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ABSTRACT

VIDAC (Video Audio Compressed), a new technology based upon non-real-time transmission of audiovisual information via conventional television systems, has been invented by the Westinghouse Electric Corporation. This system permits time compression, during storage and transmission of the audio component of a still visual-narrative audio presentation by a factor of 480:1. The Westinghouse Electric Corporation in close cooperation with the Veterans Administration and a number of other State and Federal agencies conceived and implemented a ten-week feasibility study of a central library medical information delivery system for rural users utilizing the Applied Technology Satellite (ATS-6) transmission facilities. Technically, the VIDAC protype system proved feasible for further development, and viewer evaluation indicated that users were highly positive about VIDAC and felt that it filled a specific need for improving the delivery of educational materials. Three schematic drawings illustrate the method used for compression. A 16-item bibliography is included. (Author/DS)

V/I D A C

A NEW TECHNOLOGY FOR INCREASING THE EFFECTIVENESS OF TELEVISION DISTRIBUTION NETWORKS

R E P O R T

ON A FEASIBILITY STUDY OF A CENTRAL LIBRARY "INTEGRATED MEDIA" SATELLITE DELIVERY SYSTEM

September 8, 1975

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Robert B. Wiltshire

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I. SUMMARY

A new technology based upon non-real-time transmission of audio-visual information via conventional television systems has been invented by the Westinghouse Electric Corporation. Called VIDAC (Video Audio Compressed), the new system permits time compression, during storage and transmission, of the aural component of a still visual-narrative audio presentation by a factor of 480:1. Generally, the combination of visual and aural components in this study averaged time compression of 193:1.

Prototype equipment has been developed to permit program conversion, storage and high speed transmission utilizing standard NTSC television facilities. A special terminal buffer has also been constructed which permits remote program selection, storage and real time display of the compressed information at viewer/user locations.

The Westinghouse Electric Corporation, in close cooperation with the Veterans Administration and a number of other State and Federal agencies, conceived and implemented a short term feasibility study, which took place between November 27, 1974 and February 18, 1975, of a novel central library medical information delivery system for rural users utilizing the Applied Technology Satellite [ATS-6] transmission facilities. The ten week study afforded a unique opportunity to analyze both the operational and technical conduct of a prototype network utilizing state-of-the-art technology to enhance the transmission capacity of conventional real-time television network facilities.

An attempt was made to determine the potential applications for an "on-demand", user-controlled high speed delivery system capable of providing rapid access to a large central library of "integrated media" containing textual "hard copy" as

well as conventional audio-visual material. The technical portion of the experiment was addressed primarily to verifying results obtained in prior tests conducted with the Georgia State Department of Education and assessing any special conditions which would be imposed upon a prototype system because of the characteristics of satellite television communications.

A novel approach to the transmission and distribution of hard copy text material utilizing VIDAC technology was attempted during several of the scheduled transmissions and initially proved successful enough to warrant further development.

Technically, a VIDAC prototype system proved feasible for further development. When used in conjunction with satellite communications equipment, it experienced no major interface problems and functioned within the tolerance limits of NTSC television standards.

Viewer evaluation indicated that users were highly positive about the VIDAC delivery system and felt that it filled a specific need for improving the delivery of educational materials. A VIDAC-based system would be an acceptable means for providing audio-visual material to remote users with a requirement for rapid access to a large selection of titles. Though it was not possible to statistically predict what mode of operation would be used or preferred most often, it would appear that both "continuous" and "selective" viewing at terminals close to work stations would be used to enhance work skills.

The system seemed to have particular immediate application as an abstracting service for medical audio-visual materials, enabling professionals to quickly review programs of interest. It also could be used for delivery of pre-packaged patient education programs which would be user selected and made available as required.

Library-stored materials can be quickly re-edited at a central source which would help eliminate the problems associated with inventorying large amounts of non-current materials.

Reduction of inventories would also enable small local libraries to provide rural users the same services presently being provided to urban residents by large metropolitan libraries.

Although the overall demonstration was not structured to provide detailed data susceptible to rigorous analysis for subsequent decision making, results obtained from both the technical and operational components of the study indicate that the technology may provide significant opportunity to create a new method for enhancing aural-visual communication channel capacity. In addition, the concept employed may have important future impact on the cost-effectiveness of library storage and distribution of integrated (audio/visual/hard copy) media.

II. INTRODUCTION

A. BACKGROUND

In 1971, George F. Newell, then a member of the staff of the Westinghouse Research Laboratories, invented a system for compressing the transmission time of the aural information which normally accompanies the visual portion of a television broadcast and which occupies the FM sound channel of a conventional NTSC television broadcast channel. The technology is based upon a bandwidth-time exchange -- in that the relatively slow real-time transmission of the aural component, which is achieved by conventional frequency modulation of the aural carrier, can be greatly increased by conversion of the baseband audio information into video information susceptible of transmission via the video channel.

The increased bandwidth available in the visual channel (4.2 megaHertz versus 15 kiloHertz) permits the transmission of much larger amounts of information (higher information rate capability). Therefore, the visual channel can accommodate large time-blocks of audio information if the audio is processed to become a video signal. In order to make the transformation, it becomes necessary to alter the time base of the aural component; decreasing the time inversely proportional to the desired increase in bandwidth. If the full audio basebandwidth (15 kHz) were to be accommodated within the video channel, a maximum time compression of 280 would result when the full (4.2 MHz) bandwidth of the video spectrum is utilized. Reducing the aural base bandwidth permits even greater time compression; a reduction to 6 kHz, suitable for voice quality reproduction and most music, would permit a compression of 700:1.

However, since the synchronizing information also contained within the video channel occupies about 25% of the total transmission time, a 525:1 compression would be a maximum limit. In practice this has been reduced to 480:1.

The transmission compression is achieved by time multiplexing the conventional video information (visual component) and the video information consisting of the compressed audio (aural component) into a sequence of unique video frames[1*] which comprise the complete audio-visual presentation. Reference to Fig. 1, which is a simple motion picture film analogy of the process, greatly simplifies understanding. Each of the frames containing visual imagery (optical frame) compares to a slide in a conventional slide/tape presentation. The aural component of the lecture is contained within the sequence of aural frames which are interspersed with the optical frames to form the complete presentation.

The NTSC[2] television system requires transmission of 30 video frames per second in order to overcome flicker and to produce smooth continuity of motion. When the visual image contains no motion, all of the video information necessary to create a picture on a television screen usable for human interface is contained within the first unique TV frame. The remaining frames transmitted at a 30 frame/second rate serve only to replenish the visual image at the receiving location. The replenishment function can be accomplished by using a storage device at the receiver which repeats a single frame at a 30 frame/second rate to simulate normal transmission. It becomes readily apparent that the VIDAC system permits transmission of only one frame, which can be transmitted in 33 milliseconds, to convey a picture suitable for human interface.

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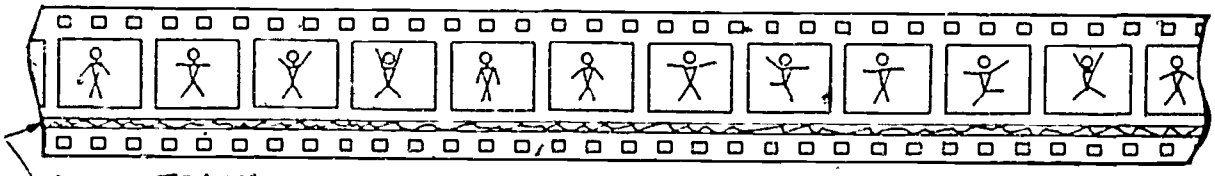
*All footnotes in this chapter are contained in the "technical footnotes" at the end of this chapter.

MOVIE FRAMES

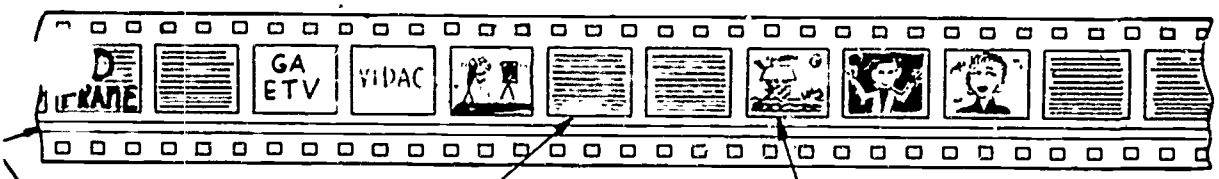
← 24 FRAMES PER SECOND →



AUDIO TRACK

VIDAC FRAMES DURING STORAGE & TRANSMISSION & ACQUISITION BY TERMINAL BUFFER

← 30 FRAMES PER SECOND →



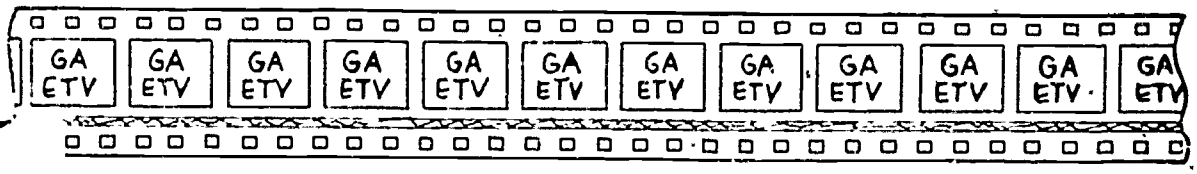
AUDIO CHANNEL NOT USED

AUDIO FRAME CONTAINS 16 SEC. OF AUDIO

VISUAL DISCUSSED BY PRECEDING AUDIO FRAME

VIDAC FRAMES DURING VIEWING ON TV SET USING TERMINAL BUFFER

← 30 FRAMES PER SECOND →



SOME OF AUDIO IN FIRST AUDIO FRAME

FIG. 1

Dubbed VIDAC (VIDeo Audio Compressed), the system makes use of a magnetic disc as a storage device at the receiver location to perform not only the replenishment function but also to store the time compressed audio frames as well. In combination with appropriate electronics, the magnetic disc assembly comprises a self-contained terminal station (buffer) which interfaces the non-real-time audio-visual transmission to the real-time requirements of the viewer. In addition to the storage function, the terminal buffer incorporates dial-up retrieval of the desired program from a large library of compressed programs; appropriate decoding of the aural frames; and remote control of user commanded functions such as program start/stop; pause; re-set; acquire; and delete.

