Real-Time Closed-Captioned Television as an Educational Tool

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Mr. Block graduated from the Merchants and Bankers Court Reporting School in New York City in 1961 and has since been engaged in general and official court reporting. He is a past president of several court reporting associations and a Registered Professional Reporter. He has written several articles concerning real-time closed captioning for publication in court reporting journals.

Marc Okrand is the Manager of News and Text Services at the National Captioning Institute (NCI) in Falls Church, Virginia, where he supervises the closed captioning of ABC's World News Tonight and other live broadcasts. He is also responsible for NCI's text service, which provides news, sports, and program information to viewers with closed-caption decoders. Before assuming these duties, he supervised the closed captioning of numerous entertainment and educational programs.

Dr. Okrand received a B.A. in Linguistics from the University of California, Santa Cruz, in 1970 and a Ph.D in Linguistics from the University of California, Berkeley, in 1977. For several years, he taught linguistics at the University of California, Santa Barbara, and later was a postdoctoral fellow at the Smithsonian Institution in Washington, D.C. He also has a background in radio broadcasting.

October 11, 1982, was a historic day for hearing-impaired people. For the first time, a nationally televised news program, ABC's World News Tonight, was closed-captioned as it was occurring.

Real-time or live captions are written on a stenotype machine connected to a computer, which translates the stenotype shorthand into English words and formats the captions. The captions are then broadcast as part of the television signal, using the Line 21 system.

The National Captioning Institute has also used its real-time system to caption other live television broadcasts, such as space shuttle launches, awards programs, and news conferences.

As with captioning in general, real-time captioning provides an opportunity and motivation to improve reading skills. It also makes it possible for hearing-impaired people to be informed at the same time, and through the same medium, as everyone else. In addition, this technology offers a new approach to providing access to classroom lectures and discussions.

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To caption most television programs, captioners view the program several days before airtime; type captions corresponding to the dialogue; determine how long each caption should remain on the screen; check the captions to insure that they appear at a comfortable reading rate, are error-free, and convey the proper meaning; and have other captioners check and double-check their work.

To caption a live event—one for which there is no script—captions must be created instantly. There is no advance copy of the program to look at and no way to read the captions before they go on the air, much less check them even once.

Since the advent of the closed-captioning service in early 1980, the National Captioning Institute (NCI) has been working toward developing real-time captioning; that is, the ability to create and broadcast captions instantly, as an event is occurring: (For a history of the closed-captioning system, see Caldwell, 1981; and Cronin, 1980.)

By 1981, NCI was able to provide captions for such live events as President Reagan's inaugural address and subsequent presidential addresses. This live captioning was limited, however, because it depended on receiving an advance copy of the script. It was still not possible to caption live broadcasts for which no script was available.

In 1982, real-time captioning became a reality. In the early part of the year, real-time captioning was used for the acceptance speeches at the 54th Annual Academy Awards Presentation. In June the launch of the space shuttle *Columbia* became the first live news event to be real-time closed-captioned from start to finish (Figure 1).

