NTID Research Bulletin

Center for Research, Teaching and Learning · National Technical Institute for the Deaf · Rochester Institute of Technology

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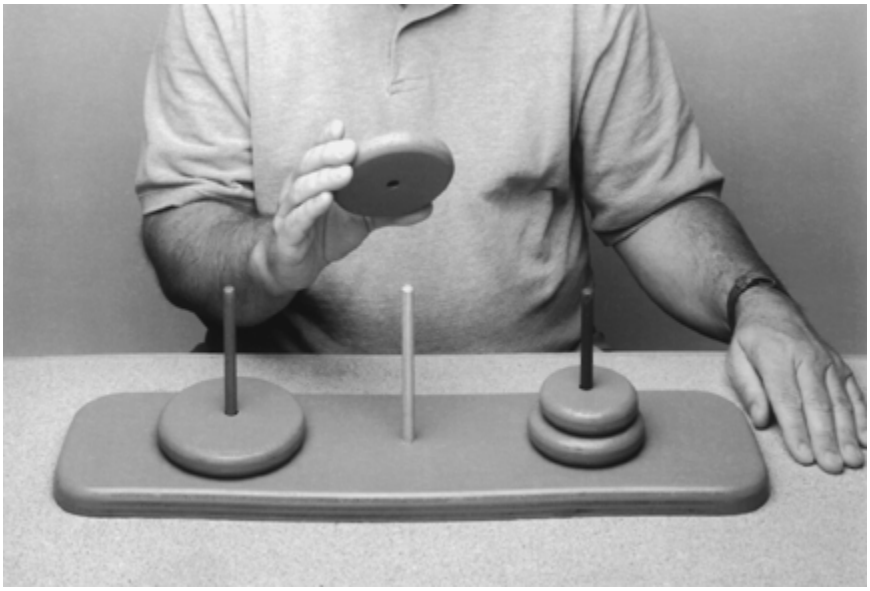


The goal of the Hanoi Tower puzzle is to move a stack of disks (four in this case) from a designated peg to another designated peg in the fewest possible moves and as quickly as possible, and end up in the same stacked ascending order (largest disk on the bottom, smallest on top) as the starting position. Only one disk may be moved at a time and a larger disk may never be placed on top of a smaller disk. See the third article, Integrating Teaching and Research to Enhance Problem Solving Skills, below.

The Balance Beam of Research

As we approach the 1996 Olympic games in Atlanta, metaphors involving sports abound in the popular press and on television, so why not here? When it comes to research, the balance beam seems to provide the most appropriate analogy.

A reality of research life is the need to balance "basic" and "applied" pursuits. On one hand, the way of science is through the gradual accumulation of research findings. On the other hand, what drives research (and its sponsors) is the need for direct contributions to the improvement of life--today! Nowhere is the balance beam of research as pronounced (narrow?) as at NTID. As educators and scientists, we have a responsibility to contribute to the knowledge base--the total sum of our scientific knowledge concerning learning, communication, social and cultural issues, and the place of deaf people in the workforce. Our clear mandate and primary goal, however, is for a program of applied research that contributes to the educational, social, and economic success of deaf people.

To those outside of research, the enterprise often seems simple. For example, mathematic skill is one of the most essential tools for students entering NTID and RIT programs in technical majors. Statistically, it is the single best predictor of whether or not an incoming deaf student will graduate from the university. What is the best way for deaf students to learn mathematics and for faculty to teach mathematics? We could take advantage of the many years of teaching expertise among our mathematics

faculty, who have some good ideas about what works and what does not. But, could our best method be enhanced if we better understood the characteristics of deaf learners? Are there particular learning strategies used by deaf students that are better suited to new teaching methods than our traditional methods? Why don't our students use the math they learn in their mathematics classes when they are in engineering classes? The NTID Research Advisory Group has identified the need for such **transfer of knowledge** as a priority need for NTID research, with mathematics as the prime example. Where do we start?

There is no simple, single experiment that will explain why deaf students do not apply math concepts **that we know they have** in a non-math course. To resolve the question requires direct research in the classroom as well as research into more general problem solving skills and strategies of deaf learners. It may require research into the self-esteem and the motivation of deaf students (and perhaps the roles of their parents in engendering that motivation), the signed communication of mathematical concepts by faculty, the readability of math textbooks, memory process, and so on.