B. DESCRIPTION OF BASIC VIDAC SYSTEM

The simplest operating system consists of:

(a) program converter
(b) tape recorder/player (library)
(c) transmission network
(d) terminal buffer
(e) conventional NTSC color television receiver

In normal use, the program converter is required only to convert the audio-visual sequence into a compressed audio plus video format which is then, for all practical purposes, a conventional video sequence and is capable of being stored on video tape in a classical manner.[3] Once this function has been completed, the program converter is no longer required for accessing and replaying the converted program. Since the compressed audio-video (VIDAC) program is stored on much less video tape[4] than conventional video, a large number of programs can be stored on one reel of tape; each identifiable by means of the digital codes inserted, during conversion, at the beginning and end of each program.

The converted audio-still video programs are stored sequentially on standard quad video tape[5] and are mechanically transportable in the tape format which can be circulated as self-contained libraries. Nearly 900 fifteen-minute programs[6] can be stored on a one-hour reel of tape which is handled and used conventionally.[7] Compressed tapes can be duplicated by standard processes and would suffer the same deteriorations as normal video with each succeeding generation.

When the compressed tape is played, it will create standard, real-time video signals which, although unsuitable for human interface, are machine compatible and can be treated like ordinary baseband video. The signals when displayed on a television monitor are a series of unique frames containing a sequence of optical and compressed aural information, none of which is repeated; each is visible for only 33 milliseconds. In this format, the audio component has been encoded to a first level and is secure.

Normal NTSC distribution networks will suffice to carry the compressed audio-visual material to terminal buffers for program selection, storage, decoding and playback.[8] The simplest such network is a passive coaxial cable interlinking the tape player (library) with a minimum number of terminal buffers. Obviously this facility suffers the usual problems associated with baseband distribution systems and is limited to in-house monitoring or very small installations for carrel use, where the tape player and terminal buffers are in close proximity.

At the other extreme, the use of a satellite in synchronous earth orbit has the capacity to service thousands of terminal buffers in a geographic area nearly as large as one-third of the world. In either case, only one tape player (library) is required[9] but the number of terminal buffers served varies directly as the capacity of the network for interconnecting them to a central library. Let us regard the link from the

central library (tape) to the remote point of use (terminal buffer) as a primary transmission network. Interconnection from the buffer to the television receiver (viewer) may require additional distribution facilities.[10]

The present experimental terminal buffer design incorporates two reception, storage, and playback channels, and utilizes both sides of a 16-inch magnetic disc. Depending on the length of programs to be stored (total number of frames), each side of the disc can accommodate a maximum of four discrete channels, each acting independently of the others.[11] A number of combinations is therefore possible — ranging from a single channel utilizing both sides of the disc, which is capable of storing 960 discrete video frames, up to eight channels each storing 120 frames. Separate electronics associated with each channel permit independent user control and widely separated viewing locations.

The distribution facility necessary to interconnect the viewing/control locations with the terminal buffer may be considered a secondary network. It may consist of a passive coaxial cable system operating at baseband (small installations) to a multi-channel RF distribution system (CATV/CCTV) providing service to an entire metropolitan community, which could include literally thousands of viewers. The considerable range of complexity among the various combinations of primary and secondary distribution networks points up the modularity inherent in the central library/buffer concept and emphasizes the need for adequate planning which is required to achieve optimal and cost-effective utilization.

The buffer serves as a locally controlled system terminal and interfaces between the high speed, non-real video information contained within the central library and the remote viewer operating on real time. Conceptually, it was decided that control of the program selection and playback would be a user function. Accordingly, provision has been made for the following buffer controls which may be operated either at, or

remote from the buffer location:

(a) Program selection (digital identification)
(b) Program retrieval (acquisition)
(c) Start/Stop
(d) Program Pause (Interrupted Audio)
(e) Reset and Recycle

Other control functions permitting discrete frame fast forward/reverse have been designed but were not implemented in the research prototypes.

Since each of the viewer channels is independently controllable[12] either locally or remotely; can be viewed individually or can be adjusted to provide signals to large audiences remote from the buffer itself; and may be preset for either single play or fully automatic operation (continuous replay), the potential for creating a large diversity of operating systems becomes quickly apparent.

C. PURPOSES OF THE STUDY

The purposes of the study were manifold — namely —

(a) to assess the needs for a "user-controlled" educational delivery system for professionals and para-professionals in an operating hospital ambiance
(b) to determine the operating (or functional requirements) of, and the user attitudes toward, a non-structured source of tutorial audio-visual materials
(c) to analyze the problems, if any, inherent in converting available audio-visual material to the VIDAC format and the associated creation of a close-packed tape library
(d) the accumulation of on-site technical data to identify any anomalies in the complete trans-

mission path from compressed library to remote viewer location

(e) to prove the feasibility of transmitting "hard copy" textual material in the VIDAC format as an adjunct to the aural-visual tutorial material

(f) identification of any technical or operational factors which were directly related to satellite technology

The Westinghouse Electric Corporation produced prototype equipment utilizing the VIDAC compression principle in order to demonstrate technical feasibility under a joint development contract with the Georgia Department of Education and the City of Atlanta Public Schools. Due primarily to the rules of the Federal Communications Commission affecting experimental broadcasts during normally scheduled hours and the tight daytime scheduling of the Georgia ETV network it was not feasible to transmit VIDAC material except during very short station breaks at irregular intervals.

The short breaks prohibited the broadcasting of reasonably large segments of related audio-visual material. Consequently it was not possible to test the validity of a remote user-controlled, central library, distribution system with any meaningful degree of continuity.

Technical field tests also indicated several areas that required further investigation — some of which were concerned with program conversion and the attendant transfer to tape storage. Moreover, since most of the reception locations used during the Georgia experiment were well within Grade A coverage of the broadcast transmitters, a meaningful test of the reliability of low signal level reception had not been performed.

The ongoing Veterans Administration satellite experiments, conducted under the Exchange of Medical Information program, which used the facilities of the ATS-6 satellite provided a test-bed which met nearly all of the criteria for a comprehensive test of

the VIDAC "integrated media" concept and the technical performance characteristics of a truly long range distribution system.

Since Westinghouse had already deployed field personnel in Georgia in conjunction with the Georgia Department of Education experiments, it was indeed fortuitous that one of the participating Veterans Administration (V.A.) hospitals was located in Dublin, Georgia, approximately 140 miles southeast of Atlanta. From a technical perspective, the location of the Dublin V.A. Center, at the southern edge of the ATS-6 elliptical eastern footprint, created the probability of lower than normal receiver signal levels and the attendant opportunity to analyze the lower limits of VIDAC signal usability.

Most important, however, was the opportunity, engendered by the unstinting cooperation of all agencies involved, to create a meaningful test of the potential for a novel distribution system for audio-visual training materials. Although the field tests were to be conducted for only ten weeks — and unfortunately to be interrupted by the Christmas-New Year holiday season — it was deemed that sufficient first order information was to be collected so that the merits of a longer follow-on phase would be determined at least cost.

D. AGENCIES INVOLVED IN THE STUDY

The following agencies were involved with the Westinghouse Electric Corporation in testing the concept of a central library, non-real time, medical information delivery network:

(a) The Veterans Administration provided the on-site facilities and personnel at its hospital in Dublin, Georgia, and participated in the use of the received tutorial information.

(b) The National Medical Audio-Visual Center [National Library of Medicine - HEW, Atlanta, Georgia] was responsible for providing and/or obtaining the audio-

visual material used in the study. Staff engineers and equipment were supplied by NMAC to the Georgia ETV Network to aid in program conversion.

(c) Georgia Department of Education through its Educational Television Network facilities in Atlanta performed all of the program conversions into the VIDAC format and the computer controlled assembly of compressed programs into the final tape library.

(d) The Foundation for Applied Communications Technology [FACT] — producers of the Veterans Administration's Exchange of Medical Information (EMI) experiments — coordinated the transmission of the VIDAC sequences and had the overall responsibility for the combined Teleconsultations-VIDAC broadcasts.

(e) The Atlanta Area Technical School, Atlanta, Georgia, provided the audio engineering personnel required to review the source material and encode the audio narrative for VIDAC compatibility.

(f) Personnel of the Southern Bell Telephone Company assisted in the conversion of textual "hard copy" into teletype signals suitable for VIDAC conversion and, subsequent to the transmission experiments, provided facilities to convert VIDAC - TTY signals into hard copy text.

(g) The Center for Educational Technology of the Florida State University provided the expert personnel to monitor the on-site activities in Dublin and to evaluate the conduct and results of the study.

(h) The technical staff of the Rocky Mountain Federation provided facilities and personnel for the initial investigation of VIDAC - satellite compatibility.

The study was conceived and organized by Mr. Henry M. Diambra, a consultant to the Westinghouse Product Design Laboratory; he was responsible for its conduct and management.

