THE PROCEEDINGS OF THE
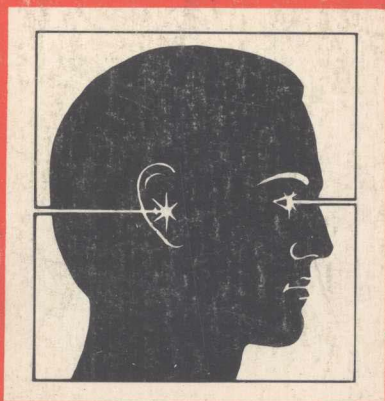# AES 4th
INTERNATIONAL CONFERENCE

Stereo Audio Technology for Television and Video

Rosemont, Illinois
1986 May 15–18

THE PROCEEDINGS OF THE

AES 4<u>th</u>

INTERNATIONAL CONFERENCE

S̲tereo Audio Technology for Television and Video

AES 4th
International Conference
Committee

Robert B. Schulein, Chairman

TECHNICAL PLANNING COMMITTEE

Don McCroskey   David Robinson
Martin Polon   Emil L. Torick
                Bill Varney

CONFERENCE PLANNING COMMITTEE

Breakout Session   Audio/Visual Services:
Coordinators:
                            Ron Steinberg
John Bullock   Todd Curry
Robert Cochran
Brian Homans   **Budget, Hospitality,**
John Phelan   **and Meal Coordination:**
Norm Relich   Bill Braun

CHAIRMAN'S MESSAGE

Stereo Audio Technology for Television and Video was selected as the topic for our 1986 Conference because of the significant technological and economic impact it is beginning to have on the audio engineering community. More than just pictures with sound, two audio channels provide a significant step forward in creating opportunities for more lifelike and exciting audio/visual experiences. The program was structured to cover all of the major aspects of the "Audio Video Chain" and was divided into five major sessions: Production, Duplication, Transmission, Consumer Product Technology, and Economic and Business Considerations.

I would personally like to thank our Program Planning and Technical Support Committee members for their dedicated efforts in working with me to produce this conference.

We are all confident that the technical papers included in this publication will provide insights into this emerging area of audio engineering and will be of lasting value.

ROBERT B. SCHULEIN
Conference Chairman
AES President 1986

CONTENTS

5 CONSUMER PRODUCT TECHNOLOGY

6 ECONOMIC AND BUSINESS CONSIDERATIONS

1

Introductory Session

Robert B. Schulein
Conference Chairman, AES President 1986
Shure Brothers Incorporated
Evanston, Illinois
U.S.A.

Abstract

Stereo audio and video technologies have developed for many years essentially as separate entertainment industries. Somewhat independent of both, motion picture technology has evolved to a highly refined state with high resolution images and multichannel surround audio. The development and refinement of the consumer video cassette recorder, the optical video disc player, large screen projection television systems, satellite transmission distribution systems, cable television systems, and stereo broadcast television systems have all come together to significantly change the consumer's perspective of home entertainment. Often referred to as the marriage of audio and video, it is possible today for a consumer to experience broadcast quality video with digitial audio on a large screen television system with multiple channel surround audio in the home. In spite of the fact that all of this is possible with available hardware and software, most consumers and audio/video professionals are only technically familiar with portions of the technology involved. Rapidly changing technology and the complexity of such systems are major factors contributing to this lack of awareness. As is typical of emerging technologies, a lack of standards and accepted practices as well as economic uncertainties are serious limitations to growth.

The Audio Engineering Society Conference on Stereo Audio Technology for Television and Video has as its prime goal the task of bringing audio and video professionals up-to-date on this emerging technology with an eye on promoting growth through better technical and economic understanding.