As NTID moves toward the next century, our research has a new, collaborative model and a new urgency to optimize opportunities for deaf learners. It does not matter if those students are at NTID today, will be here tomorrow, or will never set foot on our campus, physically or electronically; the questions are essentially the same. The balance beam is before us, and the end does not seem so far away. With each step, we feel the pull from side to side. But, with care to keep our balance and to keep the real goal in sight, we **will** get to the other side. And who knows? With a few flips and rolls, we might even bring the audience to its feet.

Marc Marschark
Director, CRTL

Who's on First? Research on WH-Questions in English and ASL
by Gerald P. Berent and Susan D. Fischer

Jerry Berent is an associate professor and Head of the Department of Applied Language and Cognition Research at NTID. His primary research interests include the English language characteristics of deaf students and issues pertaining to the teaching, learning, and assessment of English. One of his research goals is to find ways of facilitating deaf students' access to the English language in a college environment. For more information he can be reached at e-mail gpbnci@ rit.edu.

Susan Fischer is a professor in the Department of Applied Language and Cognition Research at NTID. Her research has two major foci: expanding our knowledge base about the structure of ASL in particular and signed language in general, and studying how signed language is processed. She is also engaged in a project that examines issues related to interpreting. For more information she can be reached at e-mail sdfncr@rit.edu.

The ability to ask and answer questions is vital to success in a college environment. Teachers are always asking questions which students are expected to answer, and students ask teachers--and each other--questions to seek clarification and elaboration and to satisfy their own curiosity. Questions in textbooks and written assignments serve as a guide for study and review, and of course questions on examinations are used to assess students' academic progress. Thus, the ability to compose and comprehend questions is central not only to academic success, but also to future success in the world of employment.

At NTID, both English and American Sign Language (ASL) are used in classroom communication. Students vary in their knowledge of English and ASL, and so do teachers. Individuals' language abilities, preferences, age, attitude, and teaching and learning styles all influence linguistic competence, including the ability to ask and answer questions. Since two languages are used at NTID, members of the NTID community need to understand how both languages work in order to facilitate better teaching and learning.

Two researchers in NTID's Center for Research, Teaching, and Learning have each conducted research on a specific type of question known as "WH-questions." Gerald Berent has conducted research on English WH-questions, and Susan Fischer has conducted research on ASL WH-questions. Unlike "yes/no" questions (e.g., *Do you drink coffee?*), which are intended to elicit a simple yes or no response, WH-questions (e.g., *who, what, when, where, why,* and *how* questions) are intended to elicit specific content (e.g., a response to *What did you have for breakfast?*). Most English WH-questions have the WH-word at the beginning of the sentence, as in examples 1 and 2 (in more formal English, *whom* would be used rather than *who* in these sentences):

1. *Who* did the teacher advise?

2. *Who* does the student think the teacher advised?

ASL has more freedom in the placement of WH-words. ASL can move WH-words to the front of questions as in example 3, but it doesn't have to, as shown in examples 4 and 5:

3. *WHO* TEACHER ADVISE?

4. TEACHER ADVISE *WHO*?

5. STUDENT THINK TEACHER ADVISE *WHO*?

In examples 4 and 5, the WH-word remains in its logical object position after the verb ADVISE. Examples 6 and 7 below look like direct English translations of the ASL examples 4 and 5, but they're not. In English, sentences like 6 and 7 can only be "echo" questions, which have the special function of asking for clarification or showing surprise, but ASL examples 4 and 5 are simply another option for ordinary WH-questions.

6. The teacher advised *who?*

7. The student thinks the teacher advised *who?*

There is, of course, one type of English WH-question where the WH-word doesn't have to move, that is, where the logical position of the WH-word is already at the beginning of the sentence. An example is given in 8.

8. *Who* advised the student?

Languages of the world vary in the ways they form WH-questions. Some of these ways appear to be more learnable than others. For a language learner, it is easier **not** to move something out of its logical position than it is to move it. Therefore, questions like 6, 7, and 8 (NO MOVEMENT) should be easier

to learn than 1 and 2. In addition, the farther a WH-word moves from its logical position, the harder the resulting structure will be. So a question like 1 (SHORT MOVEMENT) should be easier for the learner than 2 (LONG MOVEMENT).

