

The First Full-Scale Surround Sound Sweetening Room for HDTV

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ABSTRACT

A discrete 3-1 quadrasonic sound post-production studio equipped with full digital processing system has been completed for the purpose of producing HDTV surround sound programs. The 156 inches acoustically transparent HDTV Screen and two rear loudspeaker systems for the domestic room and the theater are introduced in this studio.

This paper describes an outline of the facilities and the state of working.

0 INTRODUCTION

Daily 8-hour HDTV(High Definition Television) broadcasts have already been conducted in Japan for the past two years. The greatest charm of HDTV broadcasting lies in the expanded sensation of presence which stems from the use of a large screen. The time is now ripe for ordinary families to share this experience in the home.

Needless to say, many excellent programs are also required in order to make the best use of HDTV's possibilities. With regard to sound, HDTV has a high fidelity 2-channel transmission mode and a surround mode which makes 4-channel transmission possible. Ordinary stereo programs of a certain level can be produced even in a conventional studio, but full-scale surround programs have to be produced in a studio equipped with facilities that possess suitable visual capabilities.

This paper outlines the design of a sound post-production studio for HDTV programs and its facilities which was recently installed at the NHK Broadcasting Center in Tokyo.

1 Basic ideas for the System

1-1 Necessity of Large Screen

HDTV is developing steadily as a next-generation information medium. Its difference from conventional TV media lies in the 6-fold increase in the volume of information used, which has made it possible to produce large image.

Comparison of a screen-size of 14 to 30 inches with one of over

50 inches easily reveals a striking difference in the sensation of immediacy. When the size of the screen exceeds 100 inches, a feeling of genuine presence begins to enlarge.

Viewers have the sensation of entering the landscape, drama or concert hall. In order to create sounds that match this world of images, a suitable production environment is essential. It is not impossible to create sounds of magnificent scale for a monitor screen of only 21 to 34 inches. The best approach, however, for producing feelings of scale and the accompanying minute precision of sound is to prepare a suitable environment that does not depend entirely for its effect upon the human imagination.

Bearing these points in mind, a 156-inch acoustically transparent HDTV screen was adopted for this studio. In addition, a new concept was introduced for the surround monitor system.

1-2 Ideas for the Sound Stage

Motion pictures pioneered the field of combining sound with picture images. In the world of movies, various sound formulae have been devised. In time, monophonic system of optical recording was replaced by a multi-channel stereo system of magnetic stripes, then by the matrix type 3-1 surround formula of the Dolby System which proved a great commercial success.

Movie sound is again beginning to undergo great changes with appearance of the digital recording formula, for instance in which the volume of information is reduced to about one-fifth by bit compression technology and then recorded optically onto the film.

This technology makes it possible to record the sounds of 6 channels on the existing 35-mm film. Whether this digital system will prove commercially successful or not must depend on the future movements of the market. The progress, however, is clear.

Regarding HDTV, moves have been reported outside Japan to adopt a transmission format using the 3-1 sound system or above.

The 3-2 system, for example, which has a 2-channel transmission unit on the rear, can reproduce stereophonic surround sounds.

In addition to conventional front 2-channel stereo reproduction capability, the 3-1 system also has a center channel in which sounds are heard from just above the screen even if the viewer changes his or her listening position. The main charm of this system is that sound images are expanded from lines to three-dimensional space thanks to the surround components obtained from the rear channels.

In addition, two or more loudspeakers are usually installed on the rear in order to emphasize the surround sensation - - the listener feels as if he or she is encircled by sound.

In dramas and similar programs, the 3-1 system can strikingly increase the feeling of presence, depending on how the formula is used.

This same sensation is clear when viewing a movie made by the Dolby stereo system, but HDTV further expands the expressional range in terms of both separation and sound quality thanks to the discreteness of the formula employed. For music programs, the system makes full use of its front 3-channel characteristics to reproduce sound with excellent realism and a strong feeling of a stationary sound source. However, since the surround component is

monophonic, the system has some problems in the reproduction of natural sounds and images.

The 3-2 system has a stereophonic rear unit, and thus has the merit of reproducing three-dimensional echoes or reverberations in the performance space as well as the atmosphere of the hall. It may be possible to use this system throughout the entire program.