FOOTNOTES to Section II

1/ For ease of comprehension, reference is made throughout this paper to VIDAC optic and aural frames. Technically, the aural compression is achieved by creating video information for each horizontal line scan by a sampling and encoding process which results in an analog video signal having a normal NTSC bandwidth. The active portion of each line scan contains 33 milliseconds of audio information having an upper frequency limit of 4.5 kHz, which is converted to a video signal having an upper frequency limit of 4.2 MHz. Each aural VIDAC frame thus created contains 16 seconds of baseband audio information plus coding signals which identify each line scan as a VIDAC signal. A time compression factor of 480:1 (16 secs/33 millisecs) is achieved in each VIDAC aural frame.

When the video channel is fully occupied only by aural information, i.e. each frame contains only VIDAC compressed audio, the total transmission time is reduced by a factor of 480:1 and maximum time compression is achieved (a 1 minute transmission would contain 8 hours of baseband audio information).

For every video frame included in the sequence which contains optically usable information (still picture) a reduction of 16 seconds of baseband audio occurs during a finite transmission time. As an example — should the number of optical video frames equal the VIDAC aural frames, the effective time compression of the aural information has been reduced by a factor of 2 -(240:1).

2/ The NTSC television system (National Television Standards Committee) is the system presently in use throughout North America and certain other countries throughout the world.

Other color television systems used primarily in Europe are PAL (phase alternation, line) and SECAM (séquentiel couleurs a memoire) which employ other scanning standards. The VIDAC compression technique has been designed for NTSC (525 line - 30 frame) broadcast compatibility, but is adaptable to other systems.

3/ The program converter accomplishes the necessary audio to video conversion by use of suitable analog-digital-analog (A to D - D to A) converters which provide the appropriate time base modification. Additionally, the composite unit provides a means of intermixing the optical and aural frames in an appropriate sequence to provide the final arrangement of transmittable information. Conventional NTSC line and field synchronizing information, VIDAC encoding data and decoding instructions, frame identification and other specialized data are provided by the program converter during the conversion and assembly process. The final VIDAC compressed video information is temporarily stored on an internal magnetic disc. Internal auditing and monitoring circuits permit checking the conversion for any malfunctions prior to transferring the converted sequence to video tape. Final storage of the finished VIDAC conversion is on video tape and the program converter permits the synchronized transfer to tape using standard broadcast editing techniques.

4/ The composite time-sequential mixture of optical and aural frames, together with appropriate program identification codes, constitutes a complete VIDAC program. The effective time compression of the composite program is a function of the number of optical vs aural frames and thus varies from a maximum of 480:1 (no optical information) to 1:1 (no aural information, only conventional video). Generally, utilizing available educational film strip or slide/tape presentations as source material, the effective overall compression ratio might average 240:1. Thus, a 30

minute narrative (113 frames) coupled with 113 visuals (113 frames) constitutes a 226 frame sequence having a total transmission or tape storage real time of 7.5 seconds (226 x 33.33 ms). A normal 30 minute television production would require 2250 ft. of quad tape (30 min x 15 ips x 60/12) whereas the same VIDAC compressed program would require only 9.38 ft.

5/ The VIDAC development program to date has been addressed primarily to NTSC broadcast compatibility. Generally speaking, quad tape machines are predominantly in use by nearly all commercial and educational broadcasters. Since helical VTRs with much improved time-base correctors are becoming broadcast acceptable the Westinghouse Research Laboratories has initiated a design program to permit either quad or helical tape storage of the VIDAC compressed information. Design problems to be overcome include poor time base stability, line drop out and skew.

6/ Assuming that each 15 minute program (56 aural frames plus 4 code frames) includes 60 visuals (60 optical frames) the total sequence would be 120 frames. Total transmission (or tape storage) time would be 4 seconds. Assuming that computer controlled close editing permits packing maximum density on a one hour reel of tape, total storage would be 900 programs. In practice, the maximum would be closer to 875 programs.

7/ The tape-stored VIDAC information is essentially baseband video and can be processed routinely as such. Dubs, edits and other post production techniques can be accommodated conventionally, except that decoding of the aural frames requires the in-house use of a program converter or terminal buffer.

8/ A self-contained terminal buffer installation would include a suitable RF television receiver for either off-the-air or cable system reception. Baseband video networks are not recommended because of the practical difficulties

involving equalization, hum and switching. An aural channel, either at RF or baseband, is not required since the information is totally within the video channel.

9/ Library size will vary based upon the informational needs of the varying audience size. However, the library will remain geographically centralized with respect to the users and therefore permits a more cost-effective electronic delivery system to be designed.

10/ After decoding the VIDAC program material, the terminal buffer provides baseband audio and video information for each of the buffer channels. Local interconnection of broadcast monitor facilities requires only single cable connections. In order to utilize conventional color TV receivers, the baseband information must be used to appropriately modulate standard VHF or UHF signal sources. Conventional MATV or CATV distribution systems suffice to provide secondary distribution to remote receivers.

11/ Geometric considerations limit to 4 the maximum number of independent channels which can be accommodated on each side of a 16-inch magnetic disc. 480 frames are the maximum number which can be stored on one side of the disc. Therefore, the system permits a certain modularity within these limits.

12/ Independent electronics and controls associated with each buffer channel permit considerable freedom of usage. For instance, new material may be acquired on one or more channels, while other channels are in the playback or idle mode. Program selection, start/stop, reset, and pause functions can be designed for local or remote control and, using external switching, can be arranged for selective routing to create a "distributed carrel" system.

III. PROCEDURE

A. GENERAL

Due primarily to the unavailability of prototype VIDAC equipment at the commencement of the planning for ATS-6 communications experiments, it was not feasible to organize full scale "compressed central library experiments" until long after the satellite operational schedule had been firmed. Consequently the only remaining opportunity lay in "piggybacking" a modest experiment onto an on going Veterans Administration (V.A.) series of Medical Teleconsultations, which afforded only two minutes of available time during a station break. The broadcasts were scheduled weekly and, therefore, provided an opportunity for VIDAC "central library" transmissions to be received on a regular basis. The schedule was to be maintained for ten weeks commencing in November 1974.

Westinghouse assumed responsibility for conducting the experiment and also for evaluating the technical aspects. Florida State University, through personnel assigned by the Center for Educational Technology, agreed to evaluate the delivery system/user interactions, the system functional performance and the user attitudinal responses.

B. EXPERIMENTAL DESIGN

The needs assessment of the Dublin V. A. hospital staff was conducted both by a review of their on-site television distribution facilities and discussions held with the Chief of Medical Services and the training directors. Consideration was given to the library size which could be created in the short

time span available and several categories of tutorial information were chosen, namely:

(a) Cardiology
(b) Transfusions
(c) PH Regulation.

The National Medical Audio Visual Center (NMAC) provided the specific lesson material after submitting a list of available audio-visual program titles to the Dublin staff for approval.

The V. A. had made available a two-minute interval during the satellite broadcasts of the Teleconsultations series for the purpose of the VIDAC study. Based upon data accrued from earlier studies involving the Georgia Department of Education, an effective compression ratio of 240:1 was assumed, which limited to 8 hours the maximum audio-visual expanded time for each two-minute VIDAC compressed transmission. Earlier examination of a sampling of medical audio-visual material indicated an average program length of 20 minutes, limiting the maximum library content to 24 audio-visual programs for each two-minute VIDAC transmission.

It was determined that a library of 33 program titles would satisfy the needs assessment and provide sufficient choice of program material to develop a meaningful audience size. However, because it had already been determined that the two-minute transmission time could handle only a maximum of 24 programs, two separate libraries, containing 17 and 16 programs respectively, had to be created. This introduced an artificial barrier to the concept of unlimited choice, since it forced viewers to specify in advance which library contained the desired program. The library chosen for transmission in a given week was that containing the greatest number of requested programs. In practice, this meant that some user choices had to be deferred for a full week or more. Inventories of both libraries are contained in Appendix A.

The basic tutorial material; consisting of commercially available color slides/film strips with audio tapes, was con-

verted to a VIDAC format after suitable VIDAC audio cues were recorded. A separate color camera chain, remote controlled slide and film projectors, and needed accessories were assembled at the Georgia ETV Center. A staff of engineers from NMAC, Georgia ETV, Westinghouse, and Atlanta Area Technical School performed the necessary VIDAC conversions using a prototype VIDAC program converter and the ETV network computer-controlled editing facilities. See Figure 2 for the functional Block diagram of conversion facilities.

Two separate tape libraries were created, but were dubbed onto a single reel of quad tape for convenience. The libraries were separated by a 30-second black segment, which permitted later insertion of an experimental teletype program which was used to demonstrate "hard copy" delivery using the VIDAC technology. Observations noted during the conversion process are recited in Section IV of this report.

At the Dublin hospital site, the received satellite microwave signals were demodulated and fed through a video distribution amplifier in order to isolate the VIDAC terminal buffers from the distribution system which had been installed to route the Teleconsultations to appropriate viewing locations. See Figure 3 for the distribution Block diagram.

The high speed VIDAC baseband video signals were routed directly to the terminal buffer input circuits. After selection and decoding, the baseband video and audio signals were fed to channel modulators to produce the four RF channels required for redistribution to the viewing locations. A single broadband RF system was used for distributing both the standard Teleconsultations and the real-time VIDAC information. Program choice at the receiver locations was achieved by channel selection. Conventional color TV receivers were used for display.