In the context of learnability theory in linguistics, Berent (1996b) proposed a learnability hierarchy based on the various possibilities for WH-question formation observed in the languages of the world. The hierarchy is depicted below:

NO MOVEMENT < SHORT MOVEMENT < LONG MOVEMENT

Berent then explored NTID students' knowledge of a variety of English WH-question structures to determine whether their performance could be predicted on the basis of this hierarchy.

The NTID students who participated in the study comprised three groups (High, Mid, and Low) on the basis of their scores on the Michigan Test of English Language Proficiency (1977), which is administered to all NTID students and is used for purposes of English course placement and admission requirements to certain degree programs. Berent tested the predictions derived from the learnability hierarchy in two tasks. The first task required students to convert statements to questions; the second required students to judge whether a variety of WH-question types were grammatical in English.

Berent's results, in fact, confirmed the predictions derived from the learnability hierarchy. The NTID students' knowledge of English WH-questions generally improved as overall English proficiency increased. Students at all three Michigan Test levels exhibited full knowledge of WH-questions that exhibited no movement, as in 8. The Low Michigan group exhibited knowledge only of sentences like 8 but had very little understanding of English structures like 1 and 2 that involve short and long movement. The Mid group showed considerable knowledge of structures like 8 and 1 but much less knowledge of structures like 2, which involve long movement. The High group exhibited relatively good knowledge of most of the structures, but their performance indicated that some types of English WH-questions would still pose a major problem for them.

This research has major educational implications. English is used in a variety of modalities: speech, print, and sign. When it is used in the classroom, in course materials, and in testing, a deaf student's limited knowledge of English question formation will result in more limited access to the knowledge required for educational and career success (see Berent, 1993). While methods of teaching English to deaf students need to be continually enhanced, teachers in all subject areas need to recognize those question structures that pose the greatest challenge to deaf students and, where possible, write and revise course materials in order to make English grammatical structures as accessible as possible to their students.

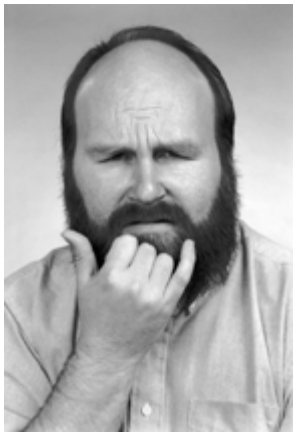
NTID English teacher Larry J. LoMaglio uses WH- questions to elicit participation from students (left to right) Demetrius Carter, Ken Rosa, Tone Gomez, Steven Gaines, Debra Brokaw, Dallas Keenan and Don Sirois.

Since both English and ASL are used at NTID, it is natural to wonder how WH-questions function in ASL. Because the formal study of ASL is relatively new, we are still learning about its structure. Susan Fischer has been doing field investigations on the structure of ASL WH-questions in collaboration with Diane Lillo-Martin of the University of Connecticut. They have found that, as noted above, WH-words

do not have to move to the beginning of the main clause. However, in "embedded questions" (the bracketed constituent in 9 below) movement is obligatory. A sentence like 10, while possible in some other languages, is not grammatical (indicated by the *) in ASL, just as it is not grammatical in French or English. This is in contrast to questions like 5 or 7, which are acceptable in ASL and are also possible in languages like French.

9. The student wonders [*what* the teacher assigned].

10. *The student wonders [the teacher assigned *what*].



Sam Holcomb, lecturer in the Department of American Sign Language and Interpreting Education, produces the sign for "what's wrong?" incorporating the WH facial expression.

In ASL, WH-questions are marked in two ways: with an *overt* (i.e., explicit) WH-word such as *WHO, WHERE, W-H-E-N, WHY, HOW,* and *WHAT* or *#WHAT* (where # indicates a fingerspelled loan sign) and with a particular WH-facial expression. Fischer and Lillo-Martin found that there are also *covert* WH-expressions in ASL that are marked by just the WH-facial expression or by a slight change in movement from a non-WH sign in addition to the WH-facial expression. An example of the latter category is the sign *FOR-FOR*, meaning "what for?". It differs from *FOR* by the repetition of the sign as well as by the addition of a WH-facial expression. Examples of covert WH-questions in ASL are given in 11-12 (nonmanual markers are indicated above the line).

11. wh

DRESS YOU USE FOR PARTY?
'What dress are you wearing for the party?'

