreters to accommodate the variety of consumer cultures and preferences.

Training: Adequate training opportunities should be available for interpreters to keep abreast of best practices regarding interpreting through video, current trends in the industry and any technical issues for which they are responsible.

Technology: VRS providers must delineate what they are responsible for in regards to technology maintenance and what technical competencies interpreters are required to have. Interpreters are not technicians and need support in this area.

Call information: Whenever possible, the interpreter should be encouraged to receive any relevant information prior to the call in order to better assist them to interpret the content. Additionally, confidentiality is emphasized in the VRS setting as it is in all settings, in accordance with the first tenet of the NAD-RID Code of Professional Conduct.[xix] Interpreters are required to hold in strict confidence any content seen or heard during calls.

Cultural Competency: VRS providers should make available information and training regarding the multicultural dimensions and language variations of consumers. Strategies for working across cultures will improve services provided by interpreters in the VRS setting.

Conclusion

VRS has revolutionized communication access for deaf people and has had a profound effect on the interpreting profession. RID will continue to work as a resource to consumer groups and the FCC as it represents the interests of the interpreters who serve as the heart of this remarkable service. For more information, please visit the RID website at www.rid.org or contact the RID national office.

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Using Networked Multimedia to Improve Academic Access for Deaf and Hard of Hearing Students

Anna C. Cavender
General Exam Document
University of Washington
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Abstract

Deaf and hard of hearing students experience barriers that make access to mainstream universities a challenge. Educational technology has the potential to better include these students in the academic mainstream. This paper begins by outlining historical trends in education for deaf students because understanding the unique characteristics and experiences of members of the deaf community will be crucial for successful design. We then discuss current trends in educational technology in general, especially those that will ultimately be made accessible or compatible with the needs of deaf students. Finally, this paper describes the author's proposed thesis work: the development and evaluation of a classroom platform for deaf and hard of hearing students to access remote interpreters and captionists, avoid visual dispersion, and facilitate classroom interaction.

1. Introduction

Entering mainstream universities involves extra challenges for people who are deaf and hard of hearing: skilled sign language interpreters and captioners with advanced domain knowledge can be difficult to find; multiple visual channels of information in the classroom can be difficult to juggle; and collaboration inside and outside the classroom is often strained due to language barriers [28].

Classroom technology research aims to improve educational experiences for all students and this creates opportunities to better include deaf and hard of hearing students. Wireless networks, data projectors, and portable computing devices can be used to bring in remote interpreters, support the sharing and capture of instructional materials, and provide additional communication channels for everyone. A more digital academic environment creates an opportunity for customization to better suit the needs of individual students.

2. Goals and Contribution

This research will investigate and develop technology to help manage the many academic tasks required of the estimated 20,000 deaf and hard of hearing students at mainstream universities in the U.S. [38]. Development will parallel other educational technologies so that technology for deaf students will be similar to those used by all students. The DHH Cyber Community project at the University of Washington will be a catalyst bringing together video remote interpreter services, remote captionists, skilled interpreters, and knowledgeable people within the deaf

community. The proposed work will utilize this web of resources and services and the high-bandwidth connections between them to promote the best educational environment and lower barriers to participation in university-level academics for deaf and hard of hearing students regardless of classroom type, instructor accommodation, or locally available resources.

3. Background

When designing for deaf and hard of hearing people, it is important to understand that as a group, they have extremely varied backgrounds and educational experiences. A person's self-identification as either deaf, hard of hearing, or hearing impaired is often primarily a personal choice and not a function of the degree and onset of hearing loss. Deaf people tend to prefer sign language, often choose not use their voice, and are likely to be involved in the signing Deaf Community (note the capital "D" indicating a sense of pride in the uniqueness of sign language and culture). Hard of hearing people tend to speak and lip-read and may rely on residual hearing, hearing aids, or cochlear implants when communicating with hearing people. They may also know sign language and participate in the Deaf Community. These groups are by no means distinct and both people and preferences can shift across group lines. Alternately, elderly people who have lost hearing later in life may better fit into a third group as they are unlikely to know sign language, do not identify with Deaf Culture, and may prefer the term hearing impaired (which is a term typically rejected by members of the Deaf Community as it is thought to negatively emphasize a deficiency).

The degree of a person's hearing loss is only a small aspect of their disability and does not necessarily determine the best classroom accessibility solution or accommodation. For some people, the ability to adjust the audio volume may be sufficient. For others, translation to a signed language may be more appropriate. For others still, access to text alternatives may be the best solution. For those who were raised in environments promoting speech training, good access to the face of the speaker may be sufficient. These different preferences are in large part due to varied backgrounds and personal experiences and no type of accommodation is perfect. Understanding the diversity of experiences from early childhood on is an important aspect of designing with and for deaf and hard of hearing students.

3.1. Issues Affecting Deaf and Hard of Hearing Students

From a strictly audiological point of view there are several ways to quantify hearing loss. The most common metric is the degree of loss in decibels (dB) from mild loss (25 to 40 dB) to profound loss (90 dB or greater). But, as the next sections will illustrate, hearing loss itself is only one of many factors affecting language acquisition and education of deaf students.

3.1.1. From Infancy to Early Childhood

There is a distinction between pre- and post-lingual deafness, meaning that deafness occurred before spoken language acquisition or after, respectively. Oral training (learning to speak and read lips) is much easier for post-lingually deaf children and much more difficult and often unsuccessful for pre-lingually deaf children. In either case, excellence at lip reading is not common.

Language acquisition depends much more strongly on early exposure to language, whether spoken or signed; relying on lip reading alone very much restricts the child's language exposure. In fact, deaf children born to deaf parents (much like hearing children born to hearing parents) experience almost effortless natural language acquisition simply through exposure to the language of their parents. However, ninety percent of deaf and hard of hearing children are born to hearing parents who do not know sign language. Many of these children are not exposed to any language in a natural way during those early critical years of language acquisition. Oral training is not a substitute for the almost effortless language acquisition that occurs naturally. This lack of early exposure to any language may be the reason that many deaf people struggle with the written form of spoken languages, for example English. In fact, for the lucky ten percent, early exposure to sign language and strong signing skills seem to act as a linguistic bridge to more easily acquiring English as a second language [31]. The effects of language acquisition during the early childhood years trickle through grade school, on to high school, and ultimately affect access to college and career.

3.1.2. From Early Childhood through Grade School

The type of schooling environment that a deaf student experiences growing up will also affect their preferred accommodation and access to the college classroom. Education for deaf children in the U.S. has undergone policy changes that have resulted in even more diversity within the deaf and hard of hearing group.