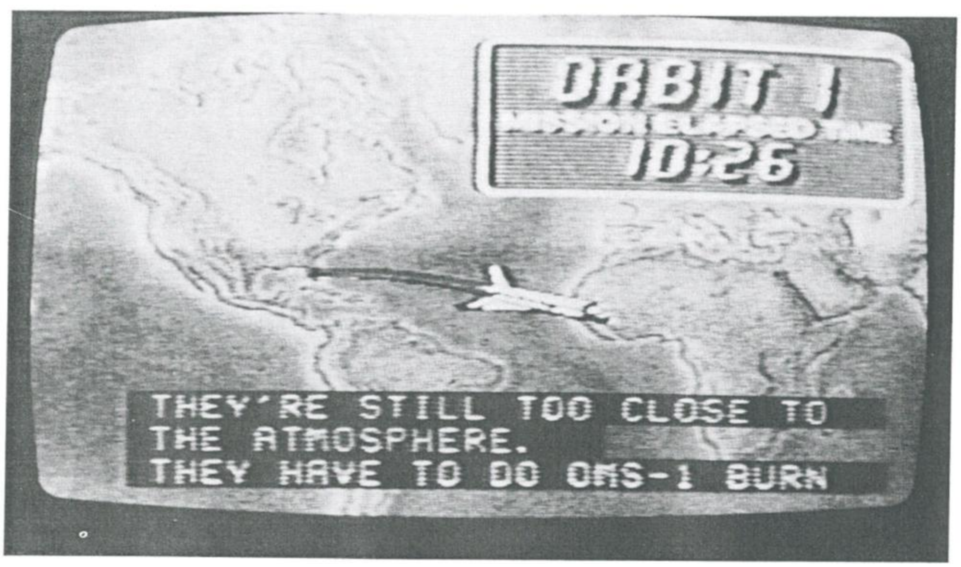

Figure 1. ABC's television coverage of the fifth mission of the space shuttle *Columbia* featured real-time closed captions.

The most significant event in the history of real-time closed captioning occurred on October 11, 1982, when a nationally televised news program, ABC's *World News Tonight*, was closed-captioned as it was being broadcast live. With funding from the U.S. Department of Education, NCI has continued to offer this service daily. ABC's early evening news program had been shown with open captions by the Public Broadcasting Service since late 1973. *The Captioned ABC News*, however, was not shown at the same time ABC broadcast the program; it was delayed to allow time to prepare the captions. As a result, most

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hearing-impaired viewers had to wait until 11:30 p.m. to view the captioned program. With the advent of real-time captioning, no delay is necessary. Hearing-impaired viewers can be informed at the same time, and through the same medium, as everybody else (Figure 2).

THE REAL-TIME CAPTIONING SYSTEM

Real-time captions are written on a stenotype machine, the kind used by court reporters to record legal proceedings. Instead of spelling out each word letter by letter, the operator of the stenotype machine uses a form of shorthand. The stenotype machine is connected to a computer system, which translates the shorthand into regular English words, formats these words into captions, and determines caption line length, placement, and other features.

For closed captions, the computer is connected to a Line 21 smart encoder, a device that adds the caption information to the television signal.

Among the early projects, striving for real-time conversion of the spoken word into printed text was one conducted by the Central Intelligence Agency (CIA). The CIA wanted a method to translate quickly into English, and then print, Russian language intelligence data. As translators translated the Russian into spoken English, the shorthand reporter would input the data on the stenotype machine. The output of the stenotype machine was fed directly to a large mainframe computer, where it was processed through a series of dictionaries matching stenotype outlines and their English equivalents. The mainframe then printed the English text.

Figure 2. A shorthand reporter prepares real-time captions for ABC's *World News Tonight.*

Out of the CIA project grew Stenocomp, a private concern marketing computer translation to court reporters. While the quality of the translation offered by Stenocomp was equal to or better than that offered by many contemporary computer translation systems, it was too cumbersome, because of its reliance on a mainframe computer, to be used successfully for real-time captioning.

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In the late 1970s, Stenocomp went out of business, but a new company developed, Translation Systems, Inc. (TSI), of Rockville, Maryland. Because of advances in computer technology, TSI was able to rewrite and install the Stenocomp software in a 128K Jaquard J-500 minicomputer. This allowed for more flexibility and a far less expensive system.

The TSI translation program is marketed as TomCat. It works by searching through three dictionaries that override each other on the basis of the order of the search.

The first dictionary applies exclusively to the job or case being translated. Data that are capable of being matched within that dictionary are translated and stored.

Shorthand reporters often develop unique abbreviations for high-frequency words and phrases. The second dictionary, a personal dictionary, contains these special entries. The personal dictionary is searched, and the data capable of translation are translated and stored.

The final search is made within the TSI universal dictionary, an enormous glossary of English words and names with various stenotype outlines reflecting different ways these words or names can be written on the stenotype machine. The data not translated during the searches of the first two dictionaries are translated by using the universal dictionary. Then everything is reassembled and output.

