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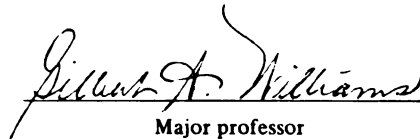
THE EFFECT OF HIGH DEFINITION TELEVISION
ON PRODUCTION TECHNIQUES
IN VIDEO

presented by

Maurice Habib Shaghoury

has been accepted towards fulfillment
of the requirements for

M.A. degree in Telecommunications


Major professor

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**THE EFFECT OF HIGH DEFINITION TELEVISION
ON PRODUCTION TECHNIQUES
IN VIDEO**

by

Maurice Habib Shaghoury

A Thesis

submitted to
Michigan State University
in partial fulfillment of requirements
for the degree of

MASTER OF ARTS

Department of Telecommunication

1989

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ABSTRACT

THE EFFECT OF HIGH DEFINITION TELEVISION ON PRODUCTION TECHNIQUES IN VIDEO

by

Maurice Habib Shaghoury

This study was designed to unveil the effects of HDTV on production techniques in video. The primary sources were obtained from four producers who were interviewed and considered as experts since they used HDTV technology in actual production. Secondary sources were gathered by reading articles from magazines, journals and other printed materials.

The secondary sources were gathered through the research library, Infotrac and other data sources such as Governmental Guides and Indexes. Some materials for the research were obtained from the National Association of Broadcasters (NAB).

The primary sources were gathered by interviewing three producers and one television engineer. These experts used HDTV technology in an actual production: Mr. Mark Blandford and Charles Pantuso from "Chasing Rainbows," Mr. Glenn DuBose and the Chief Engineer of WTTW of Chicago, Mr. Ron Yergovich. Mr. Blandford's interview was conducted in person and by telephone.

High Definition Television (HDTV) promises to have significant effect on television production and film. It was found that HDTV technology has technical problems with its equipment, and financially, the equipment was very expensive in comparison to 35mm film. On the plus side, I found that the HDTV image is much better than NTSC and it will have a wide application in electronic post-production for film and TV.

To my nieces
Helen and Randa Shaghoury

ACKNOWLEDGEMENTS

I would like to express my thanks to the individuals who made this research a part of my reality and well as their own. My deepest appreciation is given to Dr. Gilbert Williams, the committee chairman, who always told me, "I know you can do it." His guidance, patience, and encouragement led me to complete this research. Special thanks also to Mr. Robert Alberts who was there every time I needed him, despite his busy schedule, and who assisted me in so many ways by providing constant encouragement throughout the project.

Finally I would like to extend my deepest gratitude to the producers and engineers who are always busy yet who found the time to share their experiences with me. Without them this research would have no value at all. These people are: Mr. Mark Blandford, the producer and co-creator of "Chasing Rainbows," Mr. Charles Pantuso, a consultant for HDTV and regular TV and who was also one of the producers in "Chasing Rainbows," Mr. Glenn DuBose, producer at WTTW of Chicago, who produced the first HDTV pilot by a local U.S. television station, and finally the Chief Engineer for WTTW, Mr. Ron Yergovich.

Thank you so much because without you this research would be far from reality.

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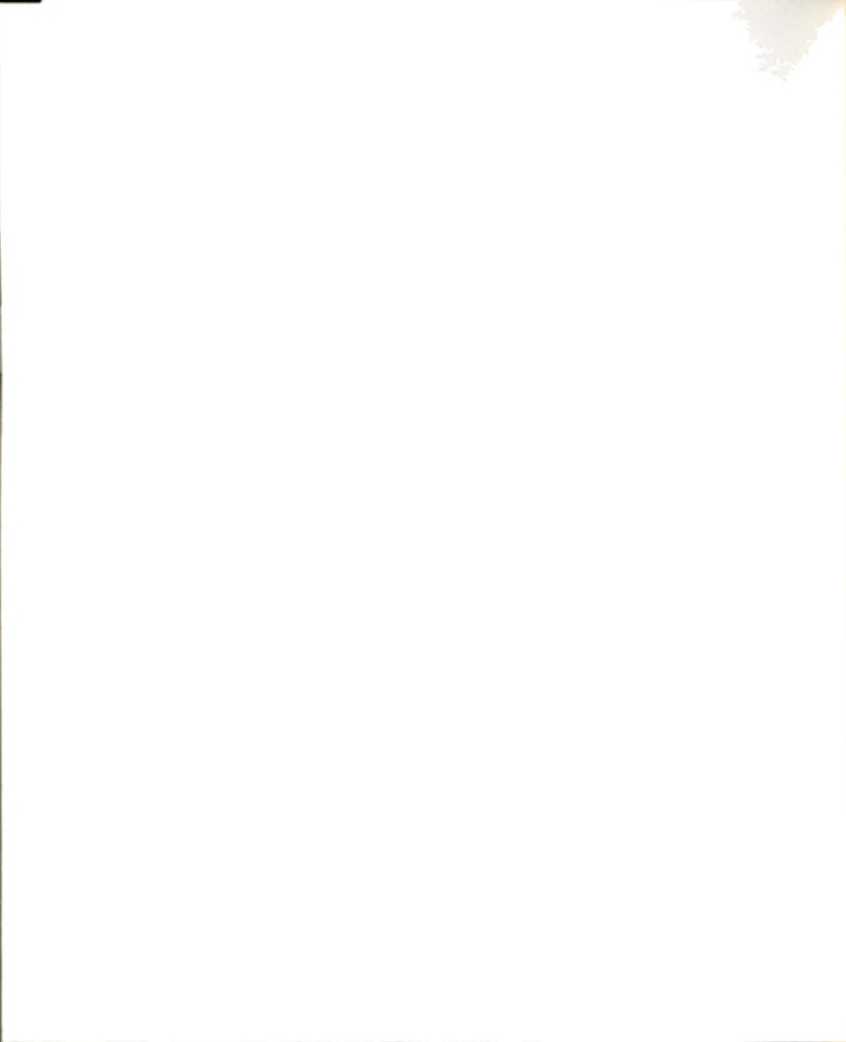
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CHAPTER 1 INTRODUCTION

Introduction

High-definition television (HDTV) is the next step in the evolution of television technology. From the production standpoint, the state-of-the-art technology may promise a rosy future for the broadcasters in terms of their production operations as time and costs are reduced. High-definition technology will mostly be used in television primetime and syndicated productions, long-form television drama and music videos to reduce production time and cost without compromise of quality.¹ Furthermore, electronic cinematography will have a wide application in post-production of motion pictures through high-definition technology where image manipulation and compositing are simplified. It is apparent that the new technology will have a dramatic impact on Hollywood which might be heading towards the "Electronic Age."