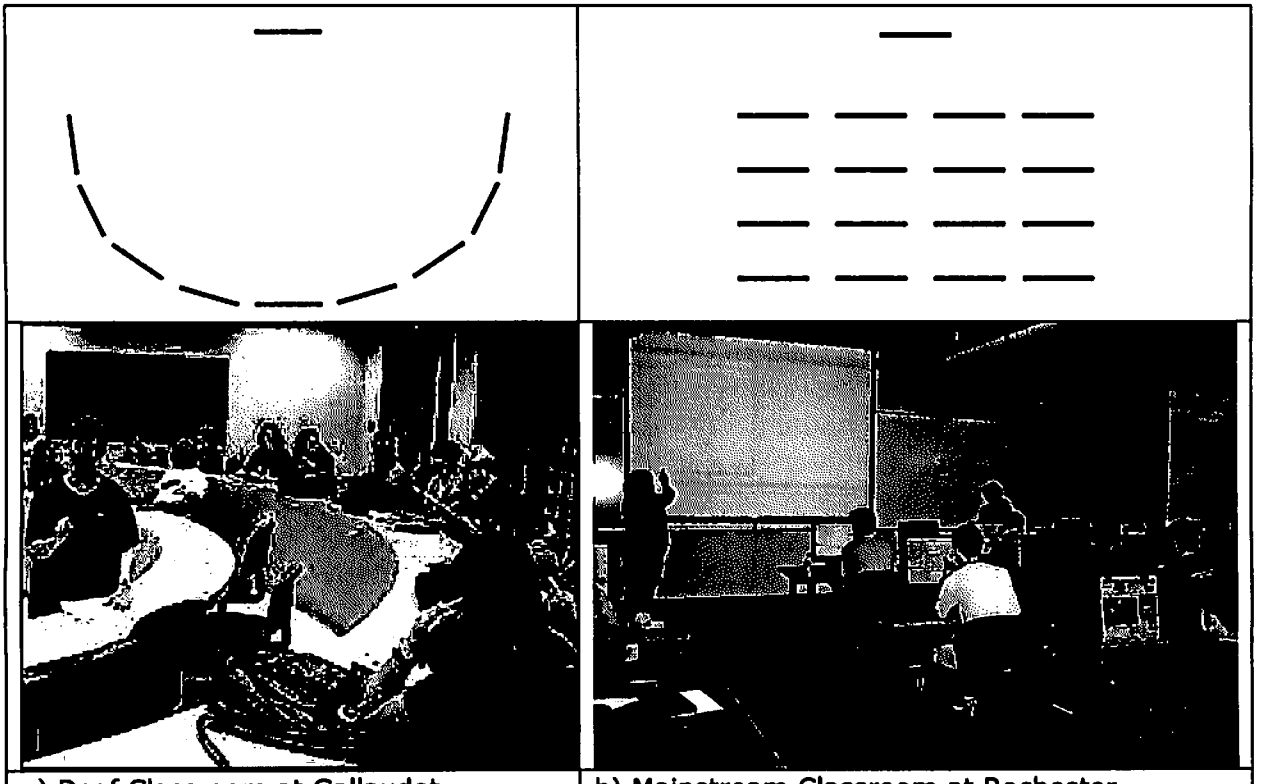
Until 1975, education of deaf children and adults in the United States was very centralized. Residential schools for the deaf were introduced in most states during the 1800s and Gallaudet University (an all-deaf liberal arts university) was founded in 1864. Centralization is based on the concept that deaf students need a specialized education because of their disability. In 1975 there was a fundamental change in public policy concerning the education of deaf people and others with disabilities with the passage of Public Law 94-142 now called the Individuals with Disabilities Education ACT (IDEA). The law mandated that all children with disabilities are assured a free appropriate public education. This "full inclusion movement" has not been without controversy [22]; some assert that a mainstream classroom may not be an ideal learning environment as it isolates students and reduces exposure to the deaf community and deaf role models. Since then, the percentage of deaf students attending residential schools has declined steadily to about 15% [45], with the majority attending mainstream schools.

3.1.3. From High School to College and Beyond

Although a large segment of deaf and hard of hearing students attend the three major universities serving primarily deaf students (Gallaudet, National Technical Institute for the Deaf (NTID), California State University Northridge (CSUN)), the vast majority of deaf students attend mainstream colleges and universities. According to the National Center for Education Statistics (NCES), over 20,000 deaf and hard of hearing students are enrolled in post-secondary educational institutions in the U.S., approximately 93% at the undergraduate level. This is likely an underestimate as the survey was conducted more than a decade ago, it did not include primarily deaf universities like Gallaudet, NTID, and CSUN, and not all

students identify themselves to the university as deaf or hard of hearing. Over 50% of 2- and 4-year post-secondary institutes in the U.S. have identified as serving 1 or more deaf or hard of hearing student, nearly 95% for larger colleges and universities [38]. This illustrates how deaf and hard of hearing students are spread thinly at universities across the country, a point we will come back to later.

There are striking differences between classrooms geared toward all-deaf classes versus typical mainstream classrooms. All-deaf classrooms tend to be aligned in a semicircle so that all students can easily see the instructor, presentation, and all other students. Mainstream classrooms may have a number of different configurations, but the most frequent is rows of students all facing the front of the class (see Figure 1). Clearly, mainstream classrooms were not designed with the deaf student in mind.



a) Deaf Classroom at Gallaudet University (www.npr.org "At Gallaudet, a Turn Inward Opens New Worlds")

b) Mainstream Classroom at Rochester Institute of Technology 9/2007 (interpreter far left, instructor front and center)

Figure 1: Deaf Classrooms as in a) focus on visual accessibility. Mainstream Classrooms as in b) are often arranged in rows.

Recent years have seen an increase in deaf and hard of hearing students attending mainstream universities, which is likely a result of the "full inclusion" movement, IDEA act, the Americans with Disabilities Act of 1990 that prohibits discrimination based on disability.

3.2. Existing Accommodations

This increase in deaf and hard of hearing students in the academic mainstream has resulted in an array of accommodations in academic settings including: interpreters, real-time captioners, hearing aids, FM systems, and note takers.

3.2.1. Interpreters

As more deaf students enter mainstream universities, there is a growing need for skilled sign language interpreters that have specialized, university-level knowledge and signing skills. Because deaf students are spread thinly across U.S. universities, matching a student interested in a given domain with an appropriate interpreter who has knowledge of that domain can be a challenge, especially for advanced courses and for universities serving only a small number of deaf students.

Video remote interpreting (VRI) has been used in the classroom to help increase resource opportunities for this matching problem. VRI uses an intermediary interpreter, not in the same room, who signs what is voiced and voices what is signed for deaf and hearing people from the within same room. Video relay services (VRS) have similar services and are very popular, but these services are restricted to telephone conversations between parties not physically co-located.

3.2.2. Real-time captioners

Communication Access Real-time Translation (CART) is the system used by court stenographers and closed captioners in both academic and non-academic settings to manually convert speech to text using a keyboard or stenographic machine.

Much like interpreters, real-time captioners can only effectively convey classroom content if they understand that content themselves. Thus, matching students with appropriate and knowledgeable captionists can also be a challenge. Remote CART can also be used where the operator receives the voice through a telephone or computer connection and the text is sent back over a data connection. Some CART systems allow the student to highlight and add their own comments to the real-time text as it scrolls across the computer monitor [41]. C-Print is a type of CART developed at the National Technical Institute for the Deaf that enables operators who are trained in academic situations to consolidate and better organize the text with the goal of creating an end result more like class notes and more conducive to study [17].