In principle, the higher the number, the better the reproduction becomes. The overall judgment must be made with regard to the work involved, total cost and effects to be obtained. In this respect, it may safely be supposed that the 3-1 formula will remain the main instrument in Japan for the foreseeable future.

The studio constructed this time is based on the 3-1 formula, but is also designed to allow production using the 3-2 system as and when future production systems are introduced.

1-3 Basic Design of the Studio

Fig.1 shows a mercator chart of the studio. It is composed of 6 blocks. The control room, which serves as the core, has an area of about 59 m² and a cubic volume of about 200 m³. The studio is shaped like a mini-theater, with a 156-inch acoustically transparent HDTV screen in the center. Its floor is 150 cm high and the stage has three levels rising to the rear. The floor of the booth is 300 cm higher than the highest stage level to ensure an unobstructed view of the screen.

The front room serves the functions of both sound rock and a meeting room for staff.

The machine room is equipped with a cooling system for the exclusive use of the studio which can be operated continuously round the clock. The pre-production room did not exist in the conventional studios of NHK and is incorporated under a new concept. As its name indicates, this room is the place where necessary SE(sound effect) and Music are put into DAW(digital audio workstation) prior to work in the control room.

The pre-production room can also monitor the output of the control room and confirm the reproductivity of surround space in a small area.

The storage room is used to store tapes and maintenance goods, but can be also used as a utility space for the keeping the inside of studio clear of unwanted items.

The eight horizontally-sliding sound-blocking automatic doors were developed by NHK. These doors improve the efficiency of sound insulation work.

1-4 Ideas about the Sound System

Fig.2 outlines the studio facilities, which are somewhat different from those of the conventional post-production studio of NHK.

The most important characteristics are related to the adoption of a system composition centered on DAW. Three DAWs were installed in the studio. One is placed in the center of the mixing console. It has an 8-channel input and 16-channel output. This DAW is also controls the mixing console.

The remaining two units are compact machines. Each has an

MO(magnet optical) disk for recording, 2-channel input and 4-channel output.

One is installed in the pre-production room so that work can be conducted apart from the main room.

In the pre-production room, arrangements of the script or preparations of SE are made in advance, and the MO disk containing the sounds is then inserted into a DAW in the control room for use during post-production. in the studio.

The adoption of this process helps to improve the efficiency of independent work in the control room and thus contributes to a marked increase in the overall efficiency of the studio.

Fig.3 shows a loudspeaker arrangement for surround sound . The center speaker at the front is centrally installed in the rear of the screen. One set of speakers is placed on the left and another on the right side of the screen. Two-channel surround speakers are placed in the rear.

The loudspeaker system is based on the 5-unit horizontal array arrangement usually seen in movie theaters. Paying consideration to viewing and listening conditions in the domestic room, a two channel speaker system is arranged on the left and right at the rear.

Further, a system composition has been adopted for the loudspeakers placed in array in order to enable each unit to change the delay time independently.

The video system uses the UNIHI VCR cassette for HDTV. Images obtained are projected onto the screen with a bright projector used for both HDTV and NTSC.

The bright projector makes a lot of fan noise, so a total sound

blocking structure was used to surround the system. This was very successful. Concretely, the NC value stands at 25 when the projector is on and at 10 when it is off.

Fig.4 is diagram of studio work flow shows, pictures and sounds are copied from the 1-inch HDTV digital VTR to the UNIHI VCR and the PCM multi-channel recorder, and used in the workstation.

After sweetening, sounds are recorded on track of the PCM multi-channel recorder, and the recorded sound are copied on the 1-inch HDTV digital VTR.

Images are processed at 60 Hz, the standard synchronization value of HDTV, during this entire process. 48 KHz word synchronization derived from this standard is use to process the sound.

In the conventional NTSC video sweetening room, by contrast, images from a 1-inch HDTV digital VTR were recorded at 60 Hz on a 3/4-inch cassette type U-Matic VTR, while sounds were went to the workstation after copying at 44.1 KHz on a PCM multi-channel recorder.