Economic, political and, mainly, technical issues have kept high-definition pictures off home television screens and have caused a major setback in the implementation of this technology. Given current technical developments worldwide, the implementation of



high-definition is essential for broadcasters in order to remain competitive; moreover digital signals and component video (any system in which the components of a video signal are processed and transmitted separately) are being used to provide new capabilities and improve performance. In addition to the previous facts HDTV technology will also be used as an improvement in television and motion pictures, especially in post-production.

The Problem

The main focus of this research is to explore and explain the effect of high-definition technology on production techniques in video. In the past 30 years a number of technological advances were introduced as improvements in television. The most important innovation was the compatible color television which was developed by RCA (Radio Corporation of America) and is presently employed in most countries under the standards of the NTSC (National Television System Committee). Other developments included videotape recording, ENG (electronic news gathering) and satellite program distribution as well as special test and monitoring equipment.² All of this equipment was designed to fit within the technological boundaries of the NTSC (National Television System Committee) standards. However, high-definition technology will require an entirely new standard of production as

well as transmission which in turn will have an effect on production techniques in video.

Recently high-definition equipment (including cameras, VTRs [Video Tape Recorders] and editing equipment), was introduced in the market to be tested in the production field. None of the HDTV equipment operates on the NTSC standards. Therefore, this research is designed to explore the effect of high-definition technology on the conventional production techniques in video.

Significance of Study

The research question is a significant problem because most of the HDTV literature discusses the technological and economic trends of high-definition and its impact on the industry, as well as the various systems that are being developed in North America, Japan and Europe. Though limited materials were found that dealt with high-definition television from the production standpoint, not enough has been written to adequately explain the impact of HDTV on production. Therefore, there was a need to understand the artistic side of high-definition and its effect on production techniques.

A number of questions emerged from the literature that need to be answered in order to understand the research problem. Among these questions are: How does the image quality of high-definition affect the colors and

detail patterns? How are high-definition signals recorded? Is there a special VTR (Video Tape Recorder) needed for high-definition?

Despite the above questions about the technological barriers, a few shows were produced using the new technology, such as "Chasing Rainbows," the 13-hour mini-series produced by the CBC (Canadian Broadcast Corporation). In addition, WTTW of Chicago is using high-definition technology in sports events. The question is whether high-definition is living up to its promise in producing a video image similar to 35mm film? How did the high-definition camera perform in special lighting effects? How much brightness can the high-definition camera produce in comparison to the conventional contrast range (see glossary), which is 20:1.

Furthermore, it has been suggested that high-definition cameras will be used in primetime television shows as a film-style single camera instead of traditional 35mm film. The point here is the portability and maneuverability of the high-definition camera in comparison to the cordless 35mm film camera. Television cameras, including high-definition cameras, always need a cord to a camera control unit which is connected to at least one VTR (Video Tape Recorder). Does this limit its portability? Another area of concern is the depth of

field of high-definition in comparison to 35mm film cameras.

Finally, there is the question which faces every producer in decision making. In film it is possible to rent just about anything, including cameras and other equipment, but not in television. As it relates to the capital outlay of equipment: Is this a problem? Furthermore, technology is always moving ahead and introducing new equipment into the market. Is the old equipment resalable without a huge depreciation? Is it adaptable to the new equipment? It is said that high-definition technology will replace 35mm in production and mainly post-production. Are there enough operators such as camera and video editors to do the job? Then how good is the training quality necessary to enable a film editor to edit on the new technology that is totally different from film editing technology?

The literature suggested that the high-definition electronic production (HDEP) will reduce the elapsed time of production. Moreover, electronic production of single-camera dramas offer savings of 15% of total production costs.³ Writers mentioned, however, that high-definition cameras need more light and that increases the use of air conditioning in studios. That is just the opposite of 35mm film because film provides good exposure and has greatly reduced the amount of light and air conditioning

required. Thus, the question is, which area contributes to cost saving? In fact, saving money is a very critical issue for the TV networks. They would use new technology if it saved money. The reason is that the networks have been losing audience share to cable and the VCR (Video Cassette Record) market. Therefore, it is very essential to cut primetime production costs, since 80 to 85% of all primetime programs have been produced on 35mm film.

Finally, a general series of questions emerged from the literature. First, what are the benefits and drawbacks of high-definition from the production standpoint? Second, what can high-definition offer in the production field that NTSC failed to offer?

These questions will be answered through the information found in literature and interviews with producers who have already experienced or are experiencing the new technology.

Research Plan

This research is a historical analysis and the order of presentation will be topical although essential chronological dates will be mentioned. The historical approach allows the author the framework by which to describe and analyze high-definition in video production. Using the historical approach of high-definition, this study will offer a qualitative and critical analysis.



This chapter contains a review of the literature, involving mainly articles from magazines and journals but also includes articles in newspapers and books. In this chapter, this research will furnish a thorough background in which the production and transmission standard of the new technology will be described. Furthermore, it will contain a comparison between NTSC (National Television Association Committee) standards and the high-definition standards which is an important issue in understanding the effect of high-definition in production in the following chapters.

The next chapter is the literature review which contains two phases. The first phase will be a brief history of television production during the last 30 years. The development of production trends such as videotape technology and electronic news gathering and the effect on the production techniques in video will be traced. The second phase of the literature review will revolve around the recent history of high-definition technology including the various systems that are being developed in the U.S. and Japan. For various reasons, some political, others technical (which will be explained in this chapter), a number of high-definition systems are being developed. This research, however, is not designed to recommend any particular system, although a few will be briefly described. The focal point of this research is to

determine the impact of high-definition on production techniques in a general way.