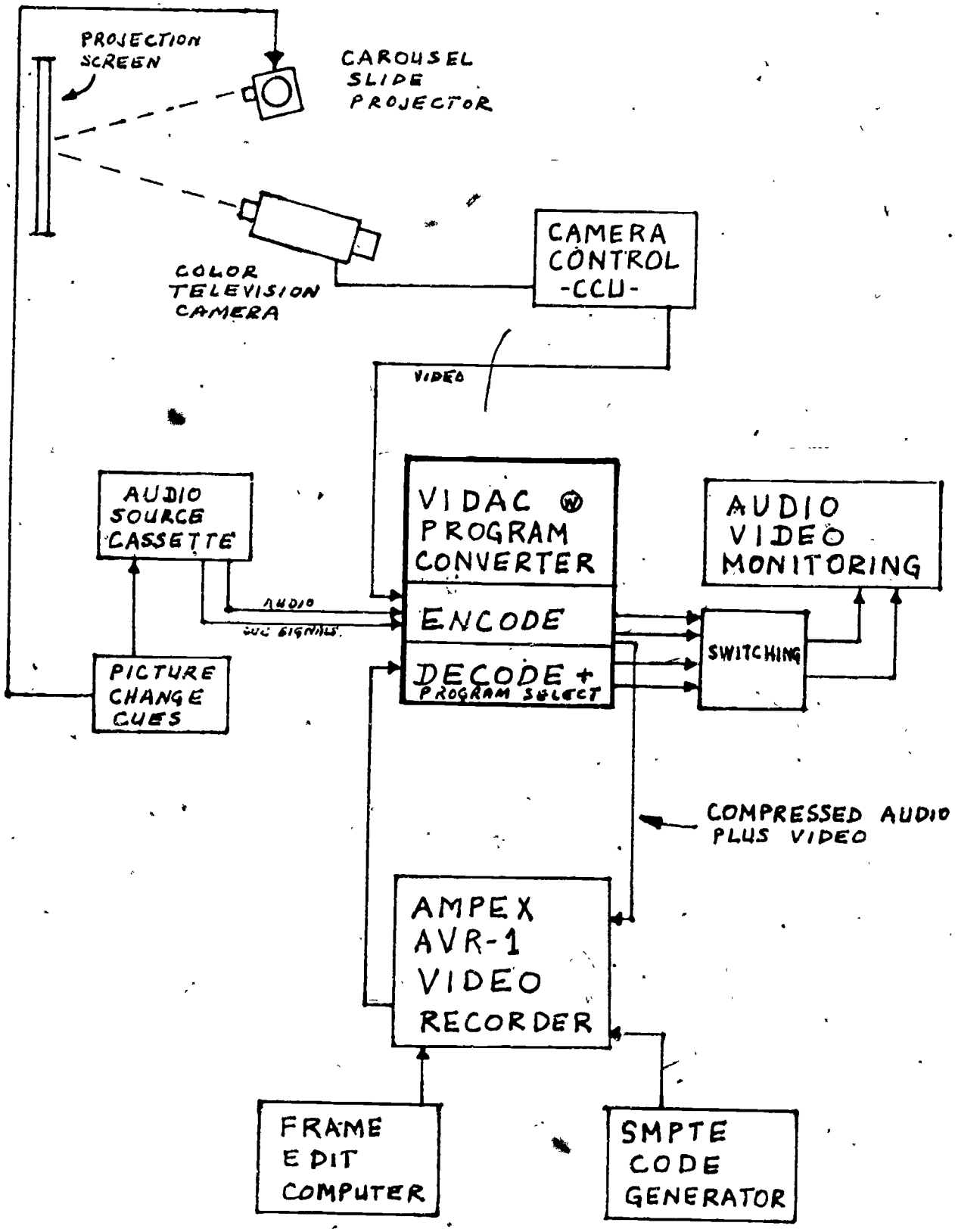

PROJECTION SCREEN
CAROUSEL SLIDE PROJECTOR
COLOR TELEVISION CAMERA
CAMERA CONTROL -CCU-
VIDEO
AUDIO SOURCE CASSETTE
VIDAC ® PROGRAM CONVERTER
ENCODE
DECODE + PROGRAM SELECT
AUDIO VIDEO MONITORING
SWITCHING
AUDIO
SYNC SIGNALS
PICTURE CHANGE CUES
COMPRESSED AUDIO PLUS VIDEO
AMPEX AVR-1 VIDEO RECORDER
FRAME EDIT COMPUTER
SMPTE CODE GENERATOR

FIGURE 2

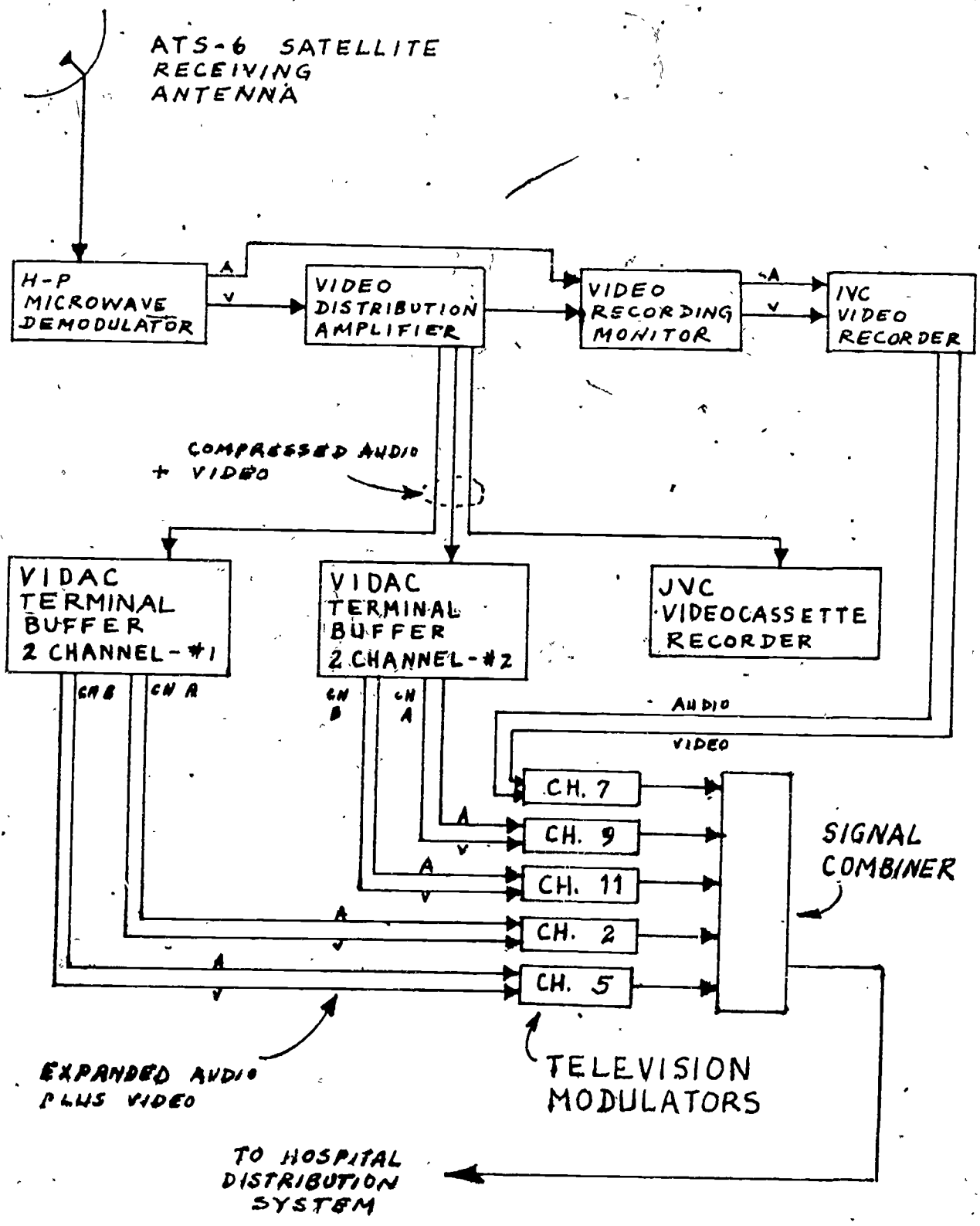

ATS-6 SATELLITE RECEIVING ANTENNA
H-P MICROWAVE DEMODULATOR
A
V
VIDEO DISTRIBUTION AMPLIFIER
VIDEO RECORDING MONITOR
A
V
IVC VIDEO RECORDER
COMPRESSED AUDIO + VIDEO
VIDAC TERMINAL BUFFER 2 CHANNEL - #1
VIDAC TERMINAL BUFFER 2 CHANNEL - #2
JVC VIDEOCASSETTE RECORDER
CH B
CH A
CH B
CH A
AUDIO
VIDEO
CH. 7
CH. 9
CH. 11
CH. 2
CH. 5
SIGNAL COMBINER
EXPANDED AUDIO PLUS VIDEO
TELEVISION MODULATORS
TO HOSPITAL DISTRIBUTION SYSTEM

FIGURE 3

C. FLORIDA STATE UNIVERSITY OBSERVATIONAL PROCEDURES

1. Development of Observational Plan

Florida State University participated in the experimental design by developing a set of evaluation procedures; carrying out the data collection, observations, and interviews on-site; and reducing data for specific items. The evaluation procedures were designed for utilization in information gathering centering on three questions:

a. How viable is VIDAC likely to be as a central library distribution mechanism?

b. What is the effect on the audience when scheduling restraints are removed and the user can choose both viewing time and program?

c. Which, if either, of two possible modalities — continuous viewing (in which programs run through and are immediately replayed) or selective viewing (in which users turn the display on, watch, and turn the display off) — seems to be preferred?

A copy of the V.A. staff procedures and the FSU evaluation procedures are contained in Appendix B as exhibits 1 and 2.

2. Design of Data Collection Instruments

Several instruments were designed to be utilized in collecting the desired data. The first of these was an evaluation form which individuals viewing VIDAC programs were requested to complete. A decided effort was made to ensure that individuals completing these forms understood that they were not being requested to evaluate the program content they viewed, but rather the delivery system which presented this content. A sample of this form is attached as exhibit 3 in Appendix B.