Introduction

The addition of a second audio channel to the familiar monaural audio associated with television and video provides more than just stereo audio with a picture. By providing two independent audio channels, the synergy associated with audio/video productions takes a significant step forward in allowing the creation of more exciting and realistic sonic experiences. On the other hand, as the presence of two audio channels becomes more widespread, a number of economic and technical factors are emerging offering both cause for concern as well as opportunities for growth. Throughout the course of the conference, these factors will be explored in detail by examining the path taken by audio signals as they flow from production through duplication and transmission to

final audition by the end consumer. These various paths are shown in the
"Audio/Video Chain" diagrammed in Figure 1.

Production

Stereo audio production for television and video takes on many forms, often
serving multiple purposes because of the various paths by which the finished
product may reach the end consumer. With most production not being live in
nature, some form of audio recording and subsequent post-production is
performed. At present, the majority of this activity is directed towards the
consumer pre-recorded video software market with an emerging broadcast market
showing signs of rapid growth.

Stereo audio for the video software market is divided between music video-type
production on film or video tape and by dramatic film production originally
produced for theater exhibition.

The defacto standard stereo format for theatrical type production is Dolby
Stereo using either the Dolby Motion Picture (MP) matrix process or the six-
channel discrete format. Soundtracks from these productions are typically
transferred to consumer video tape and disc formats from the two-channel Dolby
Stereo mix without modification representing what is typically called the L_T and
R_T (Left Total and Right Total) mix. Depending upon the degree of surround
channel encoding, such soundtracks are generally considered to be stereo and
mono compatible. Once produced, such soundtracks have the added flexibility of
Dolby Surround decoding providing suitable matrix decoding hardware is used. As
in the case of the motion picture theater, a separate or "hard" center channel
as well as surround channel may be decoded and reproduced.

Stereo audio production for music video release is very similar to and often
the same as that used for audio only recordings. A small number of music video
productions have been produced using the Dolby MP matrix process, as well as
with SQ matrix techniques.

A growing number of programs are now being produced specifically for stereo
television broadcasting. These include sports events, drama, musical variety,
talk shows, situation comedy, and commercials. Unlike motion picture
production, these programs are typically mixed for a two-speaker playback system
with prime emphasis on mono compatibility.

The problems and opportunities associated with stereo audio production for
television and video center around a number of factors, the principle one being
that a picture is involved. Unlike audio only production where the listener has
little clue as to the location of the sound sources and is generally doing
something else while listening, this is not the case with television and video.
Localization is a more significant issue. Nearly all television viewers have
grown accustomed to the fact that the acoustic image has always been
coincidental with the picture no matter where they are seated in the room. If
the same sound source is reproduced using two spaced loudspeakers, center images
will only occur for a centrally located viewer. Off-axis viewing results in
images shifted right or left dependent upon viewer location. One solution has
been to significantly reduce the loudspeaker spacing as compared to typical
stereo placements. This technique works well, however, at the expense of a
greatly reduced stereo image. In order to cope with this problem, the matrix
technology developed for the motion picture industry is a possible solution

offering a discrete like center channel while at the same time maintaining stereo and mono compatibility.

A further complication associated with the fact that a picture is involved is the wide variety of consumer viewing environments. In contrast to the motion picture environment where screen dimensions and room size are relatively constant allowing for equalization and playback level standards, the home viewer environment offers much greater variability. Screen size varies from approximately 19" to 10' for large screen projection with dynamic range restrictions varying from essentially none for audio/videophile installations to those of a noisy domestic environment with concern for adjoining neighbors. This is not unlike the audio considerations for consumer audio formats requiring a different set of dynamic range and equalization compromises dependent upon the anticipated consumer.

Duplication

Duplication takes place at many levels in the "Audio Video Chain" starting with master tape production all the way down to consumer time shift recording. In varying degrees, several problems continue to degrade such duplication and are of major concern in new product development and operating practice.

During program production, it is common to subject individual audio elements to multiple generations of copy as the final mix is completed. This process is plagued by noise buildup, cumulative frequency response errors and, in the case of stereo tracks, level imbalance polarity flips and additive phase shift errors between channels. Present and emerging techniques to deal with these problems include time code synchronization, wide dynamic range magnetic film recorders, computer assisted mixing, and digital audio recording.