The next chapter is concerned with methodology and material which includes the analysis of the data that was derived from interviews and literature. It is a straightforward presentation of the findings.

The final chapters will draw conclusions and make recommendations as to further study.

Limitations

There were a number of materials that discussed the new technology of high-definition. The amount of information is limited, however, that focuses on the research question. This research will derive the primary materials through interviews. The secondary materials will involve articles, government documents, reports, and newspapers. Because of time and language constraints, this research will not be able to conduct an extensive content analysis of high-definition implementation for future use outside the video production area. Because of time and financial constraints, this study will be limited to documentary evidence provided by the National Association of Broadcasters (NAB), literature review in the form of articles and reports. The rest of the materials will be obtained through interviews.

This research will take the path of proposing a new system that would offer different benefits in the

production field. This could be a valuable research in certain regards: i.e., it will be the first of its kind and help make recommendations for television producers. It will pose a new perspective on the technology's future, especially in terms of its production operation, and finally, it will be a useful information tool to conduct further study in the different aspects of high-definition technology, such as the implementation of HDTV and fiber optics to support a universal fiber distribution of HDTV.

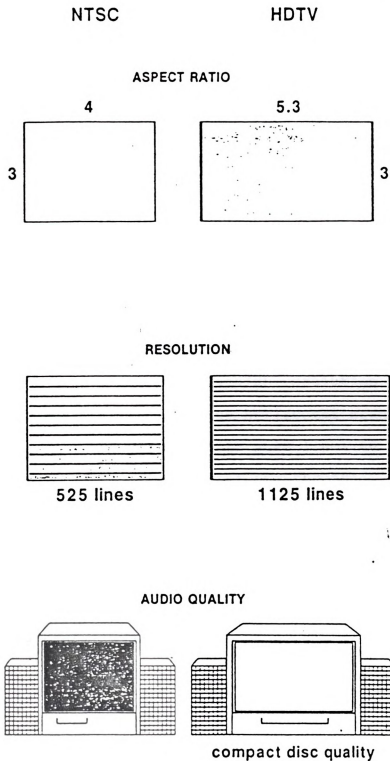
Background

High-Definition Television (HDTV) started in early 1970 when NHK (Japan Broadcasting Corporation) along with Sony, Panasonic and Ikegami initiated a research program with an ambitious goal. Its objective was to reproduce the resolution of 35mm film on home video receivers. This goal was achieved. Because of technological and economic barriers, however, the Japanese system failed to gain adoption by the rest of the world as a unified standard. Therefore, the U.S. and Europe went ahead on their own high-definition research. Of all the systems that are being developed, not one of them is recommended as a standard as of this writing. When high-definition was introduced as a whole new standard, technological concerns had to be taken into consideration. Despite the promise of high-definition, the concerns which arose included those of technical standards, i.e., bandwidth and

compatibility. These caused a major setback for high-definition implementation in addition to the economic and political barriers.

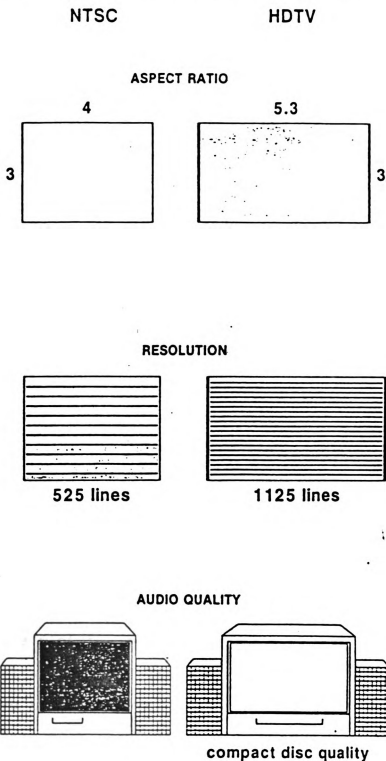
The first problem of high-definition is its production standard. This standard is totally different from the NTSC (National Television System Committee) standard. There are three main characteristics for high-definition production standards as well as two sub-characteristics. The three main characteristics (Figure 1) are a wide aspect ratio, high resolution display which contains 1125 scanlines and finally, high fidelity stereo sound. The concept of wider aspect is the proportion of screen width to screen height. Today's television sets are 3:4 (equivalent to 12:9) aspect ratio. This means that the TV screen is 3 units high by four units wide, e.g., the screen might be six units high by eight inches or nine by twelve inches.⁴ On the other hand, high-definition screen is wider. It is 5:3 (equivalent to 16:9) aspect ratio. The wider aspect ratio is a significant point when considering how movies are exhibited. The aspect ratio for theatrical exhibitions is nearly 2:1.

The reduction of the television image to a 4:3 ratio produces a visible, perceptible loss in picture quality.⁵ For example, if two men are facing each other on a regular TV screen (3:4) and behind each one of them stands his

High Definition Television (HDTV) vs. Today's Television Standard (NTSC)

Source: © 1987, National Association of Broadcasters

Figure 1

High Definition Television (HDTV) vs. Today's Television Standard (NTSC)

Source: © 1987, National Association of Broadcasters

Figure 1

horse, because of this reduction the horses are barely visible. As a medium shot, the home viewer will be able to see only the faces of the two men and their upper bodies in addition to the noses of their horses. The same shot, displayed on a high-definition screen with a 5:3 aspect ratio, will present the viewer with the same information, as well as the heads of the horses on each side of the screen. Another advantage of the wider aspect ratio relates to sports. Probably high-definition will be used mostly in sports because the camera will cover the entire field at a close range of the action without moving backwards.