The second instrument utilized was a program log kept by the media specialist who had responsibility for acquiring and routing programs requested by the instructional staff. The log

contained the number of programs requested during each hour of the day and number of times each was requested. It is contained in Appendix B as exhibit 4.

The third form was a TV terminal usage log, designed to determine to what extent program evaluation forms were being utilized. This form was deemed unnecessary when the evaluation team was informed that no after-hours viewing would be permitted due to V.A. security restraints. Additionally, persons requesting programs were informed by the media specialist that all those who viewed the program were to fill out the questionnaire; and the response was such that the cross-check form was considered redundant.

3. Site Visits

A meeting was called in Dublin, November 12, 1974, to explain the purpose and particulars of the VIDAC experiment. Personnel who attended are included in Appendix C. Administrators were informed about the capabilities and basic principles of VIDAC and told how the VIDAC system could be used within the VA facility. Explanation was given regarding what instructional programs were available to the staff and how these programs could be accessed and utilized to enhance current VA training programs.

A facility to house the VIDAC equipment was provided at the hospital and a media specialist was appointed to keep logs which reflected usage, note usage times and equipment problems, disseminate and collect evaluation forms from VIDAC users, and assist personnel in program selection. Handouts which listed the complete VIDAC library of medical programs were distributed and placed on television monitor stands, as well as posted in each viewing area on a bulletin board.

The FSU evaluation team made five site visits during the ten weekly VIDAC transmissions. During these visits, the evaluators visited the rooms in which VIDAC programming was being received, checked to see that the evaluation forms were avail-

able, viewed the programs, and discussed the VIDAC experiment with participants.

4. Interviews

Non-structured interviews were conducted during the fourth site visit with a random sample of approximately 20% of the viewers who had completed evaluation forms. These interviews were conducted to: (1) up-date information in the event that individuals had altered their opinions of the VIDAC programming during the course of their viewing experience; (2) gather further information on any points which were mentioned on the "other comments" item on the form; and (3) gather any additional thoughts, remarks, or explanations the interviewees wished to express in reference to the VIDAC presentations they viewed or their ideas about its potential.

During the last site visit, interviews were conducted with supervisors of education and training for nursing, laboratory, and dietetic services personnel. It was the staff members and trainees of these three services who comprised the majority of persons viewing the VIDAC-presented programs. These additional interviews were conducted in order to gather opinions on the operation and potential of VIDAC delivery from individuals in supervisory capacities who were responsible for the education of others. The points about which information was gathered were the same as those used for the interviews with the sample of respondent users.

5. User Population — Potential and Actual

It had previously been determined that the potential target audience population for VIDAC programming at the test site was composed of physicians, nurses, nurses' assistants, dieticians, laboratory technicians and technologists, and laboratory assistants. The total number of individuals employed at the test site in each of these categories, broken down by work shift, is shown below:

TABLE I. Potential Users of VIDAC by Job Category and Work Shift

Category	Day Shift	Night Shift	
Physician	22	0	
Nurse	73	20	
Nurses Assistant	105	35	
Dietician	4	0	
Lab Technician and Technologist	6	3	
TOTAL	210	58	268

Because of the security restraints imposed by the hospital administration on nighttime viewing, the day shift can be considered actual potential target population.

The total number of persons who viewed the selected programs and completed evaluation forms was 42, or 20% of the possible target population. They were primarily drawn from the day shift of nursing, dietetics, and lab personnel.

Since the number of usable evaluation forms completed by respondents was 107, it was determined that users saw an average of 2.55 programs each during the course of the study. However, there were certain users who had higher exposure. Four persons saw 4 different programs; 5 persons viewed 5 different programs; and 6 saw 6 programs during the life of the study. These 14 respondents' questionnaires were examined particularly for evidence of shifts in attitude over the life of the study. It was interesting to note that these users were consistent in their positive attitudinal responses to the system.

6. Program Titles Requested

During the ten weeks of the VIDAC experiment a media specialist maintained an hourly log of programs requested and

the number of times each was requested. There were 33 programs in the total library. Wednesday was the day of satellite transmission. Therefore, the following chart presents a summary of the data using Wednesday as the start date for each new viewing week.

TABLE II. Weekly Log — Number of Program Titles Requested

Dates	Number of Program Titles Requested
November 27 - December 3	0
December 4 - 10	6
11 - 17	3
18 - 24	2
25 - 31	Christmas - no programming
January 1 - 7	New Year - no programming
8 - 14	1
15 - 21	2
22 - 28	6
29 - February 4	2
February 5 - 11	0
12 - 18	4
TOTAL	26

The total number of viewings of the foregoing programs was 40.

IV. STUDY ANALYSIS

A. FLORIDA STATE UNIVERSITY

One of the basic characteristics of a VIDAC distribution system is provision of the capability which allows an individual to access a program in accordance with his own time schedule. VA VIDAC viewers were unable to use this option because viewing areas were closed at approximately 1630 each day and were not available at all on weekends. Several personnel from the day shift who were interviewed indicated a desire to go back to review programs or to see new ones, but did not have the opportunity. Reasons for this lack of opportunity included working until 1630 and short lunch breaks which precluded spare time viewing. Several of the night shift personnel interviewed indicated that they would have liked to have had access to the programs and would have watched them.

The closing of the viewing areas after VA business hours eliminated testing the continuous viewing modality. This factor had a significant effect on the evaluation effort since it was impossible to determine statistically which viewing mode was preferred; any significant difference between the use of the two viewing modes; any significant changes in utilization from one mode to another during the course of the experiment; and any clustered viewing in terms of time, program, or number of viewers watching as a group which would suggest the true benefits of freely accessible tutorial materials.

Logs indicated that about twenty percent of the estimated target population used the VIDAC library in the ten week period. One of the reasons more personnel did not take part in the study was a changeover of key management personnel during the time period. Until they understood the purpose of the study, there was little attempt to advertise the program, follow-through to

see if questions could be answered, give periodic reminders of the program's potential import to hospital personnel, or provide concurrent monitoring to ascertain program utilization. This understandably led to less than optimal utilization of available programs.

In defense of management, however, it should be noted that some of the programs were not pertinent to a given program of study due to audience sophistication, timeliness and other variables. Others were intended for use by specialized personnel only and were not appropriate for general audiences. (Seven library programs were not requested at all during the ten week period.)

Difficulty in obtaining access to VIDAC terminals during off-duty time, lack of understanding about the study and its limited life at the V. A. hospital, limited communication between management personnel and potential VIDAC users, and the unsuitability of some library material for large audiences presented major obstacles. It is reasonable to conclude that usage rates may be directly linked to these observations. Additionally, some instructors interviewed seemed to feel that the study was just one more thing to cope with in an already overloaded schedule. Proper managerial follow-through, it is felt, could have reduced or eliminated this problem.

Several problems of utilization resulted from the time period available for the study. It was designed to take place over a ten week period with programming to be sent weekly. A ten week period under the best of circumstances is a very brief time in which to build enthusiasm and continued interest for a new method of information distribution among staff members of a large hospital. There was insufficient time for an instructor to incorporate instructional material which was not previously reviewed and was received weekly into a continuing course of instruction. This problem was complicated by the interruption of the ten week period by the Christmas and New Year holidays when no programming was transmitted. The already short period

available was thus effectively divided into two even shorter periods.

These problems made it very difficult for staff members to maintain any continuity in the use of the VIDAC programs for instruction or to build a course of instruction around them. These difficulties, complicated by the other problems noted earlier, made a thorough experiment and evaluation difficult at best.

Those who did use the VIDAC system were impressed, enthusiastic, and generally felt that a program of this type would greatly benefit them as well as the hospital; and, in the opinion of some, the entire VA network. Students generally reflected a highly positive attitude toward learning via the VIDAC delivery system and felt that the VIDAC system with free program access filled a need which could not be met more readily by other media. Many expressed a desire to use the programs available on a regular basis for refresher purposes and for updating their knowledge in a range of subject areas relevant to their skill.

One feature repeatedly considered ideal by several instructors and students was the rapid access concept; one observer indicated that motion may be essential in the limited instances when certain motor skills are being taught. Suggestions for additional usages and modifications to the system included incorporating a feature allowing discrete frame replay, which one doctor felt would be useful particularly for foreign trained employees.

The evaluation team had a unique opportunity to investigate how the whole VIDAC system functions. Although their assigned role in the study was addressed to attitudinal responses at the terminal/user interface, several team members have technical competence in educational communications, and have therefore made some personal observations which are based on this knowledge, namely —

1. Since the VIDAC system allows the equivalent of some 900 fifteen-minute (450 thirty-minute, etc.) programs to be stored on a standard one-hour videotape, there is potential for large savings in tape and storage costs of central library inventory.
2. VIDAC technology permits normal dubbing on conventional equipment, thereby avoiding the cost of extra equipment for each manipulation of the tape.
3. VIDAC equipment may be "plugged in" to existing local TV networks, thereby eliminating the cost of major modifications to existing facilities.
4. The ability to send textual material as hard copy, together with audio-visual information, eliminates the costs associated with separately printing and distributing hard copy from a single central location. Production of hard copy as required at the user location can be achieved with slight modifications to the present prototype hardware configurations within the system.
5. Stored information can be updated solely at the central library, thus simultaneously affecting all users. This may have significant effect on inventory control, markedly reducing inventories of non-current material.
6. A VIDAC system can be modularly planned and scaled for large or small applications to fit user needs; it may achieve greater and greater cost advantages as both the library and audience grow.
7. The time required to broadcast many hours of material is measured in minutes, which should permit reduction of the operating costs of television facilities.
8. VIDAC central libraries could serve an area approximately one-third the size of the earth by utilizing a single dedicated satellite channel. Cost sharing based upon channel usage would permit many smaller agencies to enhance their public services to a larger number of users.

