

**Line 21:**

**Closed Captioning of Television Programs—**

**A Progress Report  
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Utilization of Educational Media  
for Teaching the Deaf**

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**By**

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## Introduction

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According to the 1978 *Television Fact* book there are over 129,400,000 television receivers in use in the United States. In spite of the ubiquitousness of television receivers and the vast amount of programming available, the hearing impaired are largely deprived of the educational and cultural, as well as downright escapist entertainment, programs available to the rest of us. With the exception of some sports events, the sound portion of the program carries a significant portion of the intelligence so that without it the program cannot be enjoyed.

The hearing impaired can be served to a limited extent by the addition of subtitles or “open captions” to programming, an excellent example of which is the *Captioned ABC Evening News* produced by WGBH, Boston, and transmitted nightly over the Public Broadcasting Service Interconnection. Open captioning of all programs, however, becomes annoying to viewers with normal hearing. Fortunately, the television system has the technical capacity to provide “closed-captions,” that is the ability to transmit and receive captions or informational text materials on specially equipped television receivers without in any way interfering with the performance of conventional receivers and thus not annoying those who do not need or wish to make use of the captioning service. Although the television picture is constructed of 525 lines, the first 21 lines (called, collectively, the “vertical interval”) in each image field are blank to allow for necessary transmitter and receiver picture synchronizing functions to take place. Some of these blank lines can be used to transmit data in many forms, including captions. Because these lines normally do not appear on the home television screen, the coded information contained on them can only be seen when converted to “visible” images by some decoding device. Because PBS has selected Line 21 for caption data transmission, the last line before the start of the regular transmitted picture, the PBS closed-captioning system has come to be known as the “Line 21 System.” Using a concept originated by the National Bureau of Standards (NBS) for precise time signal dissemination by television stations during the vertical interval and adapted by the American Broadcasting Company (ABC) for closed-captioning, ABC-TV and NBS cooperatively demonstrated the application at a National Conference on Television for the Hearing Impaired, sponsored by the University of Tennessee in Knoxville in December 1971. The response to this and a subsequent demonstration at Gallaudet College in Washington, D.C., in February 1972 was most favorable and led to the U.S. Department of Health, Education, and Welfare’s (HEW) interest in funding the development of such a system. This led to the establishment in February 1973 of the “Closed-Captioning Project” at the Public Broadcasting Service under funding from HEW’s Office of Education, Bureau of Education for the Handicapped.

Following a period of technical experimentation and field tests with the NBS and a competing system for closed-captioning developed by Hazeltine Research, Inc., as well as the development of closed-caption editing and production techniques at PBS under the direction of Doris Caldwell, PBS petitioned the Federal Communications Commission (FCC) in November 1975 for approval of the closed-captioned transmission system based on a modified version of the NBS system. On December 20, 1976, the FCC released a Report and Order effective March 1, 1977, amending its Rules and Regulations to permit use of the PBS proposed system. With the clearing of these experimental and regulatory hurdles, there remained a formidable series of tasks necessary to implement a full closed-captioned program service. With continuing funding from HEW, PBS is engaged in a four-part project to implement a design program in time for the fall 1979 programming season. The four parts are:

1. Development and construction of a caption editing programming console.
2. Development and production of mass-produced home decoders.
3. Adaptation of the film process to Line 21 closed captioning.
4. Development and implementation of an information service for the hearing impaired using the Line 21 facilities.

The remainder of this paper will deal with a progress report on each of these vital projects.

## **The Caption Editing Console**

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Since February 1974, PBS has been transmitting first an experimental and now an Interim Closed-Captioning Service (funded since September 1976 by a grant from the Corporation for Public Broadcasting) over the PBS system. Although we only transmit about two hours of such programming a week to service a handful of NBC decoders in the field, the original computer-based caption editor used by Doris Caldwell and her staff is strained to full capacity. Therefore, we are developing a modern, sophisticated editor, which includes its own microcomputer and all the necessary support systems, cassette tape player, time code reader, light pen text assembler, and keyboard entry, to provide in a single desk-console the tools for rapid and efficient caption production. The first system is undergoing tests by PBS engineers, and it will be turned over to the captioning staff on May 1 for a first experimental "shakedown cruise." After incorporation of the changes resulting from this experience, the system will then become available for both captioning and training. Seven more Caption Editing Consoles are scheduled for completion by September 30, 1978, increasing the present closed-caption programming capacity at least eightfold when this equipment becomes operational.