The second main characteristic is high-resolution display. This means an increase in the horizontal scan lines. Today's TV sets are based on 525 scan lines 60 Hertz frequency field and 30 fps (frames per second). This means that an electronic beam in the television tube travels across the screen 525 lines from top to bottom and these 525 lines travel 30 times in one second.⁶ High-definition will double these lines to 1125/60 Hz, the result is that the picture has five times as many picture pixels (elements) as existing TV sets. In other words, the image is five times sharper. Finally, high fidelity sound is comparable to compact disc sound quality. Not too long ago, today's TV sets were not able to receive a stereo sound, and were only monophonic. With the

horse, because of this reduction the horses are barely visible. As a medium shot, the home viewer will be able to see only the faces of the two men and their upper bodies in addition to the noses of their horses. The same shot, displayed on a high-definition screen with a 5:3 aspect ratio, will present the viewer with the same information, as well as the heads of the horses on each side of the screen. Another advantage of the wider aspect ratio relates to sports. Probably high-definition will be used mostly in sports because the camera will cover the entire field at a close range of the action without moving backwards.

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introduction of high-definition audio systems it is said they possess the quality of compact disc.

Table A summarizes the production standards of 1125/60Hz and Table B compares high-definition and conventional TV sets specification.

TABLE A
1125/60 HDTV PRODUCTION STANDARD

Total lines per frame	1125
Field Frequency	60hz
Interlace Factor	2:1
Aspect Ratio	16:9
Active lines per frame	1035
Analog bandwidth for primary signals	30 mhz
Sampling frequency for digital processing	74.25 mhz
Samples per total line	2200
Luminance samples per active line	1920
Color-difference samples per active line	960
Blanking samples per line	280

Source: Robert Hopkins, "Advanced Television System," IEEE Transaction on Consumer Electronics, February, 1988

TABLE B
A COMPARISON OF HDTV AND NTSC SPECIFICATIONS

	HDTV	NTSC
Lines making up picture	1125	525
Aspect Ratio (3:4)	16:9 (3:5)	12:9
Monochrome (B/W) bandwidth	30 mhz	4.2 mhz
Color band width	30 mhz	1.5 mhz

Source: Broadcasting Engineering, February, 1988

It was mentioned earlier that there are two sub-characteristics of high-definition television. The first one is related to the wider aspect ratio which is a viewing condition. (Figure 2) Since a conventional TV set is 4:3 aspect ratio, it requires a 10° field-of-vision which is accomplished when the viewer sits seven screen-heights away from the TV receiver.⁷ The closer the

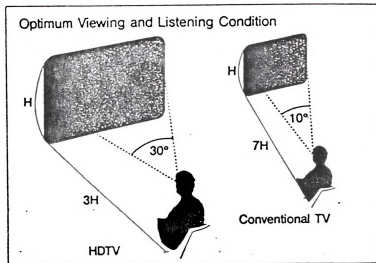


Figure 2
HDTV AND NTSC OPTIMUM VIEWING CONDITIONS

Source: Kenneth R. Donow, "HDTV: Planning for Action"
(Washington, D.C.)

viewer to the screen the more scan lines are visible and the poorer the image. High-definition television set is 5:3 aspect ratio, it requires 30° field-of-vision. This

means in order to enjoy true high-definition, the viewer should sit roughly three times the screen heights away from the screen. Since high-definition produces 1125 scan lines, no matter how close the viewer is to the screen, these lines will still be invisible. Finally, there is the matter of color rendition which improves resolution. High-definition provides 10-fold increase in color information. The result is sharper resolution especially on a small video image details.

The second concern of high-definition is the transmission standard. When high-definition was introduced, it was intended to be delivered via DBS (Direct Broadcasting Satellite). Japan was the first country to introduce the hardware of high-definition transmission equipment. MUSE (Multiple-Sub-Nyquist Sampling Encoding) is the best known DBS system ever designed to transmit the high-definition signal. MUSE has been adapted to terrestrial broadcasting with an access to the U.S. market. However, MUSE requires about 9 MHz of bandwidth for terrestrial broadcast (plus additional bandwidth for interference protection).⁸ In fact, high-definition requires 30 MegaHertz (see Table C for MUSE characteristics) of bandwidth. Although MUSE was designed to receive HDTV signal of 30 MHz, compressed down to 8.1, then transmitted to broadcasters, the issue of compatibility remained.

Table C
Characteristics of The MUSE System

System		Motion-compensated multiple subsampling system (Multiplexing of C signal is TCI format.)
Scanning		1125/60 2 : 1
Bandwidth of transmission baseband signal		8.1 MHz (-6dB)
Resampling clock rate		16.2 MHz
Horizontal bandwidth	(Y)	20 ~ 22 MHz (for stationary portion of the picture) 12.5 MHz* (for moving portion of the picture)
	(C)	7.0 MHz (for stationary portion of the picture) 3.1 MHz* (for moving portion of the picture)
Synchronization		Positive digital sync
Audio and additional information		PCM multiplexed in VBLK using 4 ϕ DPSK (2048 Kb/s)
*Values of a prototype receiver: these values should be 16 MHz and 4 MHz, if a perfect digital two-dimensional filter could be used		

Source: H.P. Gaggioni, "The Evolution of Video Technologies."
IEEE Communications Magazine, November 1987, Vol. 75, No. 11.



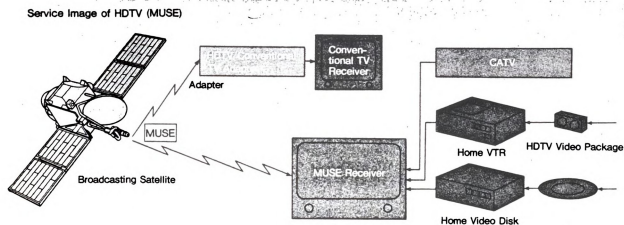
Compatibility is a major issue in high-definition technology. Today's U.S. broadcaster operates in the VHF (Very High Frequency) and UHF (Ultra High Frequency) spectrum bands within 6 MHz spectrum. This means MUSE requires roughly one-and-one-half to twice the size of the current channel and that is not available for broadcasters at this time. In other words, additional bandwidth or spectrum is needed. As a matter of fact there is an additional spectrum, but it is reserved for land-mobile operations since numerous public safety organizations depend on it, such as the police and fire departments. Because of the pressure by the broadcasters to reserve spectrum for future high-definition, the Federal Communication Commission (FCC) is looking into freezing the relocation of spectrum and reserve it for high-definition.