In this case, images were reproduced at 59.94 Hz, which is the standard sync of the studio, resulting in the extension of the time axis by 0.1%. This meant that a one-hour program actually lasted one hour and 3.6 seconds.

Accordingly, the PCM multi-channel recorder is operated at 44.056 KHz for sound during sweetening, so that their time axis become coincident with that of the image time.

The prepared sound were reproduced at 44.1 KHz by the PCM multi-channel recorder, and then inserted to the 1-inch HDTV digital

VTR for lay-back operation, returning the time axis to its original position.

In the newly-completed studio, such complicated work processes disappear, making the work simpler and producing no changes in the time axis. Another big merit of the studio is that the processes of copying and lay-back can be executed digitally become a unified audio sampling rate can be used, with the value set at 48 KHz.

2 Outline of Mixing Console

The mixing console which serves as the core of the studio system, is the Logic-2 model of AMS/NEVE Company(UK).

This mixing console is fully digital. It can handle all digital signal processing and operation control by digital processing. This, coupled with the digitization of peripheral machines, makes it possible to execute all necessary work with no deterioration of sound quality.

The basic condition for the mixing console in this studio was that the desk had to be able to cope with surround output of 3-1 or more. At first, however, this mixing console had a stereo output of only two channels.

Accordingly, additional function were developed to give it a 8-channel monitor routing section, the necessary level controller and a surround panpot(phonetic) function with a joy stick. This hardware with full function was prepared in to the remarkably short time of only four months.

The DAW(an audio file made by the same company) in the centre

functions as the control center for the whole mixing console. The automation files, etc. are also controlled by this machine.

The mixing console to be suitable for 2-man operation particularly for HDTV production. Two or three man operation is typical for motion pictures but rare in the world of TV. There is, however a limit to the power of one-man operation as we seek both to improve the degree of completeness and to execute sophisticated sound processing effectively.

We therefore asked the manufacture to change the specifications of the machine to permit 2-man operation of the mixing console. The hardware was ready by the time of delivery, but the software has not been delivered at the time of writing (June, 1993), and thus has not been used as yet.

Regarding signal processing cards (SSP cards), it is possible for the Logic-2 type to be operated by 3 to 4 cards because this machine has a composition of 28 faders and 112 signal path.

The SSP card determines the processing power of the whole of the desk. "DSP Power" activates all job assignments related to the signal path, Filter, EQ, Dynamics, Noise gate, etc.

A total of 10 SSP cards were ordered for this studio.

Unfortunately, the mixing console still cannot display its full power because the card-storing capacity of the rack is only 9 SSP cards. In general, however, the initial goals have been attained.

The 10 SSP cards we ordered for the studio represent the maximum number for the Logic-2 series. Major reasons for placing such an order were that Logic-2 has 48 faders and 192 signal paths. Another reason is that it would be complicated to assign functions for

Filtering, EQ, Dynamics, Noise gate, etc. to the necessary paths, while also paying constant attention to how much DSP Power remains.

Further, such assignment has to be made by resetting the necessary desk functions, making it necessary to halt operation whenever resetting is made.

A unique feature of Logic-2 lies in the use of the SSP card as "DSP Power." In other words, even if DSP chips on the card malfunction, this only results in a reduction of overall power. As long as power is set in the configuration file when the desk is turned on, the machine can still be operated.

The machine's self-checking function indicates DSP chip malfunctions. This is an extra source of reliability.

3 Outline of Peripheral System

For system synchronizers, we used the TEX-2000 series made by TAMURA(Japan). This synchronizer is event-drive type and performs sweetening for each item.

Synchronizing units are attached to each machine of this series, serve as slaves, and the series has a system for controlling each machine with the most appropriate timing. It is also capable of MIDI control. It thus has both high performance and high extension capacity.

In the new studio, connection was made in the manner shown in Figure No. 3. The VCRs can be controlled remotely from the audio file, which serves as the controller of the mixing console.

This makes it possible for the audio file side to control tape transport, including jog & shuttle, thus facilitating one-man operation. Needless to say, the audio file itself functions according to the Master-TC from the VCRs.