It would seem that using VIDAC technology could produce a more cost-effective system than comparable conventional systems. All of these observations should be analyzed in light of potential user needs and geographic dispersion of viewers to determine what effect each feature would have on an operating system.

There is a need for more and exhaustive analysis of whether some courseware used with the system should have provision for interactive response between the terminal and the student. Programs used in this study did not have any such features, which might include taking advantage of the built-in pause control for student responses, or automatic disabling and recycling for incorrect responses.

B. WESTINGHOUSE

Field personnel accumulated observations made during the initial program conversions (creation of the high speed library), the satellite microwave signal reception, operation of the terminal buffers, and analyzed the expanded VIDAC signal quality delivered through the hospital's RF distribution system. It was inopportune to make a detailed analysis of all of the various technical parameters affecting the entire experiment, since a number of the major system elements were not available to the VIDAC experimenters.

However, video tape recordings of the compressed VIDAC libraries, and of each of the selected and decoded VIDAC programs, were made during each weekly satellite transmission. Lead-in on each of these video recordings included several minutes of conventional television which occurred during the closing credits for the Teleconsultations programs. This short segment provided a calibrator for subsequent visual and instrument analysis of signal/noise ratios, fades, interfering signals, etc. which might have affected the reception of the high speed library, since the credits immediately preceded the VIDAC library transmission.

Notes taken during the program conversion phase indicate no outstanding irregularities. A dedicated set-up for video pickup included a Carousel projector and screen, color camera and controls, and the usual monitoring facilities. The use of an independent camera/projector combination permitted a much more flexible means for adjusting image size and color rendition prior to "freezing" the video on the converter disc and greatly facilitated the irregular use of a film strip projector as well. In order to expedite compression of the aural component of the audio-visual material, each of the audio tapes accompanying the slides or film strips was audited and re-recorded on a dual track cassette. Standard NAB cue signals, synchronized with the original picture change signals or instructions, were recorded on a separate track to provide VIDAC switch closures for encoding cue signals within the VIDAC aural frame.

Transfer to quad tape for the permanent compressed library was made utilizing the computer-directed editing facilities of the Georgia ETV Network. When the video and audio information recorded on the converter disc was deemed satisfactory, a rapid transfer was made to tape initiated by a computer-supplied trigger to permit synchronizing the program converter and video recorder. This technique permitted close-packing each of the successive audio-video lectures within several frames to maximize the program density of the library. Compression ratios were respectively 191.65:1 and 193.63:1 for each of the library segments.

Field notes taken during the ten weeks of VIDAC transmission, together with the "electronic notebooks" (video recordings) made at the Dublin receiving location, indicated no gross abnormalities in the anticipated performance of the experimental VIDAC equipment. They do point up the generally excellent quality of the ATS-6 broadcasts and are quick to identify the rare occasion when the local microwave dish required repointing to offset a 7 db drop in received signal level.

Of considerable significance was the single occasion (January 15, 1975) when the received satellite signals dropped 10 db due to a satellite mispointing. NASA's inability to reposition the satellite into Appalachian orbit quickly enough after a pre-emption of broadcast time for a Presidential national address, during which time the ATS-6 was used to relay the program to Alaska, permitted a first hand observation of VIDAC reliability. When visual observation indicated a video signal/noise ratio in the range of 20-25 db, the VIDAC library suffered serious impairment; at which time the quality of conventional television was barely watchable. When the S/N ratio increased to 28-30 db, the VIDAC reception was unimpaired, although the noise spikes and "streaking" on conventional video was seriously objectionable. Apparently the "frozen" noise in each video frame is much less objectionable to the viewer than the moving interference typical of conventional video at low S/N ratios. The same noise, when it interfered with an aural frame, produced an interesting effect. A disruption of the decoding process would occur when the noise bursts affected sync. However in all cases the buffer would resynchronize at the beginning of the next aural frame. When the noise spikes occurred during the video portion of each horizontal line, the noise spikes were converted into a low frequency component during playback and were not generally objectionable.

Of the ten broadcasts, one was impaired at the Denver area location which was used for program origination, storing the VIDAC central library, and routing up-link transmissions to the satellite. Improper dubbing techniques caused a loss of sync when the VIDAC compressed library was combined with a "credits" tape. This was a unique situation caused by a malfunctioning time base corrector for the slow scan converter associated with one of the V. A. Teleconsultations and thereafter no further impairments were attributable to the central library tape handling operations.

During the remaining nine transmissions, no malfunctions were associated with the satellite transmissions, except for the one broadcast previously discussed which involved a misorientation of the satellite.

As was expected, the experimental terminal buffers malfunctioned fairly regularly and failed to provide a full complement of four weekly programs during some weeks, a condition which affected utilization evaluation much more than a technical investigation. However, a minimum of two channels (decoded programs) were available to the users for each of the ten weeks.

VIDAC terminal buffer malfunctions ran the gamut of difficulties associated with the operation of laboratory prototype equipment under field conditions. Circuit discontinuities (bad solder joints, poor PC board contacts, intermittent switch contacts, etc.) accounted for nearly 60% of all buffer failures. No difficulties were attributable to the magnetic disc/head assemblies. Power supply failures constituted virtually all of the remaining system faults.

It was observed early-on that the in-hospital RF distribution system used for the tutorial programming was physically paralleled in many locations by an existing cable system used to provide residents with the signals delivered by a local CATV company. Insufficient shielding of some TV receivers used during the experiment caused serious co-channel interference on one or more of the channels used for VIDAC distribution, rendering some viewing locations electronically unusable.

V. SYSTEM FEASIBILITY

Contrasted with basic inventions, around which new operating systems are created, the elements of feasibility affecting new technological developments designed to operate within the narrow structure of an existing system are generally expressed in terms of potential improvements to the system.

VIDAC technology was created to enhance the transmission capability of existing television-based communications channels. Compatibility with all elements of the existing TV systems was a basic criterion imposed upon the selection of alternative methods for creating the enhancement. Of necessity therefore, the improvement must be achieved within the relatively narrow limits inherent in the NTSC system specifications and represents a trade off — limited motion vs. a shortened transmission time.

Widespread utilization of this technology will depend upon:

(a) Acceptance of the still video - narrative audio characteristic of VIDAC television in lieu of full motion capability. Research in this area[1] indicates that a significant amount of source material (slides or film strip plus audio) is currently being used tutorially and would only require direct conversion into the VIDAC format.

(b) The development of suitable management plans to permit the destructuring of "now hear this" scheduling into a more flexible system of "on-demand" retrieval of tutorial information.

1/ Audio/Visual Ratios in Commercial Filmstrips, Nancy L. Gulliford, December 1974.

(c) Establishment of a commonality of need of stored information which will justify creation of large VIDAC-compressed central libraries.

(d) Interconnection of existing networks to permit widespread dissemination of program material to large numbers of users.

(e) Appropriate design of the user hardware to permit maximum modularity of functional configurations.

(f) A cost-effectiveness for the entire central library-user demand system which compares favorably with existing, competitive delivery systems.

A first determination of prototype production costs for the present configuration of terminal buffers would result in a per channel selling price of approximately $25,000.[2] The various machine configurations indicate a range of $15-35,000 per decoding channel. Suitable utilization of secondary distribution networks to deliver decoded material from each of the VIDAC decoding outputs to user terminals greatly affects both capital and operating dollar requirements.

It is beyond the scope of this report to detail the many permutations of system elements affecting the true operating system costs. However certain general observations can be made regarding various major elements of the system, namely:

(a) Program conversion costs, when reflective of a large, multi-user-based library, do not significantly affect long term operating costs.

(b) Time-share VIDAC usage of television transmission networks during peak hours and fully dedicated VIDAC usage during off hours may constitute a more efficient enhancement of network capacity.

2/ In limited quantities based upon preproduction estimates of an eight channel configuration.

(c) Secondary distribution networks will have a significant effect upon both the cost and effectiveness of a VIDAC central library system. Simplified retrieval systems based upon fixed time scheduling of decoded material lend themselves to the least costly, but not necessarily the most effective, approach to mass distribution. More sophisticated retrieval configurations which could permit direct user interaction with the VIDAC terminal buffers are at the opposite end of the cost scale but offer great flexibility in point of user service.

(d) A well defined management plan which incorporates a series of strategems to meet changing user requirements will perhaps have the greatest effect upon the realization of maximum cost-benefit and cost-effectiveness ratios for the overall system.

A penetrating analysis of each component of the overall VIDAC delivery system should be performed. It cannot be overstressed that seemingly high machine costs initially may appear to adversely affect VIDAC implementation. Whereas what appear to be minor costs involving programming are, in reality, the major system costs. Assessing the capital and operational costs of the established components of the network in both conventional and compressed modalities will help establish the effectiveness of the VIDAC improvement.

This short-term experiment involving use of the ATS-6 satellite proved the technical feasibility of a VIDAC-based central library satellite delivery system. A much longer term experiment involving a more comprehensive library and a larger number of users would be necessary to establish functional usage requirements for a broad based "integrated media" delivery system.

VI. POSSIBLE IMPACT ON EDUCATIONAL SYSTEMS

Prominent educators (Charles F. Hoban, Robert M. W. Travers, W. H. Allen, C. Ray Carpenter, and Wilbur Schramm) long ago suggested television as a distribution medium for teaching materials because of the ubiquitousness of the ordinary television receiver — which serves as a primary terminal.[1] Television is the nearest thing to a universal medium because it is capable of instant transmission, has the bandwidth to accommodate nearly all media and has had allocated to it large blocks of publicly owned radio spectrum. Although it has the bandwidth necessary to carry full motion, it does not need to be constrained by that characteristic. Moreover, if the system is unshackled from the necessity for operating in real time, the inherent capabilities for a high volume delivery system would be realized.