Finally compatibility issues go beyond today's terrestrial stations which might have to spend millions of dollars to buy new equipment. High-definition will have a major economic impact on the consumer as well. To elaborate on the last statement, high-definition is not compatible with today's television sets as they are not equipped to receive the high-definition signal. This is one of the main reasons that the FCC rules out the Japanese system. In addition, the FCC ruled that any new high-definition system to be developed, must be compatible

with the current standards so that existing TV sets (roughly 150 million in American households) won't be made obsolete. Figure 3 illustrates how high-definition will be transmitted through DBS (Direct Broadcast Satellite). The conventional TV sets need to be attached to an adapter for compatibility purposes only, but not for high-definition image quality. With or without the adaptor, the compatibility problem still exists with the conventional transmission standards. Later on in this chapter, this research will explain other MUSE systems that are compatible with conventional standards.

But first, an important point needs to be made to avoid confusion. This part of the chapter will explain the three main systems of television operation in the world. First, the NTSC (National Television System Committee) which is used by North America and Japan. The NTSC system specifications are: 525 scan lines, 60 Hz as a field frequency and 30 frames per second. The second and third are Phase Alternate Line (PAL) and Sequential Couleur a Memorie (SECAM). Europe and part of Asia operates on this system which includes 625 scan lines, 50 Hz field scanning rate and 25 frames per second. Because of the 50 Hz field frequency rate, the images on the European screens have more flickers or dots which cause a lesser image quality than the 60 Hz countries. This piece of information is very important because it is a technical

HDTV in the MUSE Implementation



Source: High Definition Brochure on Hi-Vision, NHK

Figure 3

issue that serves as an obstacle in the selection of a world-wide standard, where production and exchange of TV programs are impossible directly without one converting a system to another. However, the 1125/60 production standard has been recommended by ATSC (Advanced Technology System Committee) and SMPTE (Society of Motion Picture and Television Engineers) as a voluntary standard for high-definition studio organization and program exchange.⁹ In fact, a few programs were produced in high-definition in North America such as "Chasing Rainbows" by CBC (Canadian Broadcasting Corporation). "Chasing Rainbows" is a mini-series drama type that was produced through 1125/60 Hz production standards and transmitted through the NTSC standards because there is no agreement upon transmission standard yet. Another program that has been shot using high-definition is "Julia and Julia" by RAI, the Italian production company and finally a feature film "White Hot" (originally titled "A Crack in the Mirror") directed by and starring Robbie Benson. This film is considered to be the first high-definition motion picture made in the U.S. There are three main high-definition studios in the U.S. so far: David Niles, Barry Rebo and Zbig Rybcqynski HDTV studios. These studios are all located in New York City.

MUSE Sisters

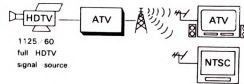
The last part of this chapter will discuss Japan's other MUSE systems which are called MUSE sisters. (Figure

4) In the U.S. the main concern is compatibility with the current channel allocation and NTSC system. Therefore, NHk (Japan Broadcasting Corporation) has been engaged in the development of compatible MUSE systems.¹⁰ There are three different MUSE systems that have been proposed to the FCC. NTSC-Compatible MUSE-6, NTSC-Compatible MUSE-9 and finally Narrow MUSE. These systems were to be demonstrated at the NAB (National Association of Broadcasters) convention at Las Vegas in April, 1989. Narrow MUSE and its sisters, MUSE-6 and MUSE 6+3 are high-definition encoding systems that permit the high-definition signal to be transmitted within the conventional 6 MHz channel. Narrow MUSE is the only system that requires a converter to operate on a standard receiver, yet it can be transmitted within a single 6 MHz RF (Radio Frequency) channel. The image quality of Narrow MUSE is the best among its sisters since there are no restrictions on the NTSC compatibility.¹¹

The other two systems, MUSE-9 and MUSE-6 are compatible with the NTSC standards; MUSE-9 is structured by adding 3 MHz augmentation channel to the NTSC-compatible MUSE-6. The resolution of the moving portion is improved by the additional channel of 3 MHz to 6 MHz. Finally, MUSE-6 can be transmitted within single 6 MHz RF (Radio Frequency) channel that is compatible with the NTSC. Furthermore, MUSE-6 can transmit two digital audio

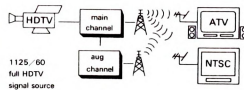
NTSC - Compatible MUSE - 6 Attributes

- ☆NTSC & 6MHz bandwidth compatible
- ☆Wide aspect ratio(16:9)
- ☆Twice the resolution of NTSC
- ☆Two - channel CD quality digital sound



NTSC - Compatible MUSE - 9 Attributes

- ☆NTSC - compatible
- ☆Compatible with NTSC - compatible MUSE - 6
- ☆Wide aspect ratio(16:9)
- ☆Twice the resolution of NTSC
- ☆Improved moving resolution with 3MHz augmentation channel
- ☆Four - channel CD quality digital sound



Narrow MUSE Attributes

- ☆6MHz bandwidth compatible
- ☆Simulcast compatible
- ☆Highest picture quality among the three(no NTSC restrictions)
- ☆Four - channel CD quality digital sound

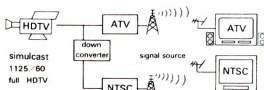


Figure 4

1989 NAB Convention, Las Vegas.

channels and MUSE-9 and Narrow MUSE can transmit four digital audio channels. For more information on the structure of the MUSE family as well as its characteristics see Appendix B, Figure 5 and Table D.

CHAPTER II

LITERATURE REVIEW

Introduction

The structure of this chapter will include two main parts. The first part will briefly discuss the history of television production since the birth of color television when the NTSC standard was established. In this part the research will explain the need and the effect of some production innovation in video. For example, what was the need for the videotape technology, and how did it affect the production techniques in video.