Several researchers are working on speech recognition for automatically displaying spoken language in text [5]. Error rates are slowly improving, but these systems have a long way to go until they are usable. Very low errors would be required as even the smallest error (imagine recognizing a "ought" when the speaker actually said "not") can completely change the meaning of the text. Using textbooks to train the system on relevant course content [27] can improve error rates. When these systems are used in the classroom, a human operator typically corrects the errors on-the-fly [49] and formats the text to show pauses to indicate speaker changes and to better facilitate later study. At this stage, the operator can not be eliminated altogether.

3.2.3. Note-takers

Because deaf students rely so heavily on visual communication, looking down to take notes causes them to miss the information that is being signed or captioned. Therefore, deaf students often receive notes from hearing students who volunteer (or sometime are employed by the university) to share their notes. Instructors may also copy class notes, slides, or transparencies for deaf students. While this helps ease visual burdens during class, the student may miss out on the value of taking and studying personal notes.

3.2.4. Accommodation of Choice

A student's choice of accommodation depends in large part on their experience and educational background: strength in sign language, comfort with English, and previous experience with a given accommodation. Studies that have compared different types of services (sign language instruction, sign language interpretation, CART, and C-Print) show mixed results, probably due to the diversity of student needs [32].

Additionally, the same student may choose different accommodations for different types of courses. As one student pointed out, real time text may be better than sign language interpretation for courses involving many new vocabulary terms: "C-Print works best in lecture-based courses and courses that rely more on words as opposed to formulas or graphics." [17]. Sign language may be better for courses such as geometry containing lots of spatial and relative information or for courses focused on discussion or debate if the student's preferred mode of communication is sign language.

Can too much accommodation be a bad thing? Mayer *et al.* showed that both real time text captioning and in-person sign language interpretation together resulted in greater loss of information than either one alone, perhaps due to visual overload [34]. In contrast, Marschark *et al.* found that having both sources of accommodation (but shown on the same computer screen) was beneficial [32]. Furthermore, students learned more from sign language during class but got more out of real time text notes for studying. This could indicate that more channels of information are in fact beneficial, but only if they are arranged in a way that reduces visual overload, a point we will come back to in Section 3.3.1.

3.3. Accessibility Goals and Design Criteria

In spite of the plethora of possible accommodations, attrition of deaf students at the university level is high. This is partly due to missed classroom information and underdeveloped study habits such as note taking, but it is also related to difficulty with social and cultural connections with other students [28]. Our work will address both missed information through visual dispersion and translation as well as issues with collaboration with other students.

3.3.1. Reducing Visual Dispersion

> "The ear tends to be lazy, craves the familiar, and is shocked by the unexpected; the eye, on the other hand, tends to be impatient, craves the novel and is bored by repetition." ~ W. H. Auden

Problem:
Unfortunately, there are several ways that a deaf student can miss classroom information. Because deaf students receive nearly all classroom information visually, they must juggle their visual attention between instructor, slides, interpreter and/or captioner, and personal notes or handouts. Due to this juggling, information can easily be missed. Even when best practices for classroom setup are followed such as reducing visual obstacles (having the student sit up front) and utilizing techniques to include deaf students, the visual juggling act still results in missed information [25].

Even if explicit information is carefully provided, inadequate access to subtler, implicit information may put students at a disadvantage. For example, both conscious and sub-conscious gestures used by instructors often contain task-relevant information that has been shown to be helpful to the learner in problem solving activities [19]. If deaf students' visual attention is focused on the interpreter or the captions, they may be missing out on this alternative mode of information. Having better visual access to the teacher and the ability to replay both the instructor's actions and the interpreter and/or captions later may further reduce missed content.

Visual distribution problems often found in the classroom are summarized nicely by the experiences of one profoundly deaf and profoundly influential researcher while enrolled in a workshop to learn a new statistical software package (from [31]):

> Superficially, the learning context seemed ideal: The lecturer was a sensitive individual who went to great lengths to ensure full access by deaf individuals participating in the workshop. He had a projection of his own computer display on a large screen behind him, and each participant had their own computer for hands-on activities. The sign language interpreters were the best that could be found: all experienced in interpreting under such conditions. The two deaf participants had strong backgrounds in the use of computers, research, and statistics. Yet, both quickly became lost, viewing the two days as a waste of time. What went wrong?
>
> Primarily the problem was one of multiple, visual tasks placing too many demands on the processing of information in the learning situation. While the hearing participants were able to look at their screens and listen to the presenter, the deaf participants had to look away from the interpreter to see the instructor's screen or to try a procedure on their own computer. Missing one sentence of the instructions was enough to slow down or even derail learning. Watching the interpreter made it difficult to catch each action of the presenter or the projected screen.

Key Challenges:
Consolidating visual content into one device may prevent missed information and reduce the visual juggling act. Laptops, tablets, webcams, and high bandwidth connections can all be used to consolidate and conglomerate the visually important

aspects of the classroom, making them easier to access. Regardless of the student's choice of accommodation and the source of that choice (whether the interpreter or captioner is physically present or remote) presenting it in one device along with the instructor, the presentation materials, personal annotations, and potentially other classmates will allow the student to make better use of their visual modality.

Consolidation will likely help since studies have shown that items located closer to a person's current visual task are more easily and accurately found than items located farther away in the periphery (the eccentricity effect). Wolfe *et al.* offer proof that visual attention is affected by eccentricity by showing that people are more likely to notice and quicker to locate nearer items. Also, the effects of eccentricity are reduced when there are fewer distractions on the screen [51]. We may be able to further reduce clutter by giving the user control over their interface to emphasize what is most important and cut out what is not, as in WinCuts [47].

A frequent question when talking about visual interfaces for deaf learners is if deafness has an effect on visual perception. While the visual modality is clearly important for deaf students, there is no evidence that deaf people are able to make better use of vision than hearing people [31]. However, in at least one study Corina *et al.* have shown that deaf students are better able to redirect attention from one spatial location to another and better able to detect important motion in their periphery [13]. This is especially impressive considering that deaf people watching sign language focus on the face of the signer over 95% of the time [10].

Empowering students to design their own layout and formatting on-the-fly will be important for supporting a diverse user group with diverse needs, but it may also offer insights into future user interface design for this group.

3.3.2. Broadening Opportunities for the Best Services

> "Teachers are the most important classroom 'technology' and students are the least utilized classroom 'resource.'"
> ~ Harold Johnson, Kent State University

Problem:
Deaf students can also miss information in the classroom if that information is not properly or accurately conveyed to them. Section 3.2.1 described the importance of matching students with interpreters and/or captioners who understand and can accurately interpret for advanced, university-level content. Because students are spread so thinly, finding appropriate interpreters and captionists can be a problem.