## **Development of Mass-Produced Decoders**

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The original NBS decoders were both cumbersome and expensive. Prior to the days of integrated circuits, they would have remained so. Integrated circuits use photographic-like production techniques to process specially treated silicon crystals into miniature "chips" which may contain literally thousands of individual transistors, electronic wiring, and components. Perhaps the most well-known applications of integrated circuits are the popular electronic calculators, which perform complex mathematical functions beyond the power of the best mechanical calculating machines, can be carried in a pocket, and at a fraction of the cost of the older machines.

In order to take advantage of this technology, PBS has contracted for the development of a commercial decoder suitable for mass production that could be used by the general public for the reception of closed-captioned television programs. To date, the contractor has successfully demonstrated a prototype decoder unit and work is proceeding on the tooling of the integrated circuits. When these are completed, it is expected that decoders will be made available in several forms including:

1. An RF Adapter Unit

This will be a wholly freestanding, separate unit that will require only connection to the antenna terminals of any standard home television receiver to convert the receiver to closed-caption decoding.

2. A Video Adapter Unit  
This will also be a wholly separate unit that will perform the decoder function in conjunction with a commercial TV receiver, which has been modified during original manufacture to have special signal input, and output plugs available.
3. An IC Kit or Module  
This will be a kit of integrated circuits or a decoder module board that can be used by a commercial TV receiver manufacturer to incorporate the decoder function into new home receivers during original manufacture.

The current PBS schedule calls for availability of RF adapters by the fall of 1979. The video adapter and complete decoding TV receiver schedules have yet to be determined pending discussions with receiver manufacturers.

Before leaving the subject of the home decoder, a brief discussion of the font used in the home television captions display is appropriate. Unlike the lettering used in titles or open captions broadcast by television stations, which are generated by expensive special equipment, the font used in closed-captioning must be generated at the home receiver, and constraints of cost limit its flexibility. For those, however, who after viewing some computer video terminal displays, are concerned about the captioned character appearance, the decoder under development will have the capability of reproducing both upper- and lowercase, italics, underlining, and special symbols, such as musical notes. By means of an electronic technique known as "character rounding," a more graceful, less mechanical character appearance is achieved. The system also has the capability of displaying characters in six colors in addition to white. This last feature will not be available in the first RF Adapter units.

## **Adaptation of the Film Process to Line 21 Closed Captioning**

Videotape production techniques have lent themselves readily to the Line 21 closed-captioning system. The Line 21 data signal itself can be recorded on the videotape, and if this is done, no further processing is required to air a closed-captioned program. Even where a so-called double system is used (captions supplied from a separate medium running simultaneously with the program master), videotape provides the necessary automatic synchronizing information to properly time the captions to the original program. While at the present time, the film medium does not have the capability for either of these systems, PBS believes that appropriate methods can be developed for the use of film in closed-captioned programming and is in the process of issuing a study contract leading to such a development.

## **Development and Implementation of an Information Service for the Hearing Impaired Using the Line 21 Facilities**

The capacity of the Line 21 system is greater than that actually required to provide a normal captioning service. The PBS system is capable of transmitting written text at a rate of over 550 words per minute. About 20 percent of this capacity is used to transmit a captioned program. In addition, many programs, such as concerts, do not lend themselves to captioning, and it is obvious that the dead spots between individual caption transmissions or between captioned programs may be used to transmit other information of interest to the hearing-impaired community. Decoding equipment, which is expected to be available in September 1979, has the capability of displaying, selectable by a switch, the captioned program service or a time-shared information service. PBS intends, with the start of the major closed-caption programming season, to provide a news and other hearing-impaired community interest service via this information channel. The extent of this service will depend on the level of funding which can be obtained.

## Conclusion

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After many years of experimental and preparatory work, it appears that the necessary combination of closed-captioned transmission system, programming, and a practical home decoder can be brought together in the fall of 1979. Let us hope that this will signal the end of the exclusion of the hearing impaired from this significant part of our social and cultural life.

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