Within the TomCat software is a unique program used to resolve the problems caused by the existence of innumerable homophones in spoken English. Because stenotype is a phonetic system of shorthand, the tendency is to input these homophonous words identically. The TomCat system is capable of arriving at the correct word by relying on context. It will be correct about 90% of the time in normal court reporting applications.

Since technology had reached the stage where high-quality real-time translation could be produced on a minicomputer, applications beyond the traditional court reporting field became possible. Using computer translation for real-time closed captioning of live television programs was an obvious next step.

TSI developed InstaText, a program that uses the TomCat software for translation, and, in the case of NCI, formats the data for the Line 21 captioning system. TSI remains the only vendor offering a captioning system.

CHARACTERISTICS OF REAL-TIME CAPTIONS

Because real-time captions are being created live, their appearance differs somewhat from that of captions on programs for which a script is available.

Delay

There is a slight delay—just a few seconds—between the time a word is uttered and the time it appears on the screen. This delay occurs for two reasons. First, shorthand reporters cannot enter the word on the stenotype machine until they hear it. Second, the universal dictionary is too large to be loaded into memory on the 128K J-500 computer. The search must be performed on its 24-megabyte Pertec hard-disk drive, whose access speed introduces a slight delay into the translation.

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Ideally, the computer should take no significant amount of time to perform the translation process, and work is being done to eliminate this delay. TSI is marketing a new product, TomCat II, a translation system based on the popular IBM Personal Computer. TSI is looking toward rewriting its translation and captioning software for loading into upgraded memory on the IBM Personal Computer, or some other product, from a Winchester hard-disk drive, and virtually eliminating any delay in translation. In the meantime, special techniques are employed to diminish the delay.

Roll-Up Captions

Currently, most closed-captioned television programs appear with pop-on captions: The entire caption appears on the screen all at once, remains there long enough to allow adequate reading time, then disappears or is replaced by another caption. NCI's real-time captions, on the other hand, are roll-up captions: In a three-line caption, the first line is written letter by letter along the bottom of the screen. The entire line then moves up so that the second line may be written underneath it, then both move up so that a third line may be written. For another line to appear, the first (top) line disappears, the remaining two lines move up, and the new line is written along the bottom.

It is possible to debate the relative merits of pop-on and roll-up captioning in general; but for real-time captioning the pop-on format, though technologically possible, is not as desirable. Using pop-on captions would introduce even more delay. If the caption contained eight words, it could not appear until the computer had translated the eighth word. In the roll-up format, each word can appear as soon as it is translated.

Verbatim Captions

When a script is available, it is possible to control both the reading rate and the language level for the captions by editing the script. Whether such editing is desirable has been debated frequently (see Earley, 1980; Torr, 1980). For real-time captioning, however, all the arguments become academic. There is no script to edit. Real-time captioning must be verbatim. In practice, real-time captions are not completely verbatim. If the shorthand reporters do not understand a word or phrase, of if they know the computer will not translate a word properly, they make an on-the-spot edit—for example, writing "The Turkish Ambassador" rather than giving the ambassador's name. Similarly, to decrease the delay inherent in real-time captioning, certain nonessential lines might be omitted or shortened. in the news, a phrase such as "For that report, we go to Peter Jennings in Beirut" might be changed to "We have a report."

Reading Rate

Most closed-captioned programs currently on television have captions edited to a reading rate of about 120 words per minute. This was also the rate used for the open-captioned news broadcasts on PBS (Hutchins & Osterer, 1980). But just as real-time captions cannot be edited, their rate of presentation cannot be controlled. The shorthand reporter must keep up with the speaker and the faster the speaker talks, the faster the captions appear. Actually, there is an upper limit. The system can currently translate up to approximately 180 words per minute. The maximum rate for captions is likewise 180 words per minute. When a speaker exceeds this rate (which occurs frequently on *World News Tonight*), the delay between utterance and caption—but not the caption presentation rate—is increased.

Speaker Identification

In other captioned programs, the location of the caption on the television screen is often used to indicate who is speaking. With real-time captions, it is not possible to use this technique. Since the

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captions appear slightly delayed and the television picture is constantly changing, the caption could be located by the wrong speaker. As a convention, NCI has adopted arrows (>>) to indicate a change in speaker.

