

INDUSTRIAL DATA PROCESSING APPLICATIONS REPORT

Applications Switching Control and Facilities Assignment
Type of Industry Broadcasting
Name of User CBS Television
New York, N. Y.

Equipment Used Bunker-Ramo 330 Computers (Two)
Friden Flexowriters
Digitronics High Speed Reader

Synopsis

CBS Television in New York is using two Bunker-Ramo 330 computers to handle switching and facilities assignment. The computers are used to control a master exchange switching system as well as other memory and control functions.

The computers perform two basic functions such as the daily assignment of all video tape, projectors and other source facilities to control rooms. They also perform on-air switching operations of two Program Control rooms. Two program lines are capable of feeding five different network lines under computer control in each of the Program Control rooms.

At present, CBS is examining additional computer systems that will add greater flexibility in producing source documents.

Before applying the use of a digital computer to automatic switching control at CBS, consideration was given to which functions would be better performed by a computer and which operations would be better performed by control room personnel.

Some operations which required a high order of manual dexterity were inherently mechanical in nature and others required some form of human supervision. For example, station break sequences, audio and video switching and the starting and stopping of video tape machines, film projectors and slide projectors are basically mechanical operations. On the other hand, the maintenance of high quality of both pictures and sound are functions that would benefit from human supervision.

The CBS Broadcast Center in New York is the center of the CBS Television Network's activities. It is a distribution point for programs sent out to network stations as well as being a production center for live television shows. Programs produced range from large television specials to uncomplicated discussion programs.

The Broadcast Center is also the focal point for the operations of CBS News and provides television facilities for the local programming of WCBS-TV, the CBS-owned station in New York.

The digital computer system at CBS in New York has interwoven the responsibilities of computer and man.

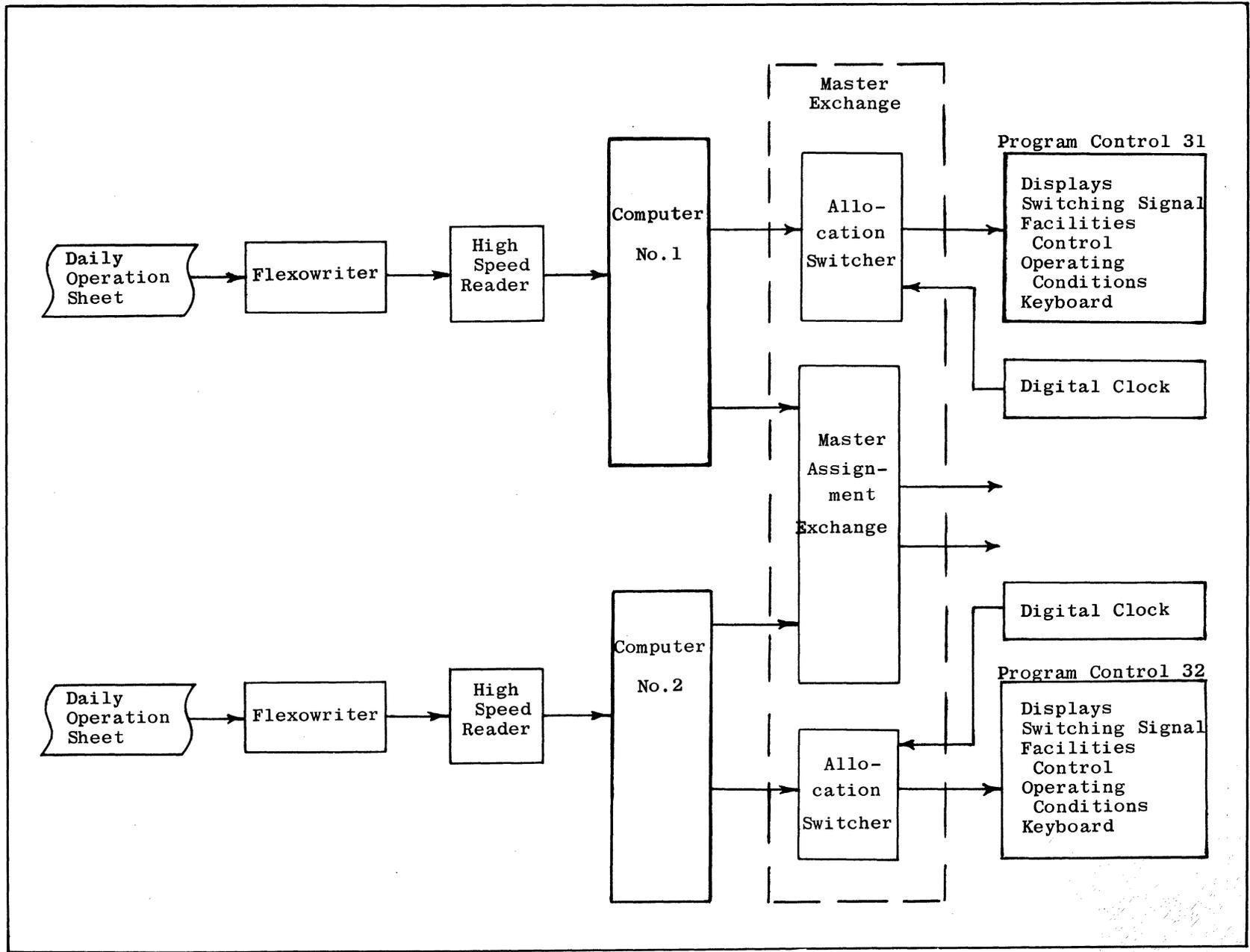
CBS in New York has replaced its original plant to provide a modern, more efficient and more flexible facility. The original CBS Television plant, like many others built at the time, was installed quickly during the early days of television broadcasting and expanded piecemeal to meet changing requirements.