Once a master recording has been prepared, the duplication process continues at many levels often complicated by a complex transmission system between recorder and reproducer. Such duplication takes place in two general forms: one involving separate duplication of video and time synchronized audio, and the other involving combined audio/video recording. Economics and equipment compatibility are the prime factors governing the process used. Separate synchronized digital audio with 1" video is becoming the preferred format for duplication masters where as 1" video with combined stereo audio tracks is used for most other duplication, particularly in broadcasting. The popular 1" video format was developed prior to the introduction of broadcast stereo television and pre-recorded stereo video formats. Even though two audio channels were provided, the principle audio application was monaural. Today both channels are being used more frequently and a number of problems are surfacing. Perhaps the most significant is the phase match between channels which has the potential of degrading monaural compatibility of program material mixed equally to both tracks. Even though this problem can be dealt with using calibration test signals and verifying machine alignment, it is not a practical solution in most production and broadcast environments. In addition to alignment errors, the dynamic range of this format is lacking, particularly in consideration of increased consumer awareness of audio quality. This limitation is effectively dealt with using companding noise reduction techniques; however, once again the need for test tones, additional patching, and encode/decode mode switching, complicate and limit the use of these processes.

In order to deal effectively with these problems, a new and robust video/audio recording format is beginning to emerge. Starting in 1979, the Society of Motion Picture and Television Engineers (SMPTE) and the European Broadcast Union (EBU) embarked on the development of a digital video tape recorder standard involving digital techniques for both picture and sound. This standard, which has now been agreed to, specifies four digital audio channels in accordance with the AES/48 kHz standard. Prototype models of digital video tape recorders (DVTR) are now becoming available.

Transmission

In its most complex form, transmission takes place inside a network production facility through a complex of cable patches, mixers, and switchers, outside the facility through a satellite distribution system, back on earth through a local broadcaster and cable operator, and finally to a consumer's receiving and amplification equipment. In contrast, a consumer may play back a pre-recorded video tape or optical video disc and eliminate a large percentage of this network. One is tempted to count all the elements of these chains and wonder how it is possible to obtain intelligence at the receiving end. The fact is, however, that quality video and audio do pass through the system because the key elements influencing quality have been properly identified and dealt with.

With the growth of stereo audio for television and video, new transmission problems are emerging primarily in the broadcasting, satellite transmission, and cable distribution areas. Problems have occurred in these areas because additional audio channels and new transmission systems are just being introduced. Complications arise because of the complexity of these systems increases the possibility of errors. As in the case of program duplication, errors are primarily attributed to noise buildup, cumulative frequency response errors, level imbalance, channel polarity reversals, and additive phase shift differences between channels. It is interesting to note that by their very nature, a stereo broadcast television system or stereo video format are self-policing of many of these problems because of the need to be monaural compatible. Channel polarity reversals and excessive phase shift errors markedly degrade monaural performance and for that reason tend to be given top maintenance priority. Other problems are more subtle and will be solved by an increase in awareness of their nature, improved monitoring devices, and marketing pressure to match the performance of pre-recorded audio and video software.

Consumer Product Technology

Stereo audio for television and video has its roots in the consumer pre-recorded software industry being driven by the availability of stereo video tape and disc formats with high fidelity audio soundtracks. In addition, the growth of the compact disc and personal stereo equipment have caused stereo audio to be a consumer demand item. A somewhat independent but effective influence on consumer awareness has been and continues to be the motion picture industry. Stereo motion picture audio using the Dolby matrix or discrete multichannel audio formats reproduced over a high performance theater sound system serves as a constant reminder to the consumer of the contribution multichannel audio offers the audio/visual experience. However, as the stereo audio/visual experience expands beyond the motion picture theater and into the home, a number of problems and opportunities are emerging requiring attention.