12. top. wh

MOTHER, SAY
'What did Mother say?'

Question 11 could be paraphrased by 13, and 12 by 14.

13. wh

WHAT DRESS YOU USE THERE PARTY?
'What dress are you wearing for the party?'

14. top. wh

MOTHER, *WHAT* SAY
'What did Mother say?

ASL and certain other languages (e.g., Russian) permit a WH-word to be "split" from an associated noun in a WH-phrase. For example, whereas English cannot split *which* from *ice cream* in 15, ASL and Russian allow questions analogous to 16.

15. *Which ice cream* do you prefer?
16. *Which* do you prefer *ice cream?*

Covert WH-constructions can also interact with the split WH-constructions, resulting in questions like 17-18:

17. wh

KIND YOU HAVE CAR?
'What kind of car do you have?'

18. wh

COLOR YOU WANT ICE-CREAM?
'Which flavor ice cream do you want?'

In 17, for example, the WH-facial expression begins with the sign KIND, which is split from CAR by YOU HAVE.

As already noted, WH-words in ASL can occur at the beginning of a clause, can remain in place, or can be missing altogether in the manual portion of a sign. There is yet another position in which WH-words can be found, as noted in the work of Karen Petronio of the University of Eastern Kentucky (Petronio, 1993; Petronio & Lillo-Martin, 1995). In both English and ASL, a subject WH-word doesn't have to move at all, so we get sentences like Who cut your *hair?* or *WHO HAIRCUT YOU?*. However, ASL has very flexible word order, so it is possible also to have questions like *HAIRCUT YOU WHO?* with almost the same meaning.

Teaching and learning in the classroom is a give-and-take process, involving communication from student to teacher as well as from teacher to student. Just as deaf students need to master as much English as possible, teachers who work with deaf students need to know enough ASL to be able to understand and respond to questions and comments from their students. In the case of the covert WH-questions in ASL, if users of English ignore what is occurring on the face, as is often the case with early sign language acquisition, they may miss even the fact that they are being presented with a question! A greater awareness of ASL structure can lead to improved instructional methods for teaching ASL and can also help teachers to build on students' knowledge of ASL in the teaching of English structures. Thus, the parallels between English and ASL WH-structures can be highlighted in the instructional process. Clearly, a better understanding of the grammatical devices of ASL can lead to a general improvement in the quality of sign language communication in a college environment.

The results of the two lines of research discussed above provide educators of deaf students with a better understanding of the English grammatical knowledge of their students and of the structure of ASL. These results validate our understanding of proposed principles and mechanisms that operate in language acquisition and use (see also Berent, 1996a), and have many specific educational applications.

Obviously, questions constitute only a small though important aspect of language structure and use. Future research will explore additional features of English and ASL along with the implications of linguistic knowledge for teaching and learning at NTID and elsewhere.

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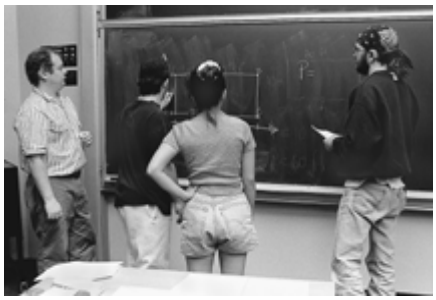
Integrating Teaching and Research to Enhance Problem Solving Skills
by Keith Mousley and Ronald R. Kelly

Keith Mousley is an assistant professor in the Department of Physics and Technical Mathematics at NTID. He taught science (basic science and chemistry) at the Scranton State School for the Deaf in Scranton, PA, for seven years, and, for the last seven years, has taught math (everything from algebra to concepts of calculus) at NTID. His research interests include finding how students solve word problems in math and science. For more information he can be contacted at e-mail kxmntm@rit.edu

Ron Kelly is an associate professor and Head of the Department of Educational and Career Research at NTID. His research interests include cognitive processing, problem solving, and captioning. For more information he can be contacted at *rrkncp@rit.edu.*

Since 1993, a combined teaching/research effort has been used to examine alternative teaching strategies and techniques that will enhance both the general problem solving and the math word problem solving skills of NTID students. This collaborative effort involves a teaching faculty member from the Department of Physics and Technical Mathematics in NTID's Center for Arts and Sciences and a research faculty member from CRTL's Department of Educational and Career Research.