The obstacles to achieving this role change would include not only the technological developments, but managerial and political ones as well. Evolutionary change comes slowly, especially when it treads on vested interests at every step of the way. A series of coordinated studies were undertaken to validate the underlying concepts and to determine the direction, time span and funding requirements for future research.

From 1970 through 1974 the Georgia Department of Education conducted a series of studies designed to:

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[1] Nancy L. Gulliford, Current Research on the Relative Effectiveness of Selected Media Characteristics. Pittsburgh, Pennsylvania: Westinghouse Electric Corporation Research and Development Center, Product Transition Laboratory, Communication Services, October 1973. (ERIC Document Number ED 098 968)

- assess a new means of improving the effectiveness of the existing statewide television network for delivery of educational materials;
- assess the areas of education where instructional TV could have the greatest impact;
- create and test audio-visual materials designed expressly to reflect teacher preferences and compatibility with a proposed new delivery system.[2]

In December 1971 a contract was executed with the Westinghouse Electric Corporation (later expanded to include the Atlanta Schools) to design equipment specifically intended to amplify the TV network capacity for delivery of audio-visual materials. While prototype equipment was being designed, a test library of teacher-specified material was prepared by specialists at the ETV Center. Assessment instruments were developed by the Planning, Research and Evaluation Division.

At the end of the study period, the following conclusions were reported by the evaluators:[3]

1. The prototype VIDAC equipment proved feasible and network compatible.

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[2]William H. Hale, Jr., and Richard E. Ottinger, "A Telecommunications System for Georgia, A Preliminary Report". Atlanta, Georgia: Georgia Department of Education. [May 25, 1971]

[3]Georgia Department of Education Division for Planning, Research and Evaluation "Simulation/Demonstration Report: VIDAC: Investigations of the Complementary and Supplementary Roles" Atlanta, Georgia. [July 1974]

2. The still visual-narrative audio format required by VIDAC technology proved acceptable; television delivery masked the absence of motion.
3. The teacher-designed materials were found acceptable by both teachers and students when they were used in two modes — complementary and supplementary to the established curriculum.
4. A flexible delivery system satisfying "on-demand" user requests would stimulate much greater use of supportive audio-visual material.

The Atlanta studies were conducted principally at the Atlanta Area Vocational-Technical School; the following additional result was reported:[4]

5. Materials delivered in this way could be used for "stand alone" instruction as a means of de-structuring the traditional rigid scheduling of classes.

The Advisory Council (created to maintain liaison among all participants) recommended a follow-on study to examine the operational requirements of a small scale network to serve selected vocational-technical schools in rural Georgia.

Funding constraints have restricted the number of full time researchers involved in the program. A full scale test of the concept has not yet occurred, and therefore findings to date have not detailed the functional requirements for large multiple-user networks, but have strongly suggested continued

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[4]Metropolitan Cooperative Educational Service Agency, "VIDAC Research and Evaluation Final Report - FY 74: Atlanta City Public Schools Project". Atlanta, Georgia [August 1974]

research in clearly defined areas. However, findings reported to date tend to validate the concept of "integrating" media and creating a user-demand delivery system.

A calculated impact on educational systems should be produced by the characteristics of the technology, as well as by the management decisions taken to implement systems of ever increasing size.

Rapid accessibility to large stores of audio-visual materials would permit a restructuring of the supportive role presently assigned to such material. The development of simplified interactive audio-visual courseware, in combination with conventional material broadcast normally by ETV networks, might have significant effect on the role played by instructional television.

The ability to create rural networks using satellites as a primary transmission channel, coupled with existing CATV cable systems to provide secondary local distribution, would significantly moderate the rural to urban migration. These networks would then permit utilizing "store front" schools for local continuing education centers.

There are 3,333 operating CATV systems satisfying the needs of 7,279 communities presently operating in the U. S. (TV Digest 44-TTT, September 1, 1975). These systems presently are required to provide at least one channel for educational needs. They are being under-utilized. Such systems could easily use VIDAC buffers on the reserved channel for automatic programming on a scheduled basis during the day and an "on demand" basis at night.

Continued development of the VIDAC technology and large scale production would result ultimately in a single program adapter for the home TV receiver capable of single program selection and storage. Such a device would expand the utiliz-

ation of both local and national ITV networks and would create a huge continuing education market.

Since VIDAC technology is based primarily on audio compression (greatest transmission compression taking place when no optical frames [visuals] are used), the creation of a national network for the blind is now an imminent reality. One minute of VIDAC transmission equals eight hours of talking book service.

As a universal delivery system, television would undoubtedly become the vast conduit of information which it was originally intended to become.

VII. IMPLICATIONS FOR FURTHER RESEARCH

ABSTRACTING

The National Medical Audio Visual Center in Atlanta produces much material which is used not only by medical practitioners, but also in major university biological sciences departments. Presently these titles are cataloged using conventional word descriptors, which are computer stored and retrieved. At best, it is difficult to adequately describe audio-visual material in this manner. It would be useful to have abstracts of the audio-visual material available for review. Titles which appeared to be of interest could be reviewed by looking at a sample of some of the visuals, accompanied by related audio. This would enable professionals to choose those few titles which are specific to a problem and to scan the entire content of the selected titles for relevancy. Such an abstracting service and subsequent delivery of unabridged materials to viewers remote from an Atlanta library would appear to be possible using a VIDAC-based delivery system.

An attempt was made during this study to investigate the feasibility of abstracting motion material (conventional videotapes) and to reduce it to a VIDAC format. Preliminary results indicate that such an abstracting technique is feasible and might prove valuable for disseminating rapidly large numbers of audio-visual samples for field review. In the attempt undertaken, a five-minute abstract of a videotape resulted in a 1.1 second VIDAC transmission.

HARD COPY DELIVERY

An "integrated media" television based delivery system of audio-visual tutorial information requires that the accompanying textual material also be formatted for electronic delivery. The VIDAC technology, by effecting the conversion of "hard copy" into compressed "aural frames", permits the creation of a single-medium library (video tape) which can store all of the components of instructional courseware. The "hard copy" could also include associated test material and computer programs.

A simple demonstration of hard copy delivery was attempted during the V.A. study. 1250 words of text material which accompanied program 507 - "Functional Anatomy of the Heart" - was compressed into a 46 frame series which, together with appropriate code frames, resulted in a 1.8 second transmission. Recovery was effected via conventional ASCII* teletype at 110 baud.

Future terminal buffer designs could incorporate decoding circuitry for driving local hard copy printers. The resulting integrated media delivery system could have a significant effect on the storage and distribution of printed matter, especially in rural areas.

INTERACTIVE PROGRAMMING

VIDAC experiments to date primarily have been concentrated on exploring the technical feasibility of a new delivery system. Existing audio-visual courseware has been reformatted without modification for VIDAC compressed delivery. Control characteristics of the terminal buffers and encoding information imparted during program conversion permit some simple branching without necessity for external computers. The interactive program can be accommodated within the audio-visual program.

Second or third generation terminal buffers could be designed for learner interaction as well as simultaneous hard

*American Standard Code for Information Interchange

copy delivery of test results. The technology permits the creation of simplified interactive audio-visual courseware which, in combination with printed tutorial material available simultaneously, would accelerate the destructuring of present instructional television.

LIMITED MOTION TELEVISION

Although considerable instructional material has been developed utilizing "stills" with accompanying audio, there is need for a motion component in certain skills training. VIDAC technology permits the integration of limited motion, when necessary, into what is essentially a still video-narrative audio sequence.

Since the rate of presentation of still visuals creates the impression of motion, encoded instructions within the compressed VIDAC format would create a variable rate presentation as needed to satisfy courseware requirements. The transmission compression ratio would be a function of the amount of motion required in the total sequence.

CONCLUSIONS

The implications inherent in the VIDAC technology suggest that it may have significant beneficial impact upon the restructuring of instructional television. In contrast with the rigid — "now hear this" — scheduling of existing networks which has markedly reduced their effectiveness, an "on-demand user-based" television delivery system could revitalize a potent teaching modality.

In combination with newly emerging high powered satellites which permit low cost ground terminals, the need for expensive and crowded terrestrial networks can be greatly reduced. Those that exist can be utilized to greater advantage by combining conventional and VIDAC-compressed transmissions. Within the next decade, the cost of satellite receiver termina..s should become low enough to permit direct home reception of a vast quantity of central library stored instructional material.

An appropriate VIDAC developmental schedule during the same time span should produce significant cost reductions to permit single program retrieval and storage on the home television receiver.