Perhaps the most basic problem is matching the sonic experience to the picture. Consumers have come to accept the fact that with television, the audio and visual images coincide. For both practical and logical reasons, the loudspeaker has always been located near the television screen. When stereo audio is presented with a picture in the traditional spaced two-speaker stereo format, a noticeable hole in the middle develops for all viewers, but those on the central axis line to the loudspeaker array. On the other hand, if the speakers are placed very close to the television screen, the wide stereo image potential is lost. An emerging solution to this problem is the development of matrix signal processing techniques similar to those developed for the motion picture theater. Using these techniques, center channel information is detected, attenuated in the front left and right channels and fed to a center channel loudspeaker near the television or video monitor. In addition, these techniques may be further extended to provide a surround channel of information to produce ambience effects and sounds behind the listener. All of this can be achieved while at the same time providing stereo and monaural compatibility.

In addition to these problems, the consumer is faced with the task of assembling and controlling a rather complex audio video system. At present, system complexity is overwhelming for many consumers because of the wide range of components requiring both audio and video connections. It appears clear, however, that once the benefits obtainable from two high quality audio channels with a picture are understood by the consumer, these problems will begin to be solved in new and different ways resulting in audio/video systems that are as common as today's stereo systems.

Economic and Business Considerations

As one observes progress in the consumer electronics area, it generally becomes clear that consumers buy new products not because of the technology behind them, but for what the technology can do for them. There is little question that the addition of a second audio channel to the television and video experience has a lot to offer in that it provides for the creation of a significantly more realistic audio/visual experience. This is not, however, a guarantee that it will flourish in the marketplace. As with any benefit, there is a price and stereo audio is no exception. It remains as a challenge to the consumer electronics industry to develop this market through both consumer education and the availability of cost effective problem-solving products. The professional audio and broadcasting industry must also respond by developing cost effective tools and techniques to produce, duplicate, and transmit program material that is attractive to the consumer as well as advertisers.

To date, the economic signs are positive. Continued growth will be fueled by a better understanding of the opportunities and problems to be addressed and the technology to solve them. Increasing this awareness is the principle objective of the conference.