Key Challenges:
Using high-bandwidth connections and remote interpreters and captionists would increase the pool of available accommodation for a student to choose from. Several universities and companies including Viable Technologies [48] and HandsOn VRS [21] are already pooling their resources and offering services for this type of remote assistance in the classroom. This has been especially important in the recent past for remote schools and colleges that otherwise would not have the resources to offer this type of assistance [18]. Also, the Media Access Group at

WGBH provides real-time captions for live Web events and Web conferencing [35], which could be used for online courses. Remote accommodation has also been shown to be adequate for both real-time captioning and sign language interpreting as video-based interpreting appears to be just as effective as in-person interpreting [33]. Because the system will be flexible with students' choice of accommodation, they could potential choose an automatic speech recognition system, assuming error rates were tolerable and alternate accommodation was not available [40].

Better collaboration through the existing high-bandwidth connections between universities would allow better access to skilled interpreters familiar with specialized, university-level topics. The DHH Cyber Community project is already pooling together these types of resources. This approach will also allow different types of students to receive differing accommodations based on preference. For example, one student may prefer a remote sign language interpreter while another student prefers real-time captioning.

Relying on high-bandwidth connections may not always be an option and anytime a technology can use less bandwidth, it will be available more of the time. Our MobileASL group has developed compression techniques specific to sign language that may help reduce bandwidth usage [11]. Finally, the digital nature of videos will also have the benefit of being recorded, archived and perhaps distributed.

3.3.3. Reducing Barriers to Classroom Participation

"Tell me and I will forget;
show me and I may remember;
involve me and I will understand."
~ Chinese proverb

Problem:
Communication, and thus participation, in the classroom can be strained for deaf and hard of hearing students due to language barriers. Plus, events outside the classroom (project group meetings and impromptu study groups) where there is no scheduled interpreter can inadvertently exclude deaf or hard of hearing students.

By the time students reach college, they are a diverse group with diverse backgrounds, knowledge, and communication/accommodation preferences. Mainstreamed students who may not have sign language skills and/or knowledge of deaf culture can feel excluded from other deaf students and sometimes stereotyped by hearing students [26]. This may further increase barriers to participation, which is crucial to academic success. A study of multimedia learning environments found that nothing affected learning more than student participation [14]. The study tested text only, text and content movies, text and sign movies, text and discussion questions, and all of these together. The only conditions to significantly affect learning were the ones involving discussion questions. Clearly, students do not learn nearly as much if they do not participate and interact in their own learning.

Key Challenges:
Deaf students may benefit from technological environments that put more students on equal footing. In fact, Richardson *et al.* found that the effects of hearing loss on

participation in distance learning courses was slight, perhaps because the asynchronous textual modalities of communication lowered the barrier to participation [43]. New "digital" classroom environments may have a similar effect, opening up new possibilities for promoting equality *within* the classroom.

3.3.4. Enabling Instructor Participation (buy-in):

"Teachers open the door, but you must enter by yourself."
~ Chinese Proverb

Problem:
Instructors do not like to trouble shoot during class-time so the platform should work seamlessly with or without other technologies being used.

Key Challenges:
While the proposed technology will likely be beneficial for a wide range of classroom, meeting, study group, and other academic situations, we are primarily focusing on lecture-style classrooms for a number of reasons. First, enabling access to the most common type of pedagogy found in large university courses will make the biggest impact for deaf and hard of hearing students pursuing degrees at mainstream universities. Second, we feel that if we were to require a different type of pedagogy, use of the system would be reduced. Instructors should be able to teach in a way that is most effective for them and deaf students should be able to take any class they like, regardless of the teaching style or compliance of the instructor. Minimizing the burden on the instructor and placing more of the power and choice with the student will not only increase adoption of the technology, but will empower and increase opportunities for the student.

To summarize, people with hearing loss form a disability group very different from other disability groups. Accommodation needs can range from sign language interpretation to visual access to the speaker to text captions to FM systems and hearing aids. Clearly, a one-size-fits-all approach has a good chance of failure as different solutions will work for different students (perhaps even for different classes or situations) and flexibility and user choice will be key to adoption.

4. Related Work

Work related to the proposed technology can be divided into technology designed for typical mainstream audiences and technology designed specifically for deaf audiences, whether in the mainstream or deaf classroom.

4.1. Educational Technology (in general)

Classroom technology research aims to enhance educational experiences for all students by using technology to better engage and involve students in the classroom through active learning. Insights from this field will be incorporated into our project to better include deaf and hard of hearing students.

Electronic classroom response systems (CRSs) allow instructors to solicit feedback and results from student activities, and receive them electronically to then summarize or discuss as a class. These systems have been shown to have positive

effects on classroom participation, active learning, and conceptual understanding [23]. They also tend to encourage shy or less outspoken students to contribute more and reduce the impact of students who tend to dominate classroom interaction [39]. "Clicker" systems are a subset of CRSs that allow students to submit short responses to the instructor (such as answers to multiple choice questions or numeric answers) so that the instructor can display summaries of class responses and opinions of students [12][16][20][44] or groups of students [15]. The summaries can serve as feedback on class understanding for the instructor and can spark conversation about a given topic, but they limit students in the type of their submissions and don't allow for anonymous, independent questions.

Systems that allow text and digital ink to be submitted to the instructor are less restrictive and better at promoting self-initiated dialog between students and instructor. The University of Washington's Classroom Presenter uses networked Tablet PCs to allow students to electronically submit work, questions, and/or comments to the instructor who can then choose to display submissions and digital ink on lecture slides [2][30]. Ubiquitous Presenter [50] and DyKnow [6] offer similar functionality, but with a web-based interface that requires no tablet (a laptop will do). In addition to submitting questions anonymously during class, ActiveClass allows students to rate the questions of other students to bring them to the attention of the instructor [42]. Because cost barriers exist to providing all students with similar technology, Classroom Presenter also offers a version using mobile phones, a device more and more students tend to already have [29].

The digital classroom has incredible potential to better accommodate the needs of students with disabilities in mainstream university classrooms. For example, LiveNotes uses digital ink over lecture slides to encourage group conversations and cooperative note-taking during lectures [24]. This type of interaction may allow deaf students to become more involved in the note-taking process without being solely responsible for their own notes.

As academic environments become more digital, capture and retrieval introduce interesting areas to improve content accessibility. Synchronization of video feeds, digital ink, and presentation materials could result in better preservation and easier post-class access, much like eClass [8] and other classroom capture techniques [37]. One might think that classroom capture would encourage students to skip class but studies suggest that it does not. In fact, in one instance students were more likely to attend if the class was being captured. Students tend to recognize the value of interactions that occur in an in-person group class [8], which helps to relieve the worry of missing class. As deaf students juggle their visual attention during class time, the ability to re-watch parts of the class that were missed may level the playing field and ease information retention.

4.2. Educational Technology for Deaf and Hard of Hearing

Both educational technology for deaf and hard of hearing students and educational technology for a general audience are developed to encourage participation and active learning. The focus of the former is typically more on translation of speech, new interaction techniques, and eliminating visual overload.