APPENDIX A

VIDAC LIBRARY CATALOG

LIBRARY #1	Compressed Time	1 min 52 sec
	Expanded Time	5 hr 58 min
	Compression Ratio	191.65 : 1

Program #	Title	Time
500	Sinus Node and Atrial Arrhythmias	19:30
501	Junctional and Ventricular Arrhythmias	25:00
502	Conduction Disturbances	20:00
503	Systematic Approach to Arrhythmia Identification	18:30
504	Bi-Valve Casts — Their Construction and Application	15:00
506	Temporary and Chronic Ventricular Pacing Technique	28:30
507	Functional Anatomy of the Heart	23:46
508	Analysis of the Electrocardiogram	29:30
510	Arrhythmias Originating in the Ventricals	19:00
511	Introduction to Supraventricular Arrhythmias and Supraventricular Arrhythmias of Sinus Origin	19:00
512	Arrhythmias of Junctional Tissue Origin, Wandering Pacemaker and Paroxysmal Atrial Tachycardia	19:00
513	Premature Atrial Contractions, Atrial Flutter and Atrial Fibrillation	21:00
514	Heart Block: Patient Care	20:00
515	Ventricular Arrhythmias	21:00
516	Understanding Your Patient's Artificial Pacemaker	24:00
517	Caring for your Patient with a Permanent Artificial Pacemaker	20:00
518	Understanding Catheter Insertion and Adjustment of Temporary Pacers	15:00

LIBRARY #2	Compressed Time	1 min 39 sec
	Expanded Time	5 hr 19 min
	Compression Ratio	193.64 : 1

Program #	Title	Time
519	Temporary Pacers - Troubleshooting	18:00
520	Blood Pressure	20:00
521	Management of Blood Transfusions	27:00
522	Venipuncture and Starting an Intravenous Infusion	25:00
523	Rotating Tourniquets	20:00
524	What is Diabetes?	21:00
525	Urine Testing	12:00
526	Insulin Injection	18:00
527	Acid-Base Balance — The Body's Regulation of PH.	23:00
528	Acid-Base Balance — Compensation of Imbalances	21:00
529	Acid-Base Balance — Respiratory Acidosis and Alkalosis	18:00
530	Acid-Base Balance — Metabolic Acidosis and Alkalosis	22:00
531	Basic Hemotology	15:00
532	Hospital Fire Safety Procedures	16:30
535	Arrhythmias Originating in the Atria - Part One	21:00
536	Arrhythmias Originating in the Atria - Part Two (Arrhythmias Originating from the A-V Node or A-V Junction)	22:00

APPENDIX B
Exhibit 1

VETERANS ADMINISTRATION

PROCEDURES FOR THE VIDAC EXPERIMENT

The VIDAC experiment is a parallel experiment with the ATS-6 (Satellite) Experiment. It will be under the general supervision of Mr. C. J. Upchurch, Chief, Voluntary Service.

The experiment will begin November 20th with our first recordings. It will continue for ten weeks terminating one week following the last recording scheduled for February 5th. There will be no recording made December 25th and January 1st. However, the recording made December 18th will be available in the machines during that period.

A catalog which we will receive will list the programs and their running times will be distributed. Three libraries--A, B, and C, will be recorded on video tape and will be kept in Denver. Only one library can be transmitted each week and only four programs can be recorded each week. Therefore, program selection will be secured by Mr. Upchurch and Denver will be advised on Monday prior to the broadcast date on Wednesday. All four programs selected must be from the same library.

Following recording, the four programs will be available for viewing until the next recording is made. The programs may be viewed over the closed circuit distribution system as follows:

A. Regular Workdays, 8:00 A.M. to 4:30 P.M. - On demand of the employee. Call Ext. #358 and the Equipment Operator will punch-up the selected program or schedule for a specific time.

B. Other than Regular Workdays - Continuous presentation. The employee can simply tune the TV set to the proper channel.

To facilitate presentation during working hours, the following channel assignments are made:

11B	(Medical Service) -	Channel 2
5B	(Nursing Service) -	" 9
2A	(Dietetic Service) -	" 5
4A	(Clinical Conf. Room)	" 11

A handout of each week's programs will be prepared by Voluntary Service showing the program title, running time, and the channel on which the program may be viewed during other than regular duty hours. Copies will be distributed to participating Services based on their need.

Records of participation by employees will be kept and compiled by Voluntary Service. Evaluation forms, if required, should be completed. Pro and con suggestions and comments are solicited.

APPENDIX B
Exhibit 2

FSU Evaluation Procedures for the VIDAC Experiment

The Questions

1. How viable is VIDAC likely to be as a central library distribution mechanism?

2. What effects does VIDAC's ability to free access to the medium from scheduling restraints have?

3. Which, if any, of the two possible modalities of utilization seems to be preferred?

Information Sought

In order to obtain measured information pertinent to answers to these questions, we need to determine:

1. what proportion of the potential audience actually uses VIDAC.

2. how frequently individuals use it.

3. to what extent is viewing clustered or dispersed in terms of:

   a. time

   b. programs

   c. number watching as a group

(If everyone tends to watch the same programs at the same time in a group, it would suggest that a schedule free multiple access system is not a very significant facility.)

4. If there is any significant difference between the use of the two alternative modalities.

5. Changes in patterns of utilization during the course of the experiment.

6. To what extent is the software of the media used in the experiment transmitted by VIDAC so that essential information is clearly perceived video and audio channels.

APPENDIX B
Exhibit 2

7. To what extent the users feel that the access system fills a need which could not be met more readily by other media.

8. To what extent is there a felt need for VIDAC in the Veterans Administration Hospital?

Uncontrolled Variables

In an experiment of this nature there are a number of contaminating variables which should be accounted for. Users may react negatively to the VIDAC system for reasons which are extraneous to VIDAC or peculiar to the experiment itself.

The following factors need to be measured and discounted:

1. Technical breakdowns due to the experimental stage of the equipment. (the technical reliability of VIDAC must at some stage be evaluated, but this is not a consideration for the FSU Evaluation Team). We understand that Westinghouse will conduct such an evaluation.

2. The extent to which the content of the presentations is didactically unsatisfactory.

3. The extent to which the content of the original material does not satisfy the needs of the user. Customer satisfaction is, of course, a basic criterion of a library system, but the present experiment does not cover a precise analysis of needs nor does it attempt an in-depth correlation of information with needs.

INSTRUMENTS

The principal instrument for obtaining the information sought is the PEF (Program Evaluation Form) (attached). These will be placed beside each T.V. terminal. Users should complete them after viewing and leave them.

APPENDIX B
Exhibit 2

It is, of course, difficult to persuade people to complete such forms. We hope there will be a degree of intellectual involvement in the experiment of the nature of the forms themselves. They are as brief as possible.

A technical log will be kept. This will record technical problems which affect utilization. In addition to the technical log, it is recommended that the use of T.V. terminals be logged. This would make it possible to estimate the extent to which program evaluation forms are completed.

Procedures

1. The numbers and categories of the potential audience will be determined from the V.A. records.

2. The potential audience will be informed of: how to access VIDAC; how to complete the PEF's; the nature of and the reason for the experiment.

3. The potential audience will be encouraged to participate and use VIDAC.

4. Evaluation forms will be collected each week by the FSU team. At this time they will eyeball the evaluation and discuss the effectiveness of procedures. It will be appreciated that the heuristic aspects of this evaluation may make adjustments to observations and procedures necessary.

5. The summative evaluation will be based on the PEF's, the technical log, a final questionnaire addressed to all the potential audience, a random sample of users who will be interviewed, and observations.

APPENDIX B
Exhibit 3 Evaluation of VIDAC Distribution System

NAME_____DATE_____TIME_____PROGRAM NO._____

What is your position: Physician___Nurse___Administrative___Other___

We are concerned with your evaluation, not of the programs or their content, but rather the VIDAC delivery system. With that in mind, we solicit your cooperation in answering the question listed below. An opportunity to comment on the content of a given program will be provided in the general comments section.

1. What technical difficulties, if any, were experienced?

   Did correct program appear? Yes No
   Were there any visual difficulties? Yes No
   Were there any sound difficulties? Yes No
   If there were any other difficulties, please specify.

2. Which would you prefer?

   a. Free choice of viewing times?
   b. Planned viewing times?
   c. Both planned free choice or viewing times.

3. What shortcomings do you see in this distribution system?

   a. Lack of motion shortcoming not a shortcoming
   b. Lack of interaction shortcoming not a shortcoming
   c. Could you obtain this information from another source? Please specify.

   d. Other (please specify) _____.
   e. None

4. General Comments:

   a. Did you understand the program irrespective of technical difficulties?

      Yes No

   b. Was this program what you wanted?

      Yes No

   c. Additional comments on the VIDAC system.

APPENDIX B
Exhibit 4

DATE _____

Please indicate program number if in brackets how many times it is requested in the hour.

TIME	CHANNEL 1	CHANNEL 2	CHANNEL 3	CHANNEL 4
00				
01.00				
02.00				
03.00				
04.00				
05.00				
06.00				
07.00				
08.00				
09.00				
10.00				
11.00				
12.00				
13.00				
14.00				
15.00				
16.00				
17,00				
18.00				
19.00				
20.00				
21.00				
22.00				
23.00				
24.00				

APPENDIX C

SUPERVISORY PARTICIPANTS

VETERANS ADMINISTRATION

Robert B. Shamaskin	- V.A./ATS-6 Program Director	

VETERANS ADMINISTRATION

DUBLIN FACILITY

Harold Duncan	- Director	*
James Kilgore	- Director's Staff - Analyst	*
Walter Townsend	- Director's Staff - Analyst	*
Jack Upchurch	- Voluntary Services[1]	*
Jordan Register	- Voluntary Services[2]	*
Lora Johnson	- Nursing Education	*
Bennett Purvis	- Nursing Education	*
Dr. Charles M. Hendricks	- Medical Service	*
Mary Thompson	- Dietetic Service	*
Lillian Laggen	- X-Ray	*
Arthur Blanchete	- Laboratory	*

FLORIDA STATE UNIVERSITY

Stephen Horwitz[3]	*
Robert B. Wiltshire	*
John Tiffin	*

WESTINGHOUSE ELECTRIC CORPORATION

Henry M. Diambra[4]	*
Harvey J. Aderhold	*
Charles Brewer	
Robert L. Nelson	
Nancy L. Gulliford	

1/ Coordinator of V. A. Activities for this project

2/ Audio-Visual Specialist

3/ Coordinator of FSU evaluation

4/ Program Manager

* In attendance at planning meeting, November 12, 1974, at the Dublin V. A. facility.

FOUNDATION FOR APPLIED COMMUNICATION TECHNOLOGY

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Joseph Staton	- Assistant to the Director
Paul Horton	- Chief of Video Engineering

GEORGIA ETV NETWORK CENTER

Robert Ware	- Director of Engineering
Chester Haldeman	- Chief Engineer
Thomas Dixon	- VTR Specialist

ATLANTA AREA TECHNICAL SCHOOL

Judy Ambrose	- Audio Specialist

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