In replacing and modernizing, the objective was to bring about a more efficient operation and one which is capable of producing a higher quality product. This has been achieved by taking advantage of current technology, particularly in the utilization of more stable and reliable equipment.

In this connection, the use of computers was introduced to augment control of broadcast operations. At CBS, two Bunker-Ramo 330 computers are used to control a Master Exchange switching system as well as other memory and control functions. Normally, the operating load is shared by both computers. However, one unit is capable of handling all of the basic network and local station operations and, consequently, the second provides back-up protection. Emergency back-up protection for an hour ahead is provided.

The computers perform two basic functions:

1. On-air switching operations of the two Program Control rooms and their related equipment are handled entirely by computer control. There are two program lines which are capable of feeding five different network lines under computer control in each of the two Program Control rooms. Audio and video switching, fading, special effects, tape and telecine transport, audio tape and turntable transport, and sync-lock are controlled. The information for control is fed into the computer in the same manner as is the facilities assignment. Changes in the instructions can be made by punched tape or manually, by use of the keyboard in the Program Control Room.



COMPUTER CONTROL SYSTEM AT CBS.

2. The daily assignment of all video tape, telecine and other source facilities to control rooms is recorded on punched paper tape by means of a Flexowriter at the time the daily operations sheets are typed and then fed directly into the computer memory by means of a Digitronics high speed tape reader. Any necessary changes in assignment can be made by punched tape or manually by means of the digital keyboard in Central Operations. The digital keyboard is not connected to the computer but can operate the Master Assignments Exchange directly.

Daily switching information is derived from a Daily Operation Sheet and Program Log which is an operation schedule for departments concerned with broadcast operations and other source documents. From this a Daily Switching and Facilities Log is prepared and it contains all data to be entered into the computer.

A punched paper tape is prepared to feed this data into the computer by the use of a Digitronics high-speed reader.

This is CBS's second computer automation system. The first was a simpler system used at KNXT, the CBS-owned station in Los Angeles.

THE SYSTEM

Master Exchange

The Master Exchange System at CBS is similar to a telephone exchange. By means of relay switching, support facilities are connected to studios and control rooms and program signals are routed to their proper destination.

The system switches signals between 109 input channels and 197 output channels. Inputs are fed from telecine cameras, video tape units, utility live cameras, on-and-off premise studios, Program Control rooms and remote pickups. Each input channel carries audio and video signals as well as control signals. Output channels provide service to studio and Program Control switching systems, video tape recording and film recording. In addition, outputs are fed to outgoing networks, monitors, viewing rooms and other circuits.