The second part of this chapter will discuss the high-definition technology from a production standpoint, and will briefly describe a few popular systems that are being developed in the U.S. The author has no interest in promoting neither the U.S. nor the Japanese system. This research is designed to explore the effect of HDTV in production as a general issue.

1. Flashback

History still recalls the bitter fight over the color television standard in late the late 40's and early 50's. RCA and CBS were the main rivals in this fight. In October, 1950, when the FCC approved the CBS non-

compatible color standard, RCA without any success fought the decision all the way up to the Supreme Court. In June, 1951, CBS broadcast the first commercial color network program in history, a one-hour show with Arthur Godfrey, Ed Sullivan and other stars.¹ RCA continued working hard to develop a compatible color TV. The issue of compatibility means that the color signal must be compatible or received on black-and-white television sets. In 1953 RCA petitioned the FCC to permit the marketing of compatible color systems. On December 17, 1952 the FCC approved the RCA compatible color system. The last event resulted in the birth of the National Television System Committee (NTSC) standard which is currently in use by the broadcasters.

In the past 35 years a lot of technological innovations have been introduced in the production field. Among these technologies are new cameras and VTRs, with an upgraded quality, new television sets that have more channel capacity and better viewing conditions, high fidelity stereo, video tape technology and Electronic News Gathering (ENG), graphic and digital effects, time based synchronizer and finally special test and monitoring equipment. The main point here is that all of these technological innovations were developed under the NTSC standard. The most popular production techniques

introduced were videotape technology and the Electronic News Gathering.

1.1 Video Tape Technology

A person might ask what was the need for this technology and how it made TV shows better? When television production started, all shows were produced live on film or on kinescope recording. The quality of the latter was fuzzier than regular film. As a result, the search to replace kinescope started. In 1953 RCA demonstrated a videotape recording system for both color and monochrome television.²

In 1956 CBS was the first to make the use of videotape recording. Some other reasons for the introduction of videotape were the need for restoring a show for delayed playback for the three hours time difference on the west coast and mainly editing which allows the director to eliminate technical errors and to assemble the best possible performance for the aired show.

The benefits of videotape made editing much faster than film because tape did not have to be processed. Special effects were achieved by a push of a button and much cheaper than film. The editing shot by shot was difficult and expensive until new electronic devices were developed in the 60's. Before the 60's, the editing used to be physical cutting until Ampex refined the editing process with the development of electronic editing in the

early 1960's. The electronic editing opened the door to the use of tape editing as a production tool in itself. In 1967, the Electronic Engineering Company of California developed a time code system that enabled each individual video frame to be addressed with its own unique eight digit code.³ Time code permitted editing with reliable single frame accuracy.

1.2 Electronic News Gathering (ENG)

In the 70's the technology allowed the making of small TV sets as well as radios. Moreover, it reduced the VTR (Video Tape Recorder) size making it more portable. The industry developed the electronic handheld cameras. Both the portable VTR and electronic color camera shaped the future of the electronic news gathering and became the heart of this business.

In other words, this equipment combined the portability of film with the immediacy of tape.⁴ The electronic news gathering technology made it possible to collect television news series without the use of film. The new generation of handheld cameras, along with a portable battery-operated VTR and microwave links, made it possible for two-way communication between the newsroom and the crew in the field. In addition to that ENG allows editorial control of a report as the pictures are shot. Editing out unnecessary statements or video images would be an example of this.

2. Recent History, HDTV

Since the birth of color television 35 years ago, the NTSC standard became the "law" for the broadcasting industries. Any equipment to be developed had to be compatible with the existing standards. The arrival of the HDTV technology challenges the 35-year-old standards and defies the NTSC image on home receivers.

To refresh the memory, HDTV started in the early 70's when NHK (Japan Broadcasting Corporation) initiated research to capture the quality of 35mm film on home video receivers. The goal was achieved, however, and it called for a new production and transmission standard which is very expensive to change. As it was mentioned earlier, the production standards of the NTSC are 3:4 aspect ratio and 525/60 scan lines per second which creates the images on the screen. The production standards of HDTV are 3:5 aspect ratio and 1125/60 scan lines. A few shows have been produced by 1125/60 production standards, however, the main concern of articles and books is the transmission standard.

In the U.S. there are three ways to send a signal to home receivers, traditional broadcasting from a transmitter known as terrestrial; through a wire cable; and finally via satellite to dish antennas placed on roofs. Broadcasters are limited to 6 MHz bandwidth as a transmission standard. Cable is not subject to these

standards since its signal travels through wires not air. So cable may be the first pioneers in sending an HDTV show through their channels.

The difference in HDTV spectrum is that HDTV requires twice the size of the channel that is currently in use by the broadcasters. HDTV roughly will need 9 to 12 MHz to transmit the more complex signal that produces the HDTV image. Technically, the main objection of the U.S. is not 1125 scan lines, the 3:5 aspect ratio or the 12 MHz spectrum, it is simply the difference between the U.S. standard which is 59.94 elements per second and 1125/60 standards which is 60 pixels per second. This is only a 1/10% speed change, however, it is impossible to perform that speed change properly without regenerating every single frame, therefore the technology to do that is very expensive. As a matter of fact in Europe also it is not the 1125, the 12 MHz or even 3:5 aspect ratio, it is the issue of 50 Hz to 60 Hz.

As was mentioned earlier in Chapter One, the European countries operate on field frequency of 50 Hz. This is the main obstacle that stands in the way for program exchange and a world standard. The power issue is almost 50 years old when the first television systems were introduced in Europe and the U.S. Countries introducing TV made the flicker frequency the same as the line frequency of the power. Moreover, this was, and is still

a very convenient thing to do and turned out to be helpful in the production field. For example, lighting equipment that is used in sports arenas and movie sets discharges at the rate of power frequency. For a better explanation, if you use a 60 Hz camera in a PAL or SECAM country where the power is flickering at 50 Hz, the image is degraded in addition to the flicker in the electronic signal. As a matter of fact, the Japanese have this problem on the island since they have 50 Hz and 60 Hz. The part of the island that was settled by the British was run by 50 Hz and the Americans came in and established 60 Hz as a frequency power in other parts of the island.