RBS:DG
4/3/86

STEREO AUDIO TECHNOLOGY for TELEVISION and VIDEO
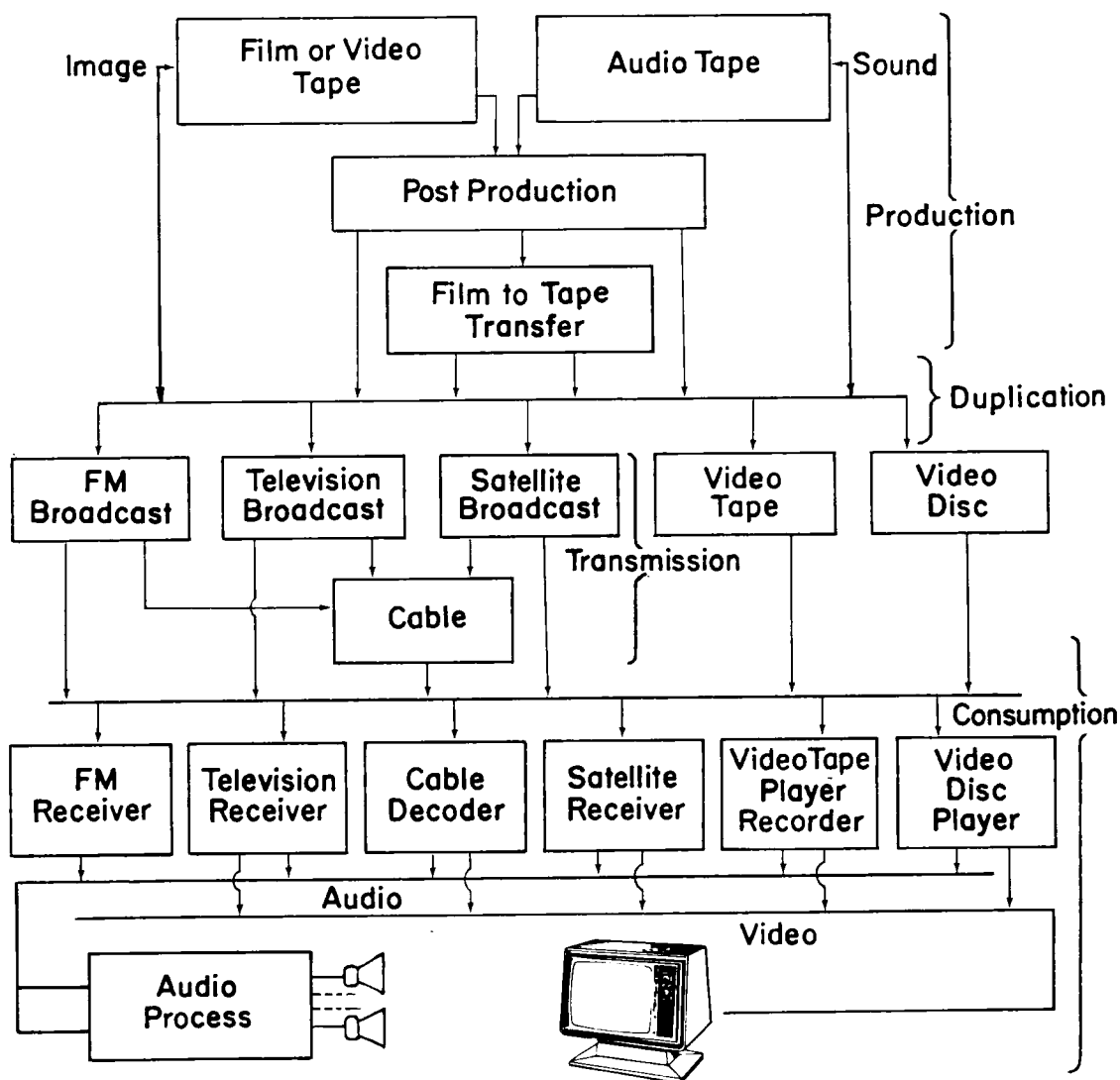
The AUDIO VIDEO CHAIN

Figure 1

Transmission

"THE REAL WORLD OF VIDEO/BROADCAST PROGRAM TRANSMISSION"

Don McCroskey - Consultant (ABC, retired)
Burbank, California, USA

ABSTRACT

The transmission path of a broadcast signal is long and
tenuous. On its way to the home TV screen it is subjected
to a variety of amplification, noise reduction, modulation,
demodulation, and digitizing processes. Many of the links
are not under the direct control of the broadcaster. These
and other factors, plus the real time constraints of
broadcasting, generate an atmosphere which is conducive to
faults and errors. The nature of the stereo audio signal is
such that transmission defects are not easily quantified
under operating conditions. Constant vigilance throughout
the transmission chain is required if the promise of stereo
sound is to be validated.

INTRODUCTION

In 1948, commercial broadcast television became a reality in
this country. Six years later, the NTSC color television
system was introduced. NBC was almost the exclusive
torchbearer for this effort until 1963 when the other
networks began to establish regular schedules. By 1966
almost all programs, except those originally produced in
monochrome, were in color. Large screen (over 12") black
and white sets have not been made for many years and their
use is relegated to portable use and casual viewing
locations. Great evolutionary strides have been made in
cameras, transmitters, and receivers since then;
particularly during the last 10 years. Gradual improvements
are not often perceived by the viewer. It takes something
new; heretofore not available in a convenient form, to spark
the interest of the public. For the first time in over 30
years, we have a true innovation in television--Multi-
channel Television Sound (MTS). Although broadcasting has
been active in many areas for almost 2 years, it has only
been within the last 6 months that the consumer market has
been supplied with a wide, affordable range of receivers,
adapters, and VCRs which tells the public that stereo is
really here.