Master Exchange performs four major switching functions. These are:

1. Facilities assignment switching. This function is performed by the Master Assignment Exchange (MAX) and assigns to control rooms facilities such as film projectors, video tape machines, standards converters, remote channels and the outputs of other studios and Program Control rooms.
2. Outgoing program channel switcher (NET) for switching complete programs to outgoing network circuits, recorders and WCBS-TV.
3. Recording switching for connecting the desired programs or sources to film and tape recording facilities.
4. Monitoring switching for feeding program material to viewing rooms, offices and control room monitors.

Computer control of Master Exchange involves two of the four switching functions named above, functions 1 and 2. In the second function the computer controls inputs from two control rooms known as Program Control rooms 31 and 32 and switches signals to outgoing channels.

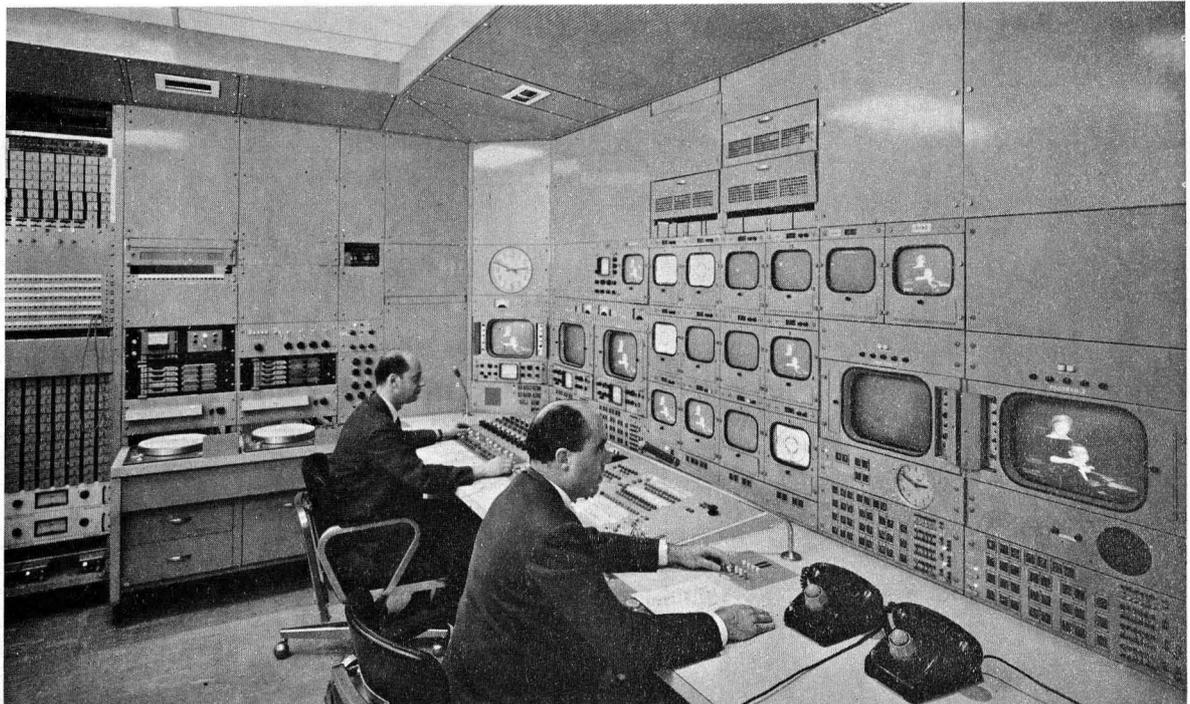
The Master Assignment Exchange, (MAX), under control of the Bunker-Ramo 330 computer, makes audio and video as well as communications and control signals connections. Inputs to the Master Assignment Exchange include film and slide projectors, video tape machines and control room signals.

The outgoing program channel switcher (NET) receives inputs from Program Control rooms, studios, the closed-circuit control room and remote installations. As mentioned above, two program lines feed five network lines. Part of NET is computer controlled when the Program Control room changes the program it is putting out on an assigned transmission channel.

Central Operations

Normally, facilities assignments are made via the Master Assignment Exchange (MAX) under control of the computer. However, when changes or additions to the scheduling are necessary and have to be made within five minutes of an assignment, the change will be made from Central Operations by the use of a central keyboard. MAX, in this instance, is operated directly from the keyboard and is independent of the computer operation.