Networking within the classroom is also utilized in educational technology for deaf and hard of hearing classrooms. Linda Burik at NTID has shown active learning benefits from using wireless laptops and a SMART board in the classroom [9]. In her system, the teacher can show the students' work on the big class display for discussion, somewhat like Classroom Presenter but the instructor can "grab" student screens rather than receiving students "submissions." Students keep both their own digital work and digital copies of the instructor's notes so that participation in class and note-taking activities are one in the same.

Researchers such as Donald Beil have recognized the potential of using tablets in class to enable deaf students to take notes on top of, instead of away from, other classroom content [4]. Digital pen-based environments create further opportunities for deaf students in terms of self-notetaking as was proposed by Miller *et al.* using transparent video and overlaid digital ink to reduce the visual distance from the interpreter (video) and the student's notes (digital ink) [31].

In online distance learning settings, high-bandwidth connections and streaming video are already being used to better include deaf and hard of hearing students [7]. While this use of the technology works well for distance learning, we predict that the same benefits of inclusion will occur in the physical classroom as well.

To facilitate communication between deaf and hearing students in his classes, Jonathan Schull proposed a system that he successfully uses at RIT/NTID for students to join a common, on-the-fly chat room and display text concurrently to best augment a face-to-face conversation.

4.3. Enabling Technology (a comparison)

ConferenceXP [3] and Adobe Connect [1] are two conferencing technologies that have potential for use in our work. Both enable video/audio conferencing and remote sharing of presentation slides, application windows, and even entire desktops. We will leverage their existence and stability as a foundation for our own work.

ConferenceXP, developed at Microsoft Research, provides the infrastructure for networking the Tablet PCs used in Classroom Presenter and is also used for audio and video distance learning and classroom capture. Classroom Presenter is currently used by at least 70 instructors at universities nationwide and this number is likely to grow in the future, so compatibility would ensure that the technology used by deaf and hard of hearing students will work well in conjunction with the classroom technology used by all students.

Adobe's Connect also offers video and presentation conferencing technology that could serve as a backbone for remote connections with interpreters and captioners and sharing of in-class resources [1]. In fact, Adobe currently has an alliance with Caption Colorado (www.CaptionColorado.com) and WGBH (www.wgbh.org) to provide captions for meetings. Several universities in the U.S. are currently using Connect for remote, online distance learning. Its use as a distance-learning tool ensures that several of the components needed for in-class involvement and participation will be available.

Both ConferenceXP and Connect have released open source versions of their systems that would allow us to make the necessary enhancements needed by deaf and hard of hearing students, discussed in Section 5.

We will also leverage the high-bandwidth, reliable internet connections that exist between universities enabled through Internet2 and Cyber-infrastructure communities to provide the best quality video/audio and stable transmission.

Describing our planned use of these systems is best illustrated with a scenario. The following three scenarios are intended to convey different types of students, accommodation needs, class structures, and enabling technologies.

4.3.1. Scenario A (Connect, Remote Interpreter)

Sally is a deaf student at the University of Io. She is fourth-generation deaf and prefers to converse in American Sign Language. She is majoring in Psychology and taking Child Psychology 101. The class is discussion-based; the instructor tends to show slides and videos and then expects students to discuss their opinions about them. For this class, Sally is using Adobe Connect to bring in a remote interpreter from a different university who happens to hold a degree in Child Psychology.

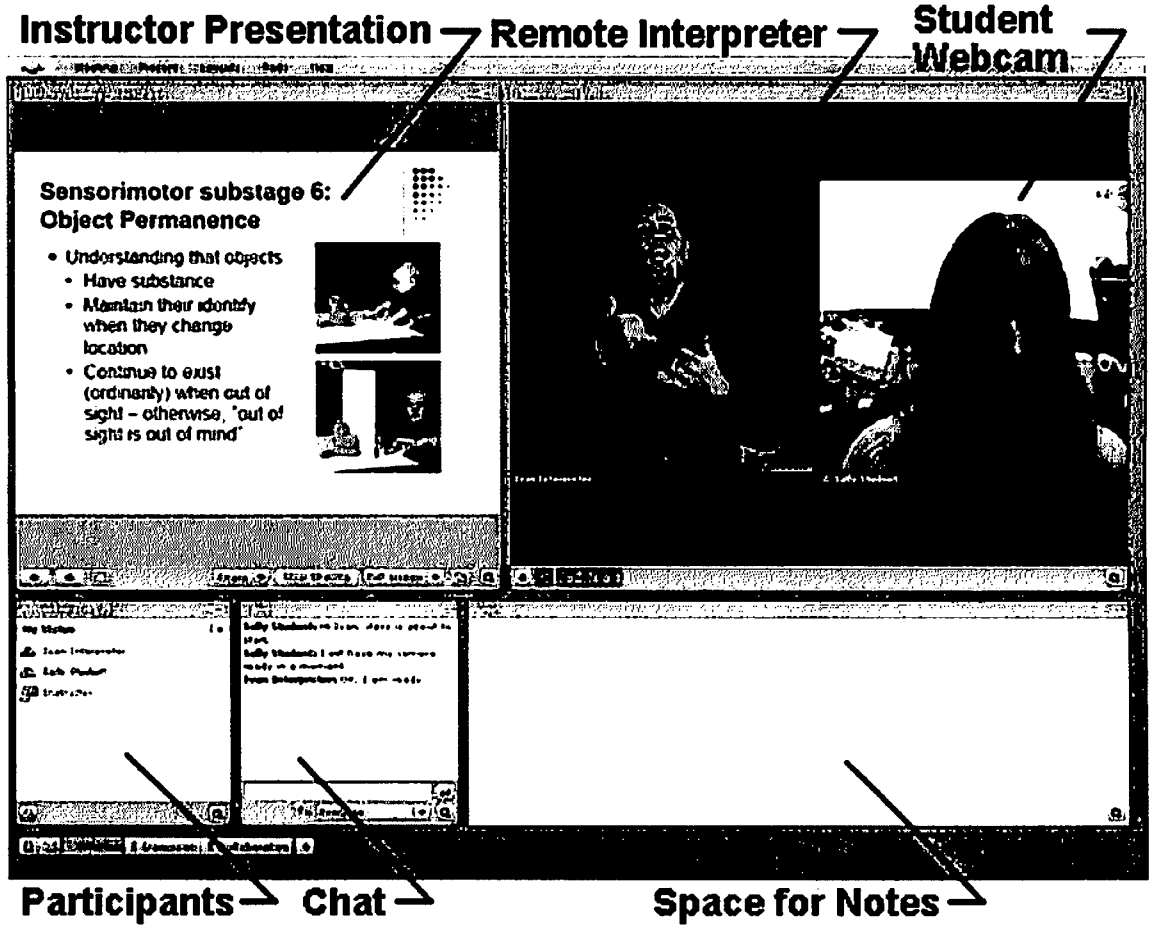


Figure 2: Using Adobe's Connect in Scenario A. Sally's computer screen show's the instructor's presentation, her remote sign language interpreter,

her own webcam, and the ability to chat and take notes.
The instructor has agreed to upload his slides and videos before classes start and to use the system during class. Because he only uses the power-point feature to show slides and videos, it is nearly the same process he would have used to teach (in fact he is even using the same materials as last quarter). The only noticeable different in class is that he now wears a microphone and earpiece to transmit voice between him and the interpreter. The students pass a microphone around during discussion and the instructor appreciates this added structure and enforced turn-taking.