Master sync of the studio is supplied from the Sync-generator for HDTV. The HDTV synch-signal is three-state. The sync-converter is used to convert from UNIHI signals for the NTSC-type synch-signal.

Regarding the loudspeaker system in the control room, the frontal area is equipped with 3 units of the PIONEER(Japan) TAD2401, which is used as the standard monitor for NHK's Hi-quality sound studio. The rear side has 2 units of the TAD2402(single woofer type). The rear side line alley speaker system uses 5 units of the JBL(USA) 8330.

4 Operation

During some one and a half months until the preparation of this paper, sound sweetening was conducted for a number of programs that included special features on the royal wedding, highlights of professional Grand Sumo, documentaries, dramas, etc.

The mixing engineers in charge of sweetening made such comments as: "It really felt like making an HDTV program," "I could sense the need for delicate sound" "The use of the dynamic range is different from the conventional method," "The sound stage is heard clearly" and "I rediscovered the charm and delight of surround sounds."

Judging from these comments, it appears that the initial purpose of constructing the new studio has been achieved.

However, this does not mean that the whole system is free from problems. These developments remind us that quality control for the software is an extremely important element in handling a digitized machine.

5 Conclusion

In constructing the new studio, we have tackled such problems as how to create a comfortable space for standardization of an HDTV sound system and program production, and have sought to produce a creative environment by introducing excellent equipment. At this point, we believe that these goals have been fully achieved.

We next seek to develop new possibilities for program production through a variety of audio and visual experiments that use this new studio.

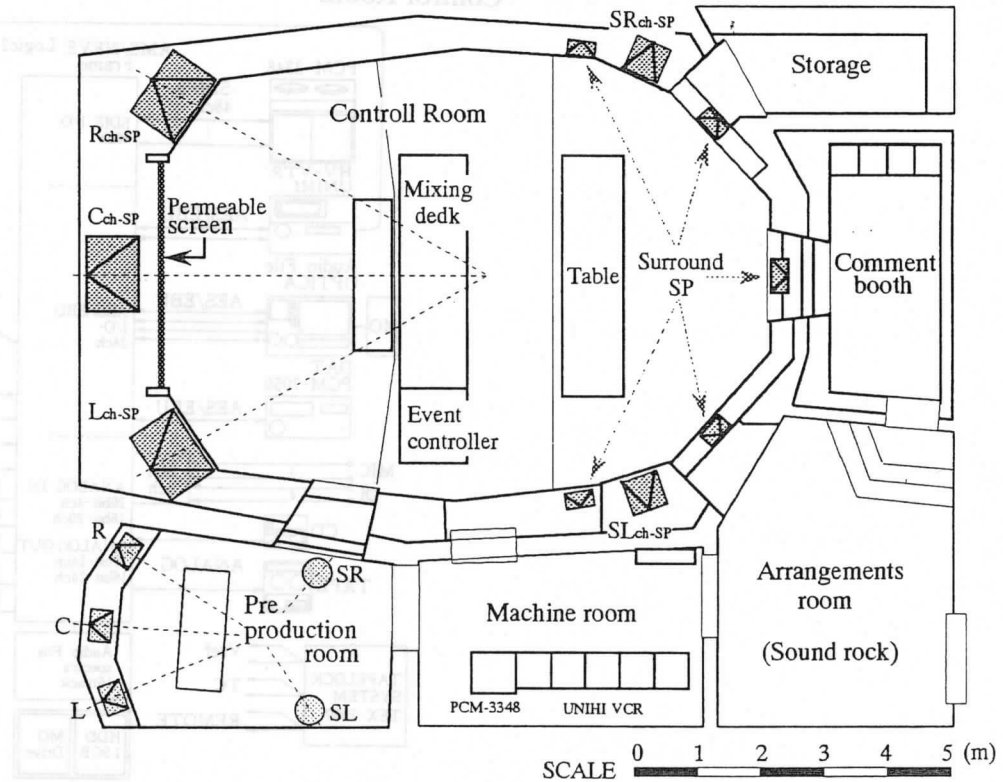
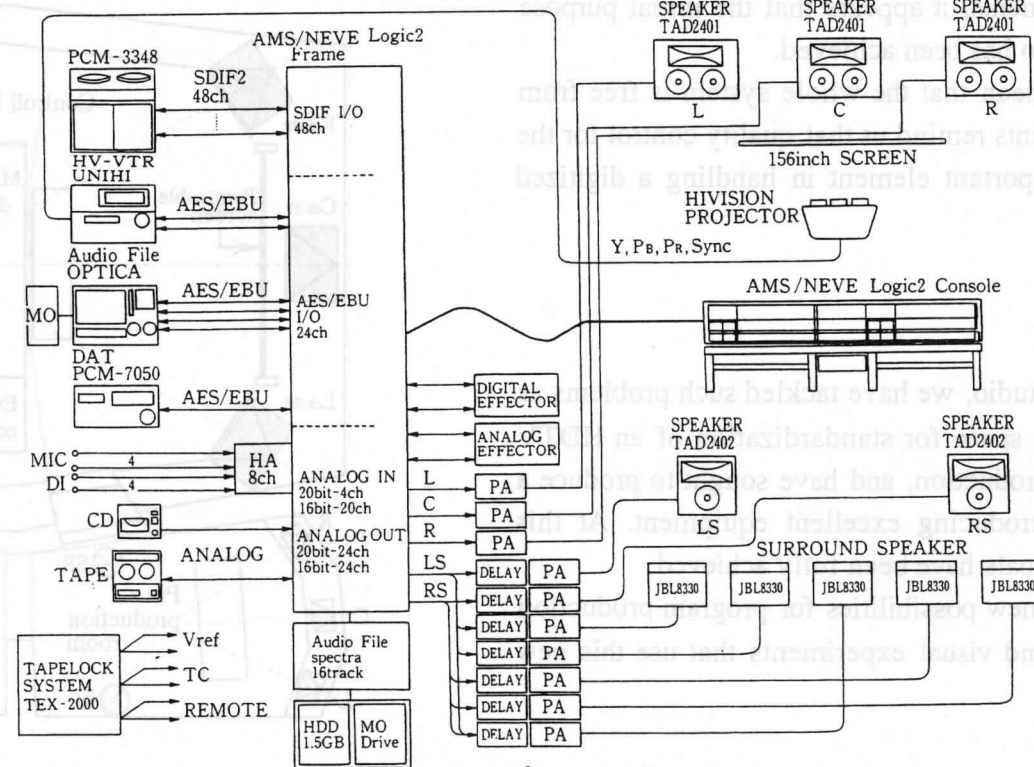