In order for Central Operations to make changes in facilities assignments manually, it must be aware of the location of all technical facilities in the plant. To keep personnel in Central Operations up-to-date, a copy of the Daily Operation Sheet and Log is kept on hand. In addition, hard copy is printed out on a Friden Flexowriter and spells out all corrections and changes to the Daily Operating Sheet, facilities changes which are not included in the computer's data and copies of messages (such as orders for video tape or film from ready storage) that are routed to various technical areas by Central Operations.



A PROGRAM CONTROL STUDIO AT THE CBS BROADCAST CENTER IN NEW YORK IS USED TO CONTROL THE FEED OF PROGRAMING TO NETWORK AFFILIATES AND TO WCBS-TV, THE CBS-OWNED STATION IN NEW YORK.

Whenever a change in facilities is to be made, a request is made to the Broadcast Control Department and a punched paper tape is prepared containing the corrections to be fed into the computer.

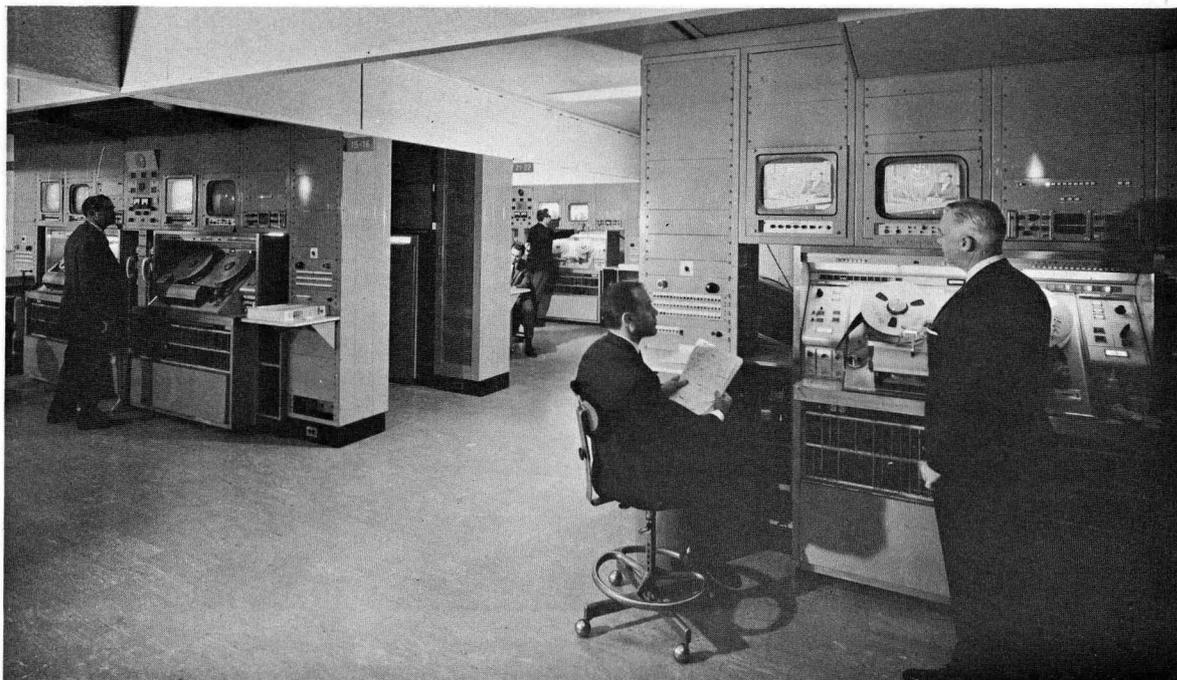
If there is insufficient time to produce a correction tape, Central Operations will change the assignment by using the MAX keyboard in the Central Operations console. The assignment is changed after the computer has already made its assignment because the computer's orders cannot be changed. In effect, the operation of the keyboard overrides the computer's selection.