Figure 2 shows Sally's screen on her laptop at the beginning of class. She has access to the instructor's slides and videos which are synchronized with his presentation. She can see both her interpreter and herself. She can chat with the interpreter and the instructor (if he checks the chat log) for example, incase the video stops working. And she has space to take typed notes. If she has a question or takes a turn in discussion, she signs to the interpreter who then voices for her. For this class, she chooses to turn the volume up on her laptop because the class is small and everyone can hear the interpreter. For larger classes, she would have the instructor repeat what he or she hears in their earpiece.

4.3.2. Scenario B (Classroom Presenter, Remote Captionist)

Bobby is a hard of hearing student at the University of Ganymede. He is majoring in Computer Science and currently taking Data Structures. He has only recently learned sign language (since he started college), so he does not yet feel comfortable with an interpreter. He prefers to use his voice to communicate and uses real-time captions during class because there are so many different vocabulary terms and acronyms in Computer Science courses and seeing the words helps him to find the topics later. He uses a note-taker because, in addition to the captions, he must watch the instructor who often writes code on the screen. Bobby has chosen ConferenceXP as a way to connect with his favorite captionist who is also a computer geek and so understands the content and is occasionally creative with ASCII art.

Luckily, his Data Structures instructor this quarter is using Classroom Presenter, so it will be easy for him to link the ConferenceXP connection he needs. All the students in class have TablePCs and submit in-class activities with digital ink. He too can create submissions and this puts him on the same level as other students. The use of tablets also gives him direct access to the notes of his note-taker. This enables him to add to the notes if he wants, but it mainly helps him refer back to the notes later because he sees them as they are created. The appearance of his screen can be seen in Figure 3.

From the instructor's perspective, her teaching process is exactly the same. She simply wears a microphone for the captionist and tells Bobby which session to connect to so that his tablet is on the same network as all the other tablets. Bobby then gives this information to his captionist, so that he too can see the slides. Instead of walking around the room with a microphone, the instructor prefers to repeat questions asked by hearing students as she feels this is a good practice to make sure all the other students heard the question.

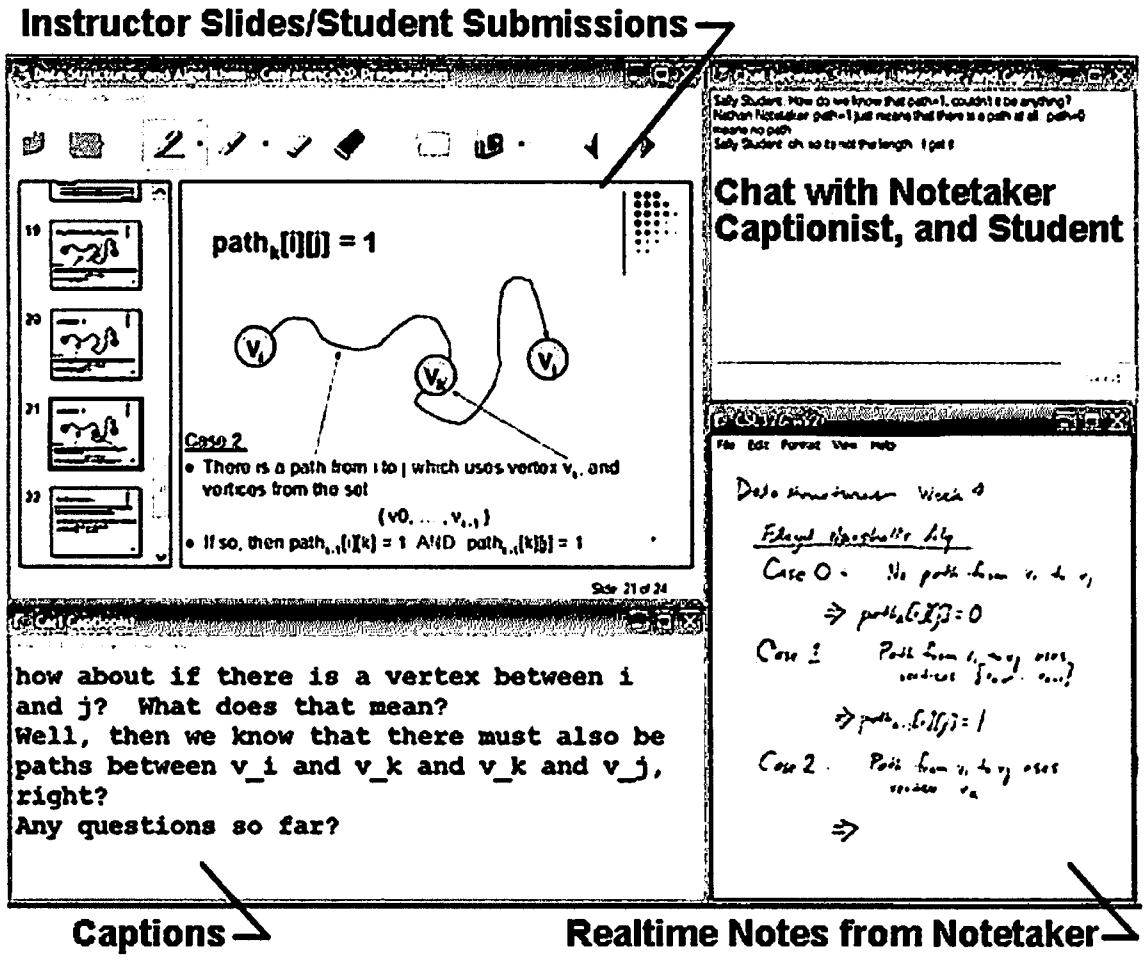


Figure 3: Using ConferenceXP in Scenario B. Bobby has the same level of involvement as all other students as they all submit activities with digital ink. He has access to a remote captioner and the digital notes created by his note-taker in class. He can chat with both his captioner and note-taker.

4.3.3. Scenario C (Interpreter in Class, Either Technology)

Tom is a deaf student at the University of Callisto and has attended mainstream schools from Kindergarten through high school. He prefers sign language interpreters and is accustomed to using them in class. This quarter, he is taking Intro to Biology in a huge, stadium-seating classroom. Even if he sits at the front of the class, the projected presentation is so large that he feels as though he is watching a tennis match between the screen, the instructor, and his interpreter. Instead, he sits a few rows back and uses a webcam to capture the entire front of the class. Then, he cuts out the important pieces: the instructor, presentation, and interpreter. He arranges these components on his screen so that he still has room for a chat window with a friend in class and a section for his own notes. Because the interpreter is present in the class with him, he can easily raise his hand, ask questions and interact.