Fig.1. Plan of sound sweetening room for HDTV

Control Room



Pre-Production Room

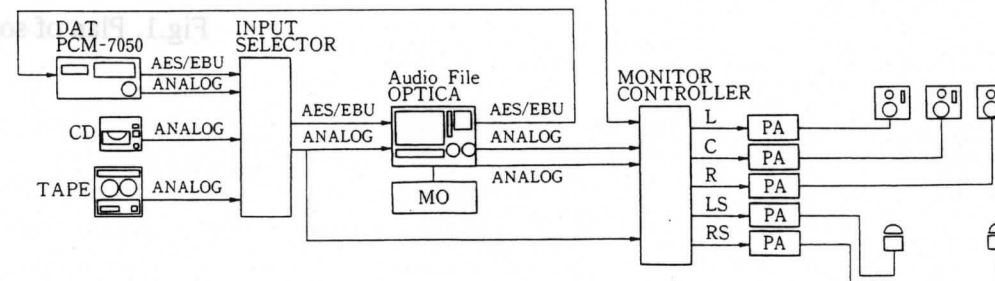
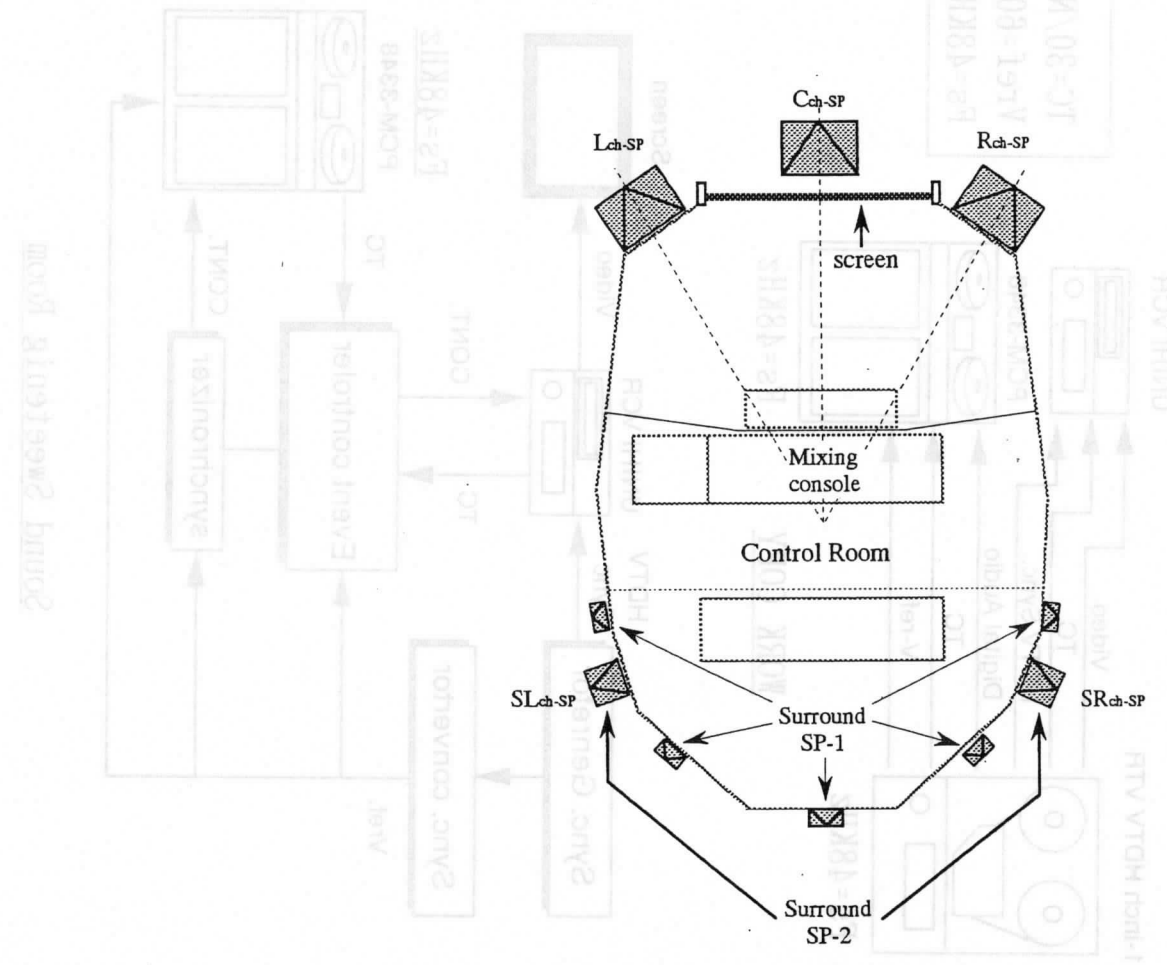