Program Control Room Operation

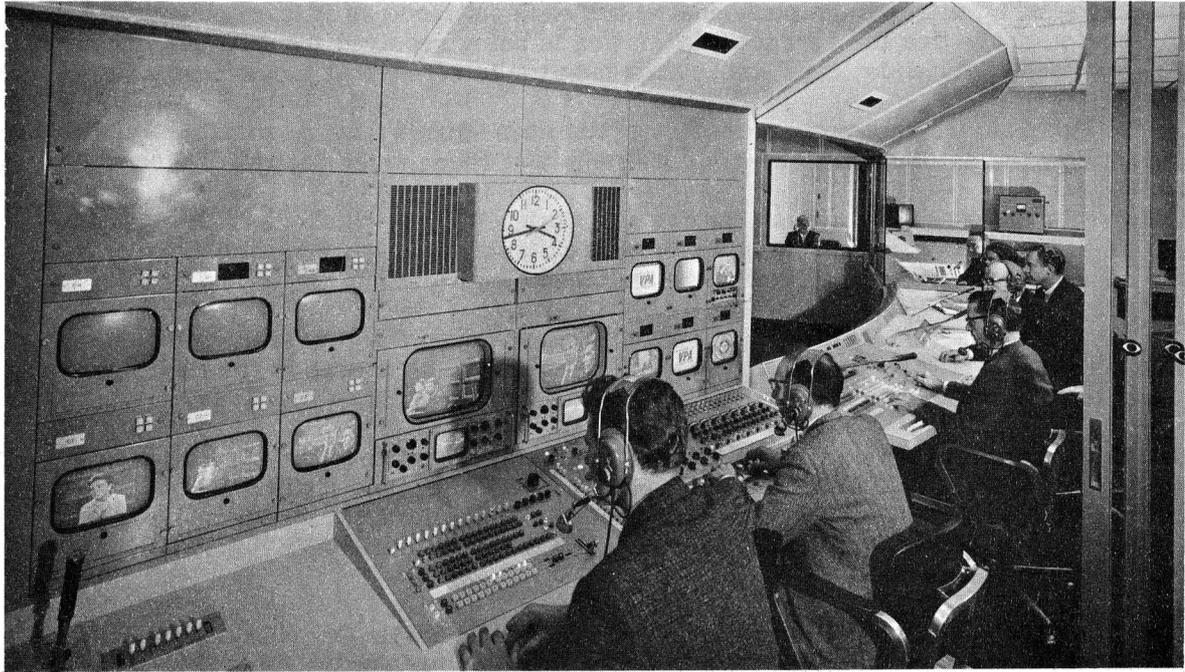
For the purposes of this report the expression, program control, will refer to the operation of Program Control rooms 31 and 32 at CBS. It does not refer to control of the computer program since the computer is preprogramed and does not need additional information except for the receipt of daily assignment and switching data.

The two Bunker-Ramo 330 computers, one for Program Control room 31 and one for Program Control room 32, perform the three basic functions as outlined above. In regard to continuity switching, the two computers function identically. However, one computer will perform lighting preset and retrieval functions for studios 42, 43, and 44 while the other will perform these functions for a different set of studios. The second computer also handles assignment of facilities and prepares hard copy printout.

All computer programs are stored in each computer allowing the system to interchange functions. That is, computer 1 can perform the tasks normally assigned to computer 2 and vice-versa. During Daylight Saving Time both computers are actively engaged in switching programs on the air, one for the Daylight Saving Time Network, and the other repeating the program one hour later to the Standard Time network.



VIDEO TAPE COMPLEX AT THE CBS BROADCAST CENTER.



TYPICAL STUDIO CONTROL ROOM WITH THE AUDIO FACILITIES ON THE RIGHT AND THE DIRECTOR AND THE PRODUCTION TEAM IN THE CENTER. VIDEO CONTROL FACILITIES AND SPECIAL ELECTRONIC EFFECTS ARE AT THE LEFT.

Each computer handles continuity switching for its designated Program Control room. For example, computer 1 performs all on-the-air continuity switching for Program Control room 31, including the following:

1. Pre-starting of all projectors and video tape machines.
2. Changing slides, "lighting" and "dousing" slide projectors.
3. Preselection of the configuration of assignment of Program 1 or Program 2 to five output lines.
4. Preselection from a group of 10 cartridge tapes to feed one of two inputs.
5. Preselection of clock time events.
6. Insertion of EPSQ (Extended Program Service Cue). This is a signal that alerts network stations 10 seconds prior to the time local or regional commercial material is to be inserted and 10 seconds prior to the continuation of the program.
7. Hard copy printout of Program Control room 31 on-the-air continuity switching log.