An example of this problem is if Japan is doing a sporting event, it is possible to modify the signal after it comes out from the remote truck to get rid of the flickers. However, if they are doing a dramatic scene where shadows are produced by lighting, it is impossible to fix the flicker problem. Therefore, the conversion of 50 elements per second to 60 per second requires a very complex procedure.

Even in conversion from PAL to NTSC the main problem is not the NTSC and PAL conversion, it is not the 525 to 625 lines but it is the conversion from 50 Hz per second to 60 Hz per second. This brief background explains why the U.S. and Europe went ahead to develop their own HDTV systems that would fit within their technological

boundaries. From the economic point of view, the European Economic Community objected the loudest, the reason being Europe makes most of its own television sets, and if Europe adopts the Japanese standard it will open the door for industrial invasion from the East.

U.S. HDTV Developments

Roughly a dozen systems are being developed in the U.S. In this section the research will describe some of these systems. According to the FCC, any system that is developed must be compatible with the NTSC environment. The ground rules are: the system must deliver the quality of high-definition or close and must be compatible with the existing television sets. This will be achieved either by accepting less than full HDTV resolution quality or by two channels assignments.

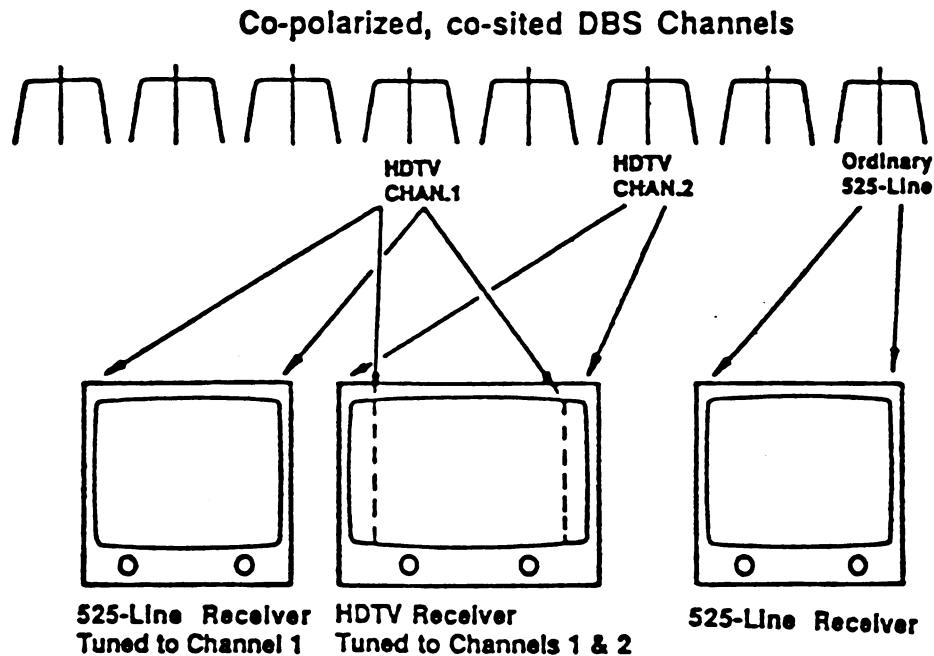
Before describing some of these systems it is important to know the economic power of NTSC which includes 150-200 million TV sets in the U.S. and \$100 billion dollars invested in the existing broadcasting infrastructure.

CBS HDTV System (Figure 6)

CBS developed a dual-channel high-definition system. The system is based on a time multiplex component using two 24 MHz-wide DBS (Direct Broadcast Satellite) channels.⁵ The viewer who has an NTSC TV system, will be

assigned to the first channel which carries 525 lines/60 Hz and 4:3 aspect ratio. The second channel will carry the HDTV signal for HDTV sets and also high quality digital sound. In other words HDTV receivers will receive both channels to enhance the high-definition image.

The CBS DBS HDTV System



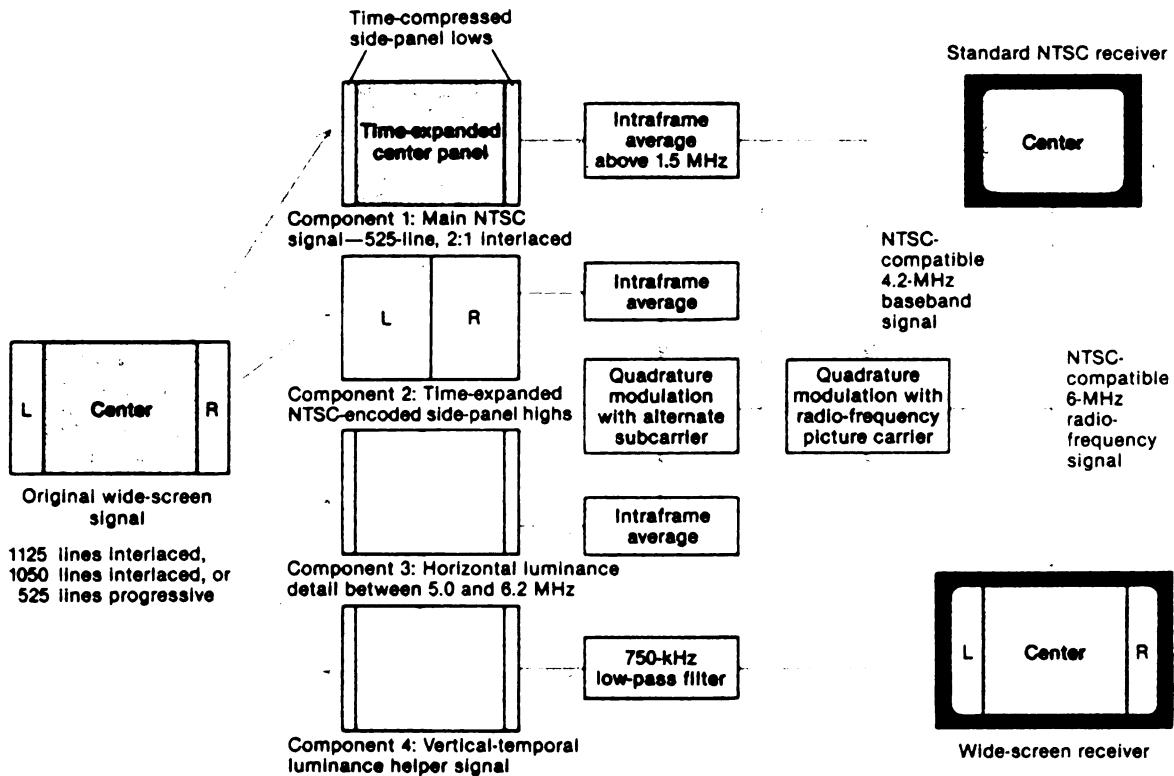
Source: H.P. Gaggioni, "The Evolution of Video Technologies,"
IEEE Communications Magazine, Vol. 25, No. 11, November 1987.