5. Thesis Proposal

Existing technology has potential to alleviate some of barriers to and encourage participation in mainstream university-level academics for deaf and hard of hearing students. Designing, implementing, and evaluating technological solutions that bring many different technical and human resources into the classroom in an accessible and unobtrusive way is a challenging research problem. Technology has been shown to enhance education in the classroom and these "digital" environments open up new possibilities for leveling the academic playing field for deaf and hard of hearing students.

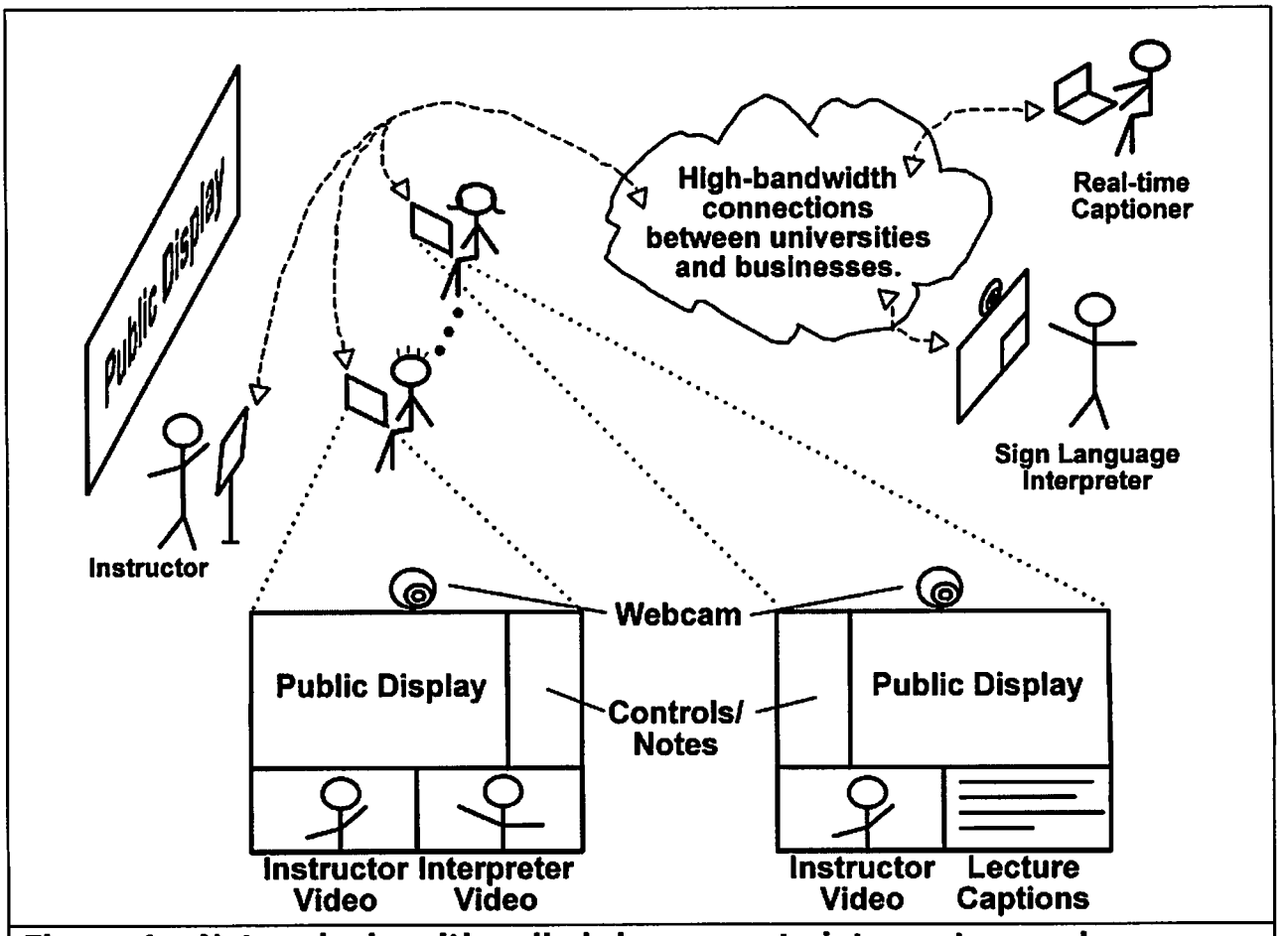


Figure 4: Networked multimedia brings remote interpreters and captioners into the classroom. Students have access to presentation, instructor, accommodation of choice, and their own notes. The instructor uses a microphone and earpiece and to relays audio, video, and presentation materials to the remote interpreter. Students' webcams relay questions and discussions through the interpreter to the rest of the class.

We will investigate effective ways for leveraging collaboration technologies for enhancing the participation of deaf and hard of hearing students in academic settings. The University of Washington's Classroom Presenter [2], Conference XP [3], and Adobe's Connect [1] will serve as a backbone so that technology for deaf students will be similar to and compatible with future classroom technology for all students. This technology will also be used to bridge the cultural and language gap

between hearing and deaf students and encourage group work using text and digital ink. Given the scenario where all students are equipped with a networked Tablet PC, an additional opportunity exists for student collaboration. Finally, capture and retrieval introduce interesting areas to improve content accessibility. Synchronization of video feeds, digital ink, and presentation materials could result in better preservation and easier post-class access.

5.1. Enabling User Control of the Interface

Different accommodations will be required for different students, different classroom situations, and various aspects of the classroom will be more or less visually important for different students at different times. Flexibility in the interface will be crucial for success. We will modify existing video conferencing and classroom technology to enable students to choose the size and visual importance of each interface component. Using techniques like those found in WinCuts [47] and Facetop Tablet [36], our interface will allow students to crop, zoom, show, hide, and arrange independently, all while maintaining compatibility with technology used by other students and the instructor. To help reduce clutter on the screen, students may choose levels of transparency for videos feeds and other desktop components so that overlap can occur when appropriate. Imagine an interpreter standing to the left of a public display. She occasionally references specific items from the display as the instructor is talking about them. The student may want to reduce his video feed of the interpreter to show only her signing box (upper body from waist to the top of her head) and it will be important that her video feed appears to the left of the video feed showing the public display. No interface could be expected to predict these types of scenarios and students preferences. The best solution will be to engage the student in the creation of their own academic environment in a way that adds minimal complexity to the interface.

5.2. Enabling Collaboration and Group Work

Communication, participation, and active learning in the classroom have all been shown to promote learning in positive ways. These types of activities can be difficult for deaf students due to language barrier and interpreter/captioner delay. Compatibility with other classroom technologies, such as Classroom Presenter, will assist with this. The ability to anonymously submit questions and answers to the instructor is likely to play a role in reducing barriers to participation.