The operation of a Program Control room can be accomplished either manually or by the computer. The Program Control room operator's main responsibilities are to monitor the incoming signals, to make level adjustments on the source material entering the PC room and to handle emergency situations. Normally, the computer will control the connecting of facilities and switching of programs, but during a live portion of a program of unpredictable length the operator will terminate the event and begin the next event in sequence. Station break sequences are normally switched by the computer. Each Program Control room is operated by a two-man team consisting of an operator and an Associate Director.

The Program Control room personnel check each sequence as it is displayed, in advance of its execution, to assure that the correct information is being received from the computer. They also visually check each film, slide, tape, etc., on a monitor to verify that the correct element is ready.

In the Program Control room a number of displays enable the Associate Director and the operator to follow the automated sequencing of events and recommend changes where necessary.

All events occurring throughout the day are assigned "item numbers," that designate switching events or preselection. These item numbers are displayed in the Program Control room and indicate the item number of the next event to be switched on-air.

Each switching action by the computer initiates an "event" and the time between switches is the duration of an event. The length of time until the next switch occurs is the time remaining of the event. This time remaining is indicated in the ON AIR display.

Displays are arranged so that the highest priority information, the ON AIR event, occupies the top row of readouts. The NEXT EVENT, SECOND EVENT, and THIRD EVENT displays pertain to data of succeeding events. Following a switch, all displays are updated; i. e., the THIRD EVENT moves to the SECOND EVENT, the SECOND EVENT to the NEXT EVENT and the NEXT EVENT to the ON AIR display.

Other displays are available such as TIME OF DAY, TIME OF NEXT SEQUENCE, in addition to audio, video and special effects displays.

If the Program Control room operator desires he can initiate a "search" of the computer memory for information pertaining to a particular item. This is accomplished by depressing the SEARCH key and typing on the computer keyboard the item number about which information is being sought. This places the computer in a search-entry mode. The item number of the information being sought will appear in the ITEM NUMBER display and the corresponding data will appear in the display that normally displays the SECOND EVENT. The second event display used for search entry is the second event display of Program 2, there being two complete sets of displays, one for Program 1, and one for Program 2.

In this mode the Program Control room operator can also change the data of any item number replacing original information with the required substitution.

To return the displays to normal the operator will depress the OPERATE key. The search-entry mode does not interrupt the on-air operation of the computer.

Automated Operation of Program Control Rooms

After information has been fed into the computer by means of a punched paper tape, the only regular information fed into the computer is a timing signal which interrupts the computer once a second. These signals start a series of searches by the computer that determine whether there are functions to perform in the next one-second interval.

After each one-second signal the computer performs the following functions:

1. It determines if there is a video tape machine that requires prestart. If there is, it prestarts that machine.
2. It determines if there is a film projector that requires a prestart. If there is, it prestarts the projector.
3. It determines if any "on-line" keys have been depressed (i. e., such as HOLD or DISCARD NEXT EVENT keys) and performs the functions called for.

4. It determines if a duration event is on-air and decrements the ON-AIR display by one second.
5. It determines if the TIME REMAINING has counted down to zero and, if so, switches to the next event on air.
6. It determines if video tape machines or projectors have started and, if not, switches to a backup machine or projector.
7. In the event that neither the on-air machine nor the backup machine started, the computer activates an alarm in the Program Control room.

After the computer switches an event it updates all displays in the Program Control room. It moves the second event to the NEXT EVENT display, the THIRD EVENT to the SECOND EVENT display, etc., as described above.

In some operations video tape machines and film projectors require prestarts. This means that, in the case of a video tape machine, a seven-second prestart signal starts the machine running, prior to its being placed on-air. For example, if the next event to go on-air is a manual event (initiated by the operator), a five-second slide and a video tape is displayed in the SECOND EVENT, the slide will be on-air two seconds after a SWITCH key is depressed. This places the computer again in automatic operation and it starts the video tape machine. Two seconds later the slide is placed on-air and after the five-second duration of the slide the video tape machine, now running for seven seconds, is placed on-air.

