Automated computer controlled editing
sound system (access)

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HARDWARE

General system description

The ACCESS hardware is comprised of eight 200 megabyte moving head, removable disk pack disk drives. There are two microcomputers, a disk drive controller, two auxiliary memory banks, three sound data channels and a two channel independent high speed memory bus (DMA) which interconnects all of the preceding devices. There are various peripheral controllers for interfacing and controlling external equipment such as video tape record/playback units, magnetic tape recorder/players, sound amplifiers, level monitors, and SMPTE code conversion units. The CRT terminal (with keyboard), a 300 line per minute printer, video monitor, speakers, and the operations console which contains, switches, indicators, and sound modification controls are all located in the operations room which is about 60 feet from the computer room where all the other equipment is located. The computer electronics hardware is mechanized on two sided printed circuit cards (PCB) approximately 5 x 8 inches, with wire-wrapped integrated circuit sockets, and interface, connectors on both ends. The PCBs plug into standard 7 inch high, 19 inch wide card cages with combination wire-wrapped and printed circuit backplanes. Ribbon cables on the back edge of the PCBs interface between card cages and to external peripheral equipment. The card cages, disk drive controller, and power supplies are mounted in a standard cabinet 84 in H x 19 in W x 24 in D.

Major component description

The master computer (MACPU) contain a microprocessor, CRT terminal interface, 36 kilobytes (KB) of memory, disk controller (DCU) interface, arithmetic/logic unit, interrupt logic, printer interface, a direct control interface to the monitor computer (MOCPU), and the master DMA control logic. The MACPU performs most of the data processing load, handles interrupts, issues control tables and checks status of the DCU and DMA. As the name implies the MACPU is the master of the system and essentially controls the entire system. The CRT terminal and the printer interface directly to the MACPU. The DMA consists of two independent 8 bit data channels that allow simultaneous data transfers between any two pairs of devices on the DMA. Data transfer rates vary with the fastest rate being memory to memory transfers, 2 megabytes (MB) per second, and the slowest when the DCU is one of the devices, 806 KB/sec. There are six major devices interconnected on the DMA—MACPU, MOCPU, DCU, two auxiliary memory banks (AUX1, AUX2), and the sound channel DMA controller (SCHDMA) which coordinates data transfers to two sound data output channels (SCH1, SCH2) and one sound data input channel (SCH3). The MOCPU is almost identical to the MACPU except for the resident peripheral controllers. It handles all SMPTE code operations for synchronization purposes and has a floppy disk controller interface. It interfaces to all three sound channels via an independent 8 bit bidirectional data bus which is used to send/receive sound modification data, issue mode controls, monitor sound data memory balance counts, and is also used to control and monitor status of the external video tape equipment and audio tape equipment. The AUX1, AUX2 memory banks contain 28 KB each and are used primarily as buffer storage areas. The DCU is the most sophisticated device in the system. It can control up to 8 disk drives, each capable of storing 200 MB on a removable disk pack. Each pack can hold 40 minutes of digitized sound data so 4 hours and 40 minutes of sound effects (7 packs) can be on line and instantly available to the system. One drive is used as the system software drive and is also used to hold sound modification data, master library index, system maintenance and test routines, etc. Normally only a few seconds of a sound effect are required to be stored in the library. That basic piece of sound can be modified in an infinite number of ways and then only the mod data need be saved which requires virtually no storage space by comparison. The DCU requires a minimum of intervention from the MACPU which initiates operations and monitors status. The DCU accesses its command tables and transfers data under DMA control to/from any device on the DMA except the SCHDMA. Command tables can be linked or chained which allows a series of operations to be performed automatically. The DCU will select a drive, move
its heads to a specified cylinder, search for a selected record or key, and when located perform a read or write data block operation, and then signal the MACPU that it is finished. The DCU can execute 25 commands and can provide full track buffering to ease timing constraints. The sound channels each contain 36 KB of memory configured as first in first out (FIFO) memory. SCH1,2 accept digital sound data and the analog sections read the data out and convert it into an analog voltage, send it to the output multiplexer which routes the sound voltage to external equipment such as audio amplifiers, level monitors, and tape recorders. The nominal output sample rate is 50 KHZ and the digital sound sample size is 12 bits. SCH3 is identical to SCH1,2 except for the analog section which accepts, scales, and conditions a sound voltage input from any external source or from the outputs of SCH1 and/or SCH2 through the input multiplexer. The input sound is digitized at a 50 KHZ rate into a 12 bit word and written into the FIFO where it is read out to the DMA. The operations console contains the modification controls and indicators for two sound channels (effectively an automated mixer with added capabilities). Each channel has a volume (level) control, frequency (pitch) control, six equalization controls that provide a range cut and boost from -15db to +15db over three frequency bands (each adjustable). There are also bandpass shape selection switches for each band. There are enable switches and indicators for each of the controls, system status and mode displays, and a SMPTE time code display. There are remote controls for both video tape and audio equipment.