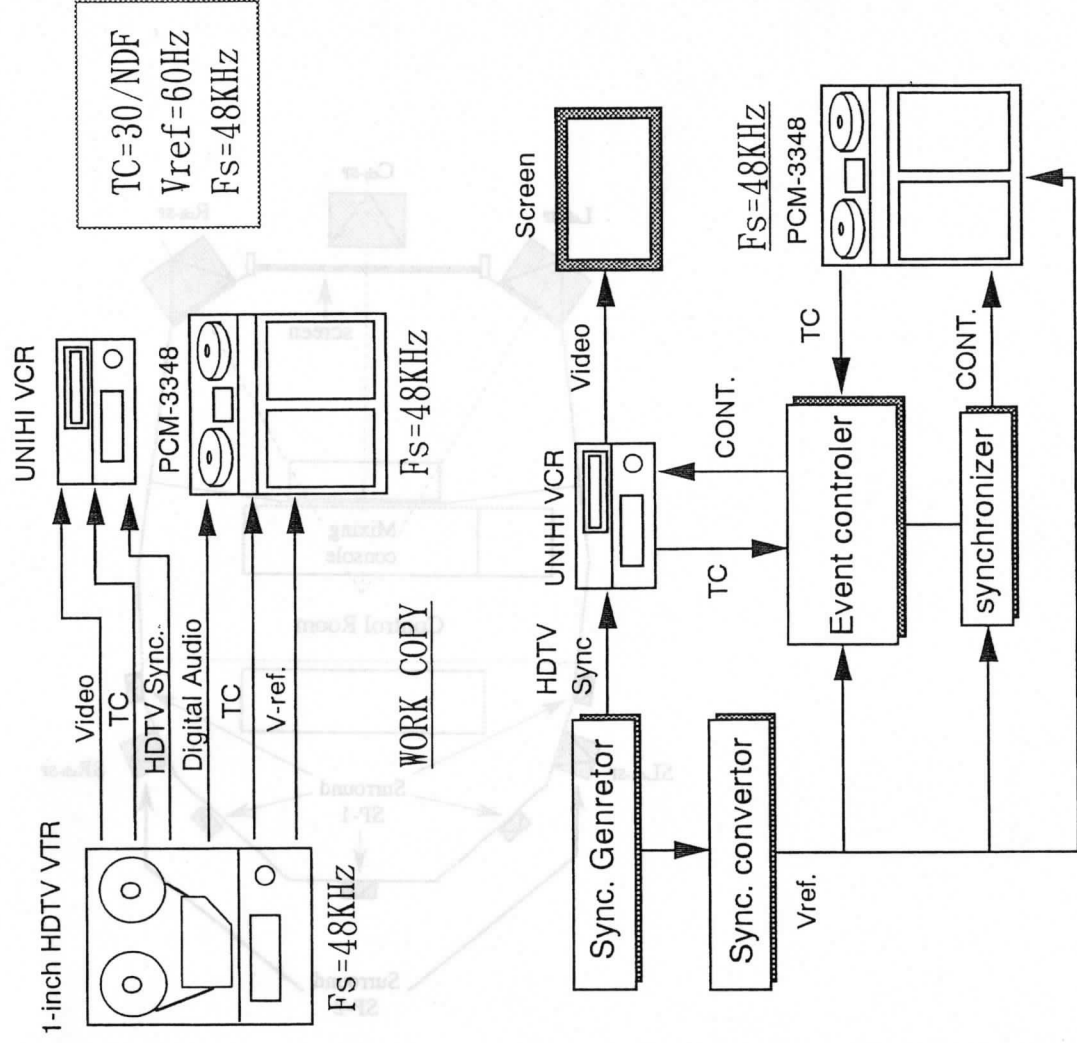
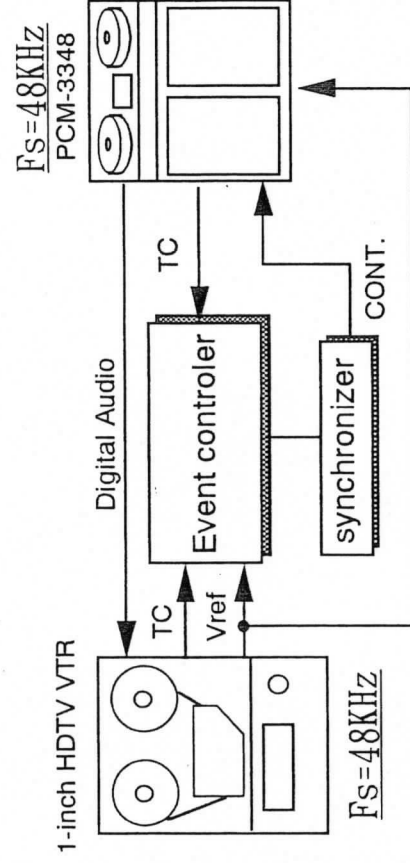


Fig.2. Outlines the studio facilities





Sound Sweetening Room



Ray Back

Fig.4 Diagram of stdio work flow