Most of the data stored in the computer memory are items of switching information. Some of the data, however, pertains to direct operation of the technical equipment. Specifically, this data is known as a "preselect," and is not a switching instruction but rather an instruction to predesignate equipment to be used in a subsequent event.



CENTRAL SUPERVISORY POSITION FOR TECHNICAL SUPPORT FACILITIES.

Keyboard Functions

By the use of the computer keyboard the Program Control room operator has access to the computer which enables him to make changes in the switching sequence and to initiate certain operations. The main functions of the computer control keys are designated in the following table:

KEY DESIGNATION	FUNCTION
SPECIAL ROUTINE	This places the computer in a special routine mode, but does not affect the normal operation of the computer, until a code number is typed on the keyboard. The code determines the special function.
SEARCH-ENTRY	The search-entry mode does not affect normal computer operations, but blanks out the SECOND EVENT and THIRD EVENT displays of Program 2. The computer then stands by to accept an item number typed from the keyboard.
OPERATE	This places the computer into the operate mode, and returns the SECOND EVENT and THIRD EVENT displays of Program 2 to normal.
DISCARD NEXT EVENT	As the key designates, the NEXT EVENT is discarded and the third event is moved to the SECOND EVENT display and the second event is moved to the NEXT EVENT display.
DISABLE	This disables the computer from performing Program Control room switching.
HOLD	This puts the computer into a manual operating condition. It is also used to "enable" the computer after use of the DISABLE key.
SWITCH	This switches the event that is indicated in the NEXT EVENT on-air. If the ON-AIR display indicated a manual event with a prestart posted, the computer will prestart the next event before switching.
PRE-CHECK	This manually places the computer into a five-minute pre-check routine.

Other computer control keys and alphanumeric keys enable the operator to carry out the functions listed above as well as performing reset, clear and enter operations.

Station Break Operation

In order to explain more fully the computer's role at CBS an example of a station break routine is given to show the interaction between the computer and the Program Control room operator.

Five minutes prior to a station break the Program Control room operator will initiate a pre-check routine by depressing the PRECHECK key on the computer keyboard. This will change the function of the NEXT EVENT display to a "next sequence" display. All switching items contained in the next sequence are cycled through this display, posting each item for about three seconds. In the order of occurrence, projectors are lighted and video tape machines turned on. If the proper facility has not been tied in to the Program Control room, an alarm is sounded.

After being assured that all of the facilities used in the next sequence are operable, the operator extinguishes projector lights and turns off video tape machines manually.

About one minute before the station break a "standby" operation is started and projectors and video tape machines are readied to go on-air. The operator then operates the SWITCH key which starts the computer cycling through the station break routine.

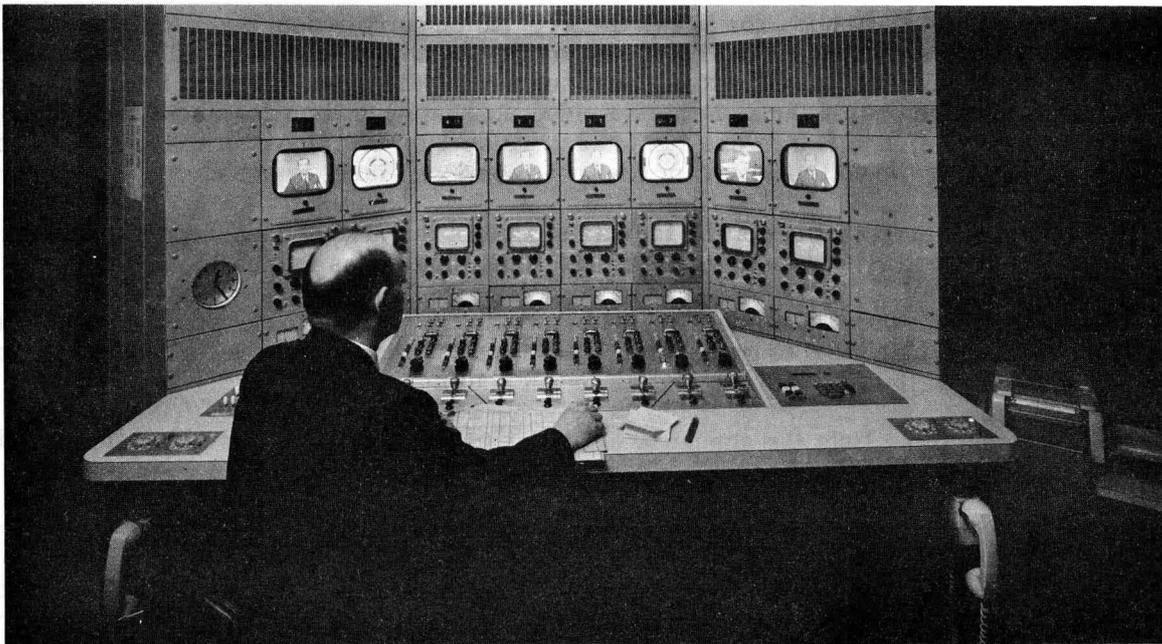
The following table lists the sequence of events to take place during the station break:

Status of Event	Item Number	Duration	Input Position	Source of Video	Source of Audio
ON-AIR	7D07	Manual	7	ST-42	EFF (Studio 42)
NEXT EVENT	8A01	0:20 (20 sec.)	2	16-10	EFF (Track)
SECOND EVENT	8A02	0:08 (8 sec.)	3	16-11	EFF (Track)
THIRD EVENT	8A03	0:02 (2 sec.)	1	SL-1	ANN 1
Fourth Event	8A04	0:00	11	VT-1	(none)
Fifth Event	8A05	Manual	12	VT-2	EFF (Track)
First Event of next sequence	8B01	0:20 (20 sec.)	5	VT-3	EFF (Track)

At 7:59:27 (three seconds before the scheduled break) the Program Control room operator depresses the SWITCH key which prestarts the film projector noted by 16-10 in the column headed, Source of Video. The projector is then running for three seconds prior to being placed on-air. When the ON-AIR display counts down to zero, it then changes to read 0:20 and begins to decrement each second while the projector is on-air. As the count reaches 0:03 the computer prestarts projector 16-11. When the ON-AIR display reaches 0:00 this time, it changes to 0:08 or 8 seconds, the duration of the SECOND EVENT. The ON-AIR display again begins to count down as the projector 16-11 is on-air. When the count reaches 0:05, the video tape machines, VT-1 and VT-2 are prestarted. This five seconds plus the two seconds of the slide (SL-1) add up to the required seven seconds prestart time for the video tape machines.

The slide, SL-1 then goes on-air for two seconds, followed by the video tape event. The video tape machine, VT-1, is started for the purpose of backing up VT-2. In the table above, the fourth event has a duration listed of 0:00 or zero seconds. The video tape machine, VT-1, would be used only if a feedback signal from VT-2 was not received by the computer.

In this particular example the fifth event using video tape machine, VT-2, is a manual event and the operator terminates this portion of the sequence.



CLOSED CIRCUIT CONTROL ROOM USED TO MONITOR THE AUDIO AND VIDEO LEVELS OF MATERIAL BEING VIEWED PRIOR TO BROADCAST.

Emergency Operation

An emergency operation takes place whenever an unforeseen occurrence interrupts the normal sequence of events during a program that is being aired. This might be caused by a news bulletin, a film break or a mis-timed program segment.

When a news bulletin is to be aired, for example, during the showing of a feature film, the Program Control room personnel are informed of this fact by Broadcast Control. A special slide projector used for news bulletins is lighted by the operator and microphones turned on and the bulletin aired. After the bulletin is aired the program is switched back to the feature film which was kept running. During this operation there was no interruption to the normal computer cycling.

Results and Future Plans

The use of a digital computer for television switching and facilities assignments has permitted CBS almost complete freedom in the development of a man-machine relationship. The techniques employed at CBS allow a versatility in approach to the many operations that have to be performed in the course of a day's programing. Changes in scheduling, an inherent part of television programing, can be handled with ease by operator intervention and the need for special-purpose equipment has been minimized.

In the future, lighting control board presets for studios will be stored in the computer and recalled to automatically reset the controls as required by actuating a keyboard at the lighting console.

CBS is presently examining additional computer systems that will add greater flexibility in producing source documents.