SOFTWARE

A detailed description of the software is beyond the scope of this paper and it is difficult to describe in a general manner and still be meaningful. In order to realize maximum efficiency and flexibility from the system the hardware was designed as general purpose as possible to permit continuing software development to expand the capabilities of the system. A very good balance has been achieved whereby hardware handles real-time system requirements such as sound data transfers, time code processing, interrupt generation, high speed 16 bit arithmetic and logical operations, etc. The DCU performs many operations while requiring very little intervention from the MACPU which allows maximum processing time. Programs are generally modular and self contained which permit modification and upgrading without impacting the entire system. The power of the DCU enables the computer to use virtual memory techniques which allow the system disk to look like program storage. Program data blocks can be moved between DCU and MACPU very rapidly, 36 KB in less than one tenth of a second and MACPU processing is suspended for less than one third of that. The variable record format capability of the DCU permits optimum program and data block size. Indexed sequential access methods (ISAM) techniques are used allowing the DCU to locate and fetch a sound (begin transfer) in less than one tenth of a second. The editor seldom has to wait on the system because of programming delays. The menu concept is used where the editor is presented a list of functions, sounds, etc., which are displayed on the CRT. He then responds by choosing the desired item by entering a letter or number corresponding to that item. Direct questions are displayed requiring only a single entry to respond. Keyboard entries are kept to a minimum as much as possible. Entries are error checked and error messages displayed if the editor makes a mistake such as an invalid time code, specifying overlapping sounds on the same track, attempting illegal operations, etc. If auxiliary information is allowed such as descriptions of sounds or modified sounds the entry format is free form, i.e., the editor can enter anything he wants. There are no “computerese” type entries required. All information entered or generated during operation is saved by the system to eliminate redundant entering of data which permits many tasks to be performed virtually automatically. Complete recall and re-creation of previous work done at any level is kept available so changes can be made quickly no matter how long ago the original work was done. Reports are generated in various formats and printed for use by editors, sound technicians, and mixers. System software utilities consist of a modified INTEL assembler and editor for program generation, DCU format, test routines, disk pack evaluation, memory test programs for fault detection and isolation, and system diagnostics.

OPERATION

A brief description of the major programs and their functions available to the editor will be covered although it should be noted that approximately one hour is required for a live demonstration of the general capabilities of the system.

Editor

This program is used to fetch and edit a sound(s). The desired sound is selected by entering its key ID (up to 15 alpha/numeric characters) or the list program will display a screen full of sounds with their ID and description for selection. The display can be started at any point in the library and will be continually displayed until the end or until the editor selects one by entering a number associated with the sound. Previously modified sounds can be called by entering the mod sequence number and they also can be displayed on the CRT. The selected sounds can be played for listening only or for modification using the operations console. The sounds will be played upon command from the editor or if the VTR is being used for picture display when SMPTE time code agreement is found. (All picture material is recorded on 3/4 inch video tape cassette with SMPTE time code superimposed on the picture and also recorded on one of the audio tracks. If production sound was available it is recorded on the other audio track.) The editor can choose one of the following functions—play the sound as it exists in the library, play a previously modified sound, create background (continuously repeats the sound) or edit the sound. The edit function permits modifying the length of the sound by pro-
gressively delaying the beginning or shortening the end of the sound or will enable the editor to select any portion of the sound. After the sound is played he can again select one of the functions or if mods were made he can reset them or save them. If the mods are saved the system assigns a mod sequence number and after the editor enters a description it is entered into the library. Mods made using the operations console are retained and replayed so mods can be made to mods on successive passes without losing the previous mods (automated mix feature).