Accuracy

Unlike most of the graphics that appear on a TV screen and unlike the captions on other programs, there is no way to proofread or correct real-time captions. There will be an error if the shorthand reporter happens to hear a word incorrectly, hits a wrong key, or uses a shorthand notation that is not in one of the computer's dictionaries.

For the most part, errors are not misspellings, but a direct result of the computer translation program. For example, one shorthand form of *institute* is EUPBS TEU TUT. On the stenotype machine, this can be entered in three strokes (more than one key can be pressed down at a time): one for EUPBS, one for TEU, one for TUT. Since this set of three strokes is in one of the computer's dictionaries as *institute*, the computer will translate the word correctly. If, however, this particular three-stroke entry were not in a dictionary, the computer would try to make sense out of the first pair of strokes, the second pair of strokes, or each stroke individually. In this case, the computer might translate the three strokes as "insurance at this tut." EUPBS by itself is shorthand for *insurance* and TEU stands for *at this*. TUT does not have an English equivalent, so the computer leaves it untranslated—"tut."

For real-time captioning of news programs, names pose a particular problem. As inclusive as the computer system's universal dictionary is, it does not include the name of every person, place, or technological innovation that might be named in the course of a broadcast. If a special entry for the name is not made in the dictionary, it will not translate properly. For example, the name Ken Kashiwahara, an ABC News correspondent, might translate as "keen cashew what had a are a" or "keen cash what har regard." In fact, the computer's dictionaries contain thousands of entries to account for the many different legitimate ways to write various words in machine shorthand. In addition, as part of preparing to real-time-caption a program, names and other important words are added to the dictionaries so they will translate properly.

Nevertheless, no matter how much time and effort goes into preparation, it is not possible to foresee the future, and words will be said that were not anticipated. When this happens, there will be an error.

The number of errors depends on the skill of the shorthand reporter and also on the nature of the material being broadcast. The accuracy rate on the news—where correspondents speak quickly, switch from topic to topic, and never pause—generally is 95% or better. For press conferences and other live events, it has been as high as 99%.
To minimize the number of errors, NCI's shorthand reporters regularly revise the computer dictionaries, adding new entries and altering old ones so that previous errors do not occur again.

APPLICATIONS OF REAL-TIME CAPTIONING

In addition to the daily captioned broadcasts of ABC's *World News Tonight*, NCI has used real-time captioning for a number of televised news conferences, speeches for which no advance scripts were available, and special news bulletins. Expanding on its earliest real-time efforts, NCI has also provided real-time captions for the acceptance speeches for the 34th Annual Emmy Awards program in September 1982, as well as for the launch and landing of the space shuttle's fifth mission in October.

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Audience reaction to real-time captioning has been extremely favorable. Most of the mail NCI receives which mentions real-time captioning expresses thanks for making it possible for hearing-impaired people to participate in live events, and it requests that the real-time captioning service be expanded.

Real-time captioning, of course, is not limited to over-the-air broadcasts. In a classroom, it can be used to caption videotapes or uncaptioned live television programs. In a situation where communication is by voice only, the same technology can be used to generate full-screen texts. In 1982, the system was used in the Supreme Court to allow a deaf attorney to read what the justices and other attorneys were saying. At NTID, a real-time graphic display is being used to provide instant texts of lectures and classroom discussions (Stuckless & Hurwitz, 1982.)

EDUCATIONAL AND SOCIOLOGICAL IMPLICATIONS

The educational and sociological implications of closed-captioned television have been pointed out many times (see Caldwell, 1981). Stepp (1981) cites vocabulary development, the opportunity to observe good sentence structure, and motivation for reading as three important educational benefits. He notes that captioned television can also bring about a better-informed deaf citizenry.

Now that real-time captioning is available, the benefits of captioning have dramatically increased. It is possible to watch live news while it is still news and to witness current events while they are still current. Television's potential to educate and inform, as well as to entertain, is finally available to hearing-impaired and hearing persons at the same time.

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