Within the context of the normal instructional setting for math at NTID, this integrated teaching and research approach was designed to examine and document over time the outcomes of a variety of problem solving strategies and techniques with deaf college students. The goal was to identify practical teaching strategies that could be used with deaf students at different ages and grade levels to support their developing thinking and problem solving skills. Also, we wanted to find ways to provide a more natural bridging between the research findings and the practical application of such findings within the classroom. This on-going teaching/research effort is examining deaf students' problem solving approaches and exploring a number of instructional strategies and techniques for both a visual/tactile problem and a variety of math word problems.



Shown here in the classroom (left to right) are Mousley, Mark Najarian, Becky Phung, and Bill Kane.

The kind of teaching research questions that helped shape the focus of this integrative effort are:

- Depending on the students' primary language, does the presentation and explanation of a problem in either ASL or English influence the students' ability to deal with problem solving?
- Do deaf students tend to forget or misunderstand the specific problem goal and related problem rules while trying to solve the problem?
- For problems that have a number of possibly correct solutions, are deaf students able to utilize an "if-then" approach and explain their rationale for selecting the approach to the solution that they chose?
- Do different teaching strategies and varied approaches to problem solving (e.g., modeling, visualization, paired observer with individual solving the problem, individual problem solving, team problem solving in groups of two or three, etc.) influence deaf students' abilities to solve the problems presented?

Stages of the study The four stages of this continuing effort completed so far have involved approximately 50 deaf college students enrolled in first and second year NTID math courses over a three year period. In each stage, directions were provided by the teacher, who is deaf, in an appropriate communication mode for each student. After completing each problem, students were expected to individually provide a written explanation of the problem and how it was solved.

The **first stage** involved the pairing of two college students for each problem solving session. One student was the "problem solver" and the other student was the "observer." Each student "solver" was given two problems to solve: a visual manipulative problem called the Hanoi Tower puzzle and a math word problem. A written explanation of each problem was also provided. The student "solver" then had to explain the problem to the student "observer" in sign language.

In the **second stage,** students were only given the Hanoi Tower puzzle to solve. Each student solved the Hanoi Tower on an individual basis; there was no student observer. However, half of the students were instructed to visualize the moves of the disks in their heads for two minutes before starting to solve the Hanoi Tower puzzle. The other half of the students were not given the opportunity to visualize before starting.

During the **third stage,** students were given two math word problems. They solved these problems on an individual basis in a typical classroom setting. The teacher provided half of the students in this group with specific instructions and modeling for solving math word problems. Each of the math word problems had several possible correct answers depending on the "if-then" decision that a student made in solving the problem.

And in the **fourth stage,** students were given two math problems to solve in a group problem solving situation, rather than on an individual basis. Each student participated in both a two-person and a three-person team problem solving effort. The goals were to see whether the student teams were able to share and discuss the pertinent information necessary to solve the problems, to see to what extent group interaction helped or hindered problem solving, and to assess the potential differences in interaction that

might occur with teams of two and three students. The focus was to identify considerations and strategies for helping teachers utilize a team problem solving approach with deaf students.

Results We found that the students who visualized strategies and moves for solving the Hanoi Tower puzzle before beginning were more efficient than those students who did not visualize prior to starting to solve the puzzle. Students who had the opportunity to explain the math word problem to a student observer and to obtain feedback did better on the problem solving tasks than those students who worked independently. Both the visualization strategy and the paired student/observer interactive strategy appear to serve a similar function: these strategies require the student to study and think through the problem prior to attempting to solve it.

When using a team approach as a learning experience for problem solving, a teacher has to consider the interactive behavior and styles of each student. For example, with the 12 problem solving team matchups (both two-person and three-person teams), five were not very successful in terms of reciprocal discussions because a dominant person took control of the process.

The outcomes of these studies support recommendations pertinent to using teaching/learning strategies such as modeling, explanations by students with feedback, visualizing problem solving steps/solutions by students prior to solving a specific problem, practice with "if-then" possibilities with a variety of math word problems, and, upon completion of the problem solution, the requirement for each student to explain the basis of the answer in both sign or spoken language and in written form, and receive feedback and clarification if necessary.

Currently, this collaborative teaching/research effort is continuing to examine additional problem solving strategies, while infusing the findings identified to date into the instructional activities of selected NTID math courses.