Prescript

This program is used to create up to 19 sound tracks (10 min. each) for up to 23 picture reels (10 min. each). For example, a 1 hour show will typically consist of six 10 min. reels, each requiring seven sound tracks for a total of 42 tracks. The editor will assign the reel number, track number, start/stop time code, and the sound ID or mod number and the program will assign a chronological sequence number within the track and error check the entries. The accumulated track data is always available for display or printing. Once entered the entries can be modified, deleted, or moved to any tracks or reels very simply. This program also consolidates all data pertaining to the show being worked on—sounds, mods, timing data and stores it on one (or more) disk packs called the “show” pack. This permits an entire show to be played or laid off without the need for all the library packs (where the sounds originated from) to be on line. It can also be used as a library pack and allows an entire show to be saved in the physical space required for about five 35mm 1000 foot reels instead of the typical 42 reels required for a one hour show. Changes can be made and laid off almost instantaneously using the show pack. There is also a “show history” pack which contains all the data necessary to re-create a show pack except the basic sounds. A show pack is not normally retained after a show has completed final production. When a show pack is to be re-created the program will tell the editor which library packs need to be on line. Up to 80 show pack histories can be accommodated by one show history pack.

Play tracks

This program permits the editor to play back one or two tracks (of the same reel). The editor enters the reel number, track(s) number, and if the track playback is to begin at a point other than the beginning of the track the sound sequence number is entered. Playback commences upon command from the editor (the SMPTE time code is simulated by the program) or when SMPTE time code agreement is found with the external equipment (usually the VTR). As with all programs the operation can be terminated at any time by the editor.

Record

This program is similar to the Play Track program and it is used to lay off or record sound tracks to an external device (usually a single or multi-stripe magnetic tape recorder). An output multiplexer allows the tracks to be assigned to any of six output lines. The editor enters the reel number, track(s) number, the stripe assignment number, and if recording is to start at a point other than the beginning the sound sequence number is entered. Recording begins when the external equipment is interlocked (up to speed and in sync) and SMPTE time code agreement is reached.

Update library

This program is used to load new sounds into the sound library. A sound can be input from any source (synchronized or not) and after being digitized it is saved temporarily on the system pack. It can then be played back and checked for quality, level, and then edited for length (usually several seconds is sufficient for most sounds). When satisfied with the sound the editor enters the key ID and description and specifies the library pack the sound will be stored on. The program checks the sound key ID for duplication and verifies that there is enough space on the specified library pack. The sound data is then transferred to that pack and the master library index is updated and the key entered into the ISAM table.

List

This program enables the editor to display and/or print out numerous lists of information in a variety of formats (alphabetical or numeric order, time code sequence, etc.). Some of these are the contents of the sound library, modified sound library, show pack, show history pack, and track contents. Cue sheets with time ordered entries and 35mm feet/frames references for mixers and lay-off sheets for sound technicians are also provided.

SUMMARY

ACCESS was installed at Neiman-Tillar Associates, 8304 Beverly Blvd., Los Angeles, in January 1977 and has been used to create sound effects tracks for many feature films and TV shows. ACCESS has enabled the editor to expand and utilize his creative abilities as well as increase production output fivefold. The instantaneous availability of sounds and the electronic editing capability results in a tremendous time savings. Software development continues to enable dialog clean-up and music editing to be performed on ACCESS. The second system is almost completed (pre-production model). ACCESS has become the biggest technical advance in the Post-Production sound editing field over the past 50 years.