Additionally, we will develop mechanisms to create or access alternate channels of communication if they are available. If students in the classroom have digital-ink-based devices, students will be able to share notes much like LiveNotes [24]. Students will be able to connect to synchronous text chat channels for discussion much like in the classrooms of Schull [46]. If the deaf student has arranged to have a note-taker, the two could combine efforts by having access to the digital ink or text notes being created on-the-fly.

5.3. Enabling Capture and Later Retrieval

Because deaf students have a multitude of priorities that divide their visual attention during class, having access to a captured version of that class for review may help them to fill in missed content and parse class notes.

We will create an online repository for classroom capture if the student chooses this option. Mechanisms for both student and instructor security will be explored. We will borrow some of the tried and true techniques from eClass [8] for implementing segmentation of the recordings. For example, slide changes are a natural way to segment the video and allow students to easily access the interval of the class they are interested in. We will also explore techniques for allowing students to mark their own points of interest for later retrieval during class.

5.4. Evaluation Techniques

Evaluation of the proposed classroom technology will be an integral aspect of the project from day one. Involvement from the deaf and hard of hearing community is key to adoption, so evaluation will take the form of focus groups, participatory design techniques, and iterative design where feedback from students is incorporated into the design at every iteration.

However, implementing traditional HCI techniques of evaluation will be difficult due to a limited number of diverse users, inconsistencies in instructors' teaching style, and technology and classroom setup. Doing studies with sustained use over several courses and several students will be impractical. For example, it would be difficult to teach the same course with and without the proposed technology because comparisons may not easily be made across a small handful of students.

Some of the most successful and influential work in the field of educational technology has studied the effects of learning, scores, participation, and student responses to questionnaires and interviews across hundreds of students and tens of years [8][24]. Interestingly, none of the studies were able to find significant results from the collections of attendance and grades (two data points that would be difficult for us to use reliably). Even 33 years of research on electronic response systems yields inconclusive results on effects of academic success, citing pedagogical practices of the instructor among other things as dominating factors [23]. The most significant and meaningful results from these studies were obtained through student questionnaires, surveys, and observations of student behavior.

Student surveys, focus groups, student and instructor artifacts, observational interviews with both instructors and students that focus on student perceived benefits seem to be the norm [6][15][20][30]. Learning improvements, test scores, and grades may not be reliable measures because evaluations "in the wild" in actual classrooms will have too many confounding factors, including variability of students, instructor's teaching style and level of engagement, participation of other students in the class, time of day, and lecture topic. Cost/*benefit* analyses may be more practical than cost/*effective* analyses and may even result in better indicators of quality of learning and interaction with instructors and peers. Thus, we will measure impacts on classroom environment, participation rates, and subjective measures based on student perceptions.

Evaluations for the project will test the following hypotheses.
Potential Hypotheses:

1. Students will feel that using the technology in class makes lectures more engaging.
2. Students will feel they have learned more as a result of using the technology.
3. Students will participate more in classrooms when using the technology.
4. Students will feel they participate more as a result of using the technology in the classroom.
5. Students will feel that the quality of their interaction in the classrooms is improved when using the technology.
6. Some students will alter their seating behavior as they are no longer forced to sit at the front of the class.
7. Students will view the technology as a useful study tool.
8. A majority of students will voluntarily continue to use the technology after participating in the study.

In addition to these hypotheses, we will also include evaluations for some of the adverse effects that we hope to avoid or outweigh with our technology, including 1) a learning curve for the technology that distracts from learning course content, 2) in-class distractions caused by the technology, 3) increased potential for off-topic behavior. Although we should decide carefully if any effects from point 3) are in fact adverse. In light of research that suggests that attrition of deaf students is partly due to isolation, increases in communication, even if off-topic, may have more of a positive than a negative effect.

During evaluations, we will collect the following types of data. We will collect quantitative data from recording student interactions and observing student and instructor behaviors. We will also collect qualitative data from focus groups, student survey, interviews, and voluntary student feedback.

Quantitative data:
- Attendance and/or classroom participation
- Effects on note-taking behavior.
- Effects on seating behavior.
- Increased or continued use (even without study requirements) would likely imply that students see the technology as valuable.

Qualitative data:
- Students' self-reflections on access to classroom content, note-taking behavior, participation, performance, learning experience and feeling of inclusion.
- Effects of classroom engagement.
- Students' perception of the technology as a useful in-class tool.
- Students' perception of the technology as a useful study tool.

We are currently collaborating with Rochester Institute of Technology (RIT), home of the National Technical Institute for the Deaf (NTID) supporting over 400 deaf students in the academic mainstream, over 120 sign language interpreters, and over 50 captioners. Evaluation of the technology will take place in mainstream classrooms at the University of Washington using both technical and human resources at RIT.

Another excellent opportunity for evaluation and feedback is the Summer Academy for Deaf and Hard of Hearing Students hosted each summer at the University of Washington. The top ten deaf college freshmen or sophomore applicants join the program to take college courses focused on introductory Java programming, computer science, and related fields. Because the academy involves mainstream courses, it presents an ideal testbed situation. Students who are interested in participating will be asked to use the technology, including a remote sign language interpreter or captioner, during class time and rate its usefulness through a series of questionnaires. Weekly one-on-one interviews will be conducted to discuss problems, suggestions, and other feedback.

5.5. Timeline

Spring 2008

- Prepare a working prototype of the classroom technology for the DHH Cyber Community Summit gathering in June 2008.

Summer 2008

- Implement and evaluate an initial version of the classroom technology locally at the University of Washington.
    i. This version will be fully functional, but may not include all of the desired features, such as capture.
- Conduct evaluations with students from the Summer Academy for Deaf and Hard of Hearing.

Fall 2008

- Use feedback from the summer release to improve the design of the system.
- Create an online repository for capture and retrieval.
- Implement and evaluate the classroom technology with interpreters and captioners at RIT and students at UW.
- Execute a formal user study to determine the best digital educational environment using the classroom technology.

Winter 2009

- Iterate improvements to the system based on the results from the formal user study.

Spring 2009

- Continue to improve and develop.
- Begin longitudinal studies with UW students to investigate long term use and results of any novelty factors.

Summer 2009

- Release and evaluate at Summer Academy for Deaf and Hard of Hearing and compare results to previous summer academy.

Fall 2010

- Finish remaining analysis and research.
- Prepare dissertation and defend.

6. Conclusion

Our primary research goal is to find ways to increase involvement of deaf and hard of hearing students in university academics. With this goal in mind, we will strive to broaden the accommodation resources for students through high-bandwidth remote interpreting, reduce the visual dispersion of important in-class components

through on-screen consolidation, and encourage in-class inclusion through new channels of communication and interaction. Solutions will be viable for traditional classroom environments as well as for lab sessions, study groups, and project meetings. And because our work will parallel that of other educational technology, we will follow universal design guidelines so that the technology used by deaf and hard of hearing students is compatible and seamlessly coexists with educational technology designed for a general, mainstream audience. By utilizing networked resources and flexible design that empowers students, we hope to create a more inclusive, easily accessible classroom environment.

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