Notes of Note
New Publications from NTID
Simon Carmel, associate professor in the Department of General Education Instruction at NTID, has written a section on deaf folklore in J.H. Brunvand's *American Folklore: An Encyclopedia.* The article describes and gives examples of the folklore (a collection of anecdotes, jokes, sign play, personal experiences, riddles and other related stories) transmitted "by sign of hands" within the Deaf Community. *American Folklore* was published by Garland Publishing in 1996.

Deaf Persons in the Arts and Sciences: A Biographical Dictionary, written by **Harry Lang** from CRTL's Department of Educational and Career Research and **Bonnie Meath-Lang,** who has a joint appointment in CRTL and in the Center for Arts and Sciences at NTID, was recently published by Greenwood Press. The book includes 151 biographies of Deaf people who have excelled in their fields, and was written not only to increase awareness of the contributions Deaf people have made, but also to serve in motivating aspiring young Deaf artists and writers. It builds on Harry's first book, *Silence of the Spheres: The Deaf Experience in the History of Science,* published by Bergin & Harvey, which is a historical look at the interplay between science and Deaf people, and which examines the effect of deafness on those scientists who reached prominence.

Marc Marschark has just published his fourth book. *Models of Visuospatial Cognition* is the second volume in the Oxford University Press series *Counterpoints: Language, Cognition, and Memory,* which he edits. Each volume includes four or five international experts writing on an issue of current controversy; this volume provides new insights into visuospatial processes and current psychological theory concerning mental imagery.

Hearing Journal recently asked a number of influential audiologists to name the "Best of 95" articles in the literature in a number of categories. For the category of "Rehabilitative Audiology," the "most thought-provoking" article was one written by **Carol De Filippo, Don Sims,** both from CRTL's Department of Applied Language and Cognition Research, and **Linda Gottermeier,** from the Center for Student Resources, on the efficacy of lipreading training. In the article, the authors examine the value of multisensory feedback (kinesthetic, motor, visual) in lipreading practice, finding that a key element in this type of training is the lipreader's perception of his or her own speech. For more information on this research, contact De Filippo at 585 475-6456 (V; 475-6268 TTY), e-mail cdfncp@rit.edu.

Supported by a federal grant, researchers from the Department of Educational and Career Research at NTID have been developing a computer-aided speech-to-print transcription system called C-Print. C-Print has been designed as a classroom support for deaf and hard- of-hearing students in mainstream educational environments.

The system uses a specially trained typist to transcribe classroom dialogue into a computer file for both immediate ("real- time") viewing and later use as a study tool, thus combining some of the characteristics of interpreting and note taking.

The C-Print system has been piloted in RIT classes, and experience with the system to date, including students' responses, will be summarized in an article to appear in the next issue of the *NTID Research Bulletin.*

Progress in hearing aid technology has recently resulted in a computer hearing aid that improves speech recognition and may allow more flexibility for fitting and also solve the problem of the squealing, acoustic feedback that plagues hearing aid users. However, deaf users may not benefit from the new technology. **Don Sims**, from CRTL's Department of Applied Language and Cognition, is working to help NTID students (and their audiologists) spend their hearing aid dollars wisely by modifying evaluation techniques to take advantage of this technology. However, some fundamental questions must be answered. First, does degree of hearing loss affect the students' perceptions of speech intelligibility with various hearing aid fittings? Second, will these differences in the students' perceptions be reflected in their ratings of the benefits of this new type of hearing aid? For more information, contact Sims at 585 475-6285 (V; 475-6268 TTY), e-mail dgsncp@rit.edu.

The 1996 edition of *NTID Papers & Publications* covers research in cognition; communication and language; culture; educational issues; post-secondary education and employment; reading, writing and speech; social processes; and technology and classroom applications. The final section covers recent books by NTID faculty. Copies of it are available on the CRTL Home Page at http://www.rit.edu/~490www, or by contacting Gail Kovalik at NTID, 585 475-5343 (V/TTY), e-mail glk9638@rit.edu.

The CRTL web site includes department and individual home pages; addresses, telephone numbers, and e-mail addresses of each CRTL member; and the texts of *NTID Papers & Publications 1996,* the *CRTL*

Newsletter, the *NTID Research Bulletin,* and an extensive bibliography on employment of deaf persons. Look for us at http://www.rit.edu/~490www.

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