Figure 6
 CBS DBS HDTV System

Advanced Compatible Television (Figure 7)

The David Sarnoff Center, along with NBC, believes the ACTV is the next generation of TV technology. The emphasis of this system is on compatibility with the

Advanced Compatible Television Block Diagram



Source: Ronald K. Jorgen, "Consumer Electronics." *IEEE Spectrum*, Vol. 25, No. 1, January 1988.

Figure 7

current over-the-air broadcast system. This system is supposed to come in two stages. The first stage is ACTVI which provides less quality than full HDTV, however, it uses only one channel. Then years later the second stage will unveil ACTVII which will still be compatible but will require two channels. The system will use time-compression and expansion-processing techniques to transmit four signal components in a single 60 MHz spectrum. Special TV sets will be made for the second phase where it will offer more than 420 lines per picture height which can be designed for 1125 scanning lines or 525 lines with 1:1 progressive scan. In other words, the ACTV receivers will decode the enhanced-definition signals while today's TV sets will display a normal picture. Figure 8 is an actual picture for ACTV that was displayed at the National Broadcasting convention, Spring 1989, in Las Vegas. This actual picture shows the image quality on NTSC compatible television screens which is 525 scan lines and 3:4 aspect ratio and advanced compatible television with 1125/60 scan lines and 3:5 aspect ratio.

ND-NTSC by the Del Rey Group (Figure 9)

This system is a one channel solution. It is based on the introduction of a sub-sampling technique called TriScan which takes a high-definition monochrome (black-and-white) signal and compresses it down to NTSC format.⁶ The principle here is delivering a HDTV signal on a single

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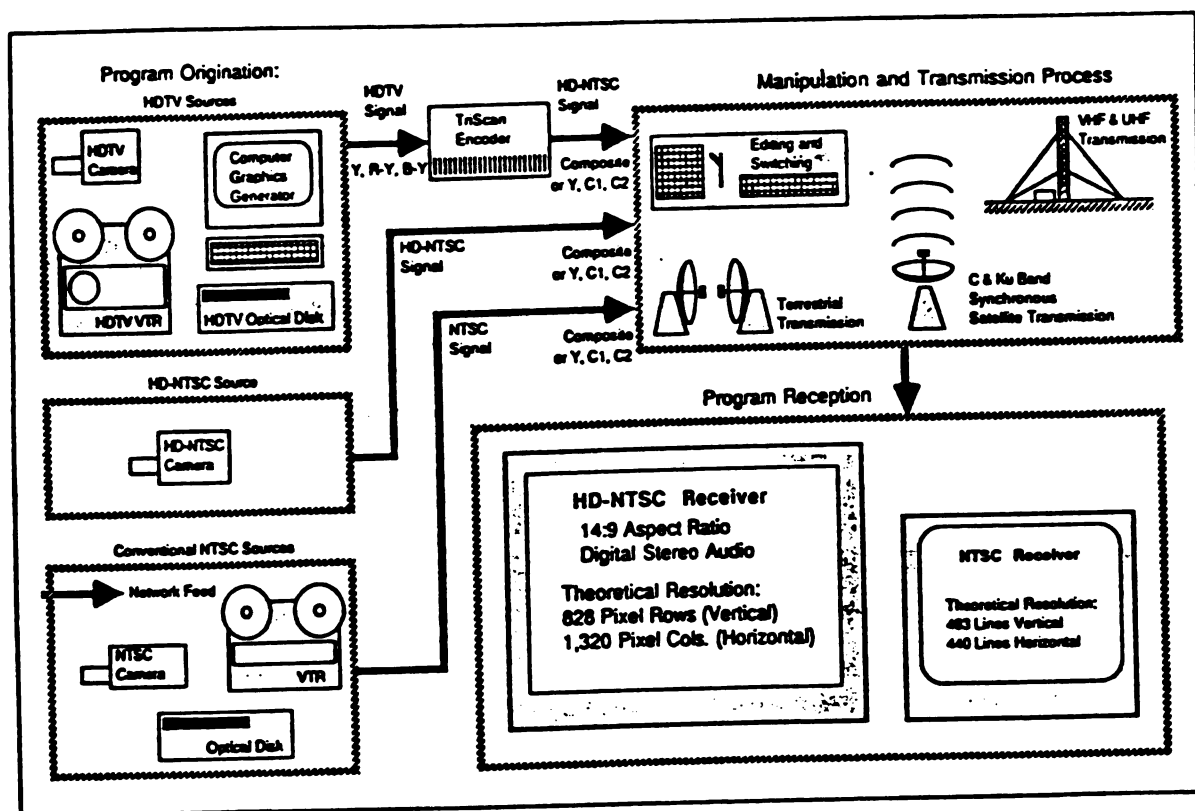
NTSC from Advanced Compatible Television (Photo of Actual Screen)



Advanced Compatible Television 1 (Photo of Actual Screen)

David Sarnoff Research Center
Subsidiary of SRI International
Spring 1989

The HD-NTSC Process -- A Conceptual View



Source: Richard L. Iredale, "A Proposal for a New High-Definition NTSC Broadcast Protocol," *SMPTE Journal*, Vol. 96, No. 10, October 1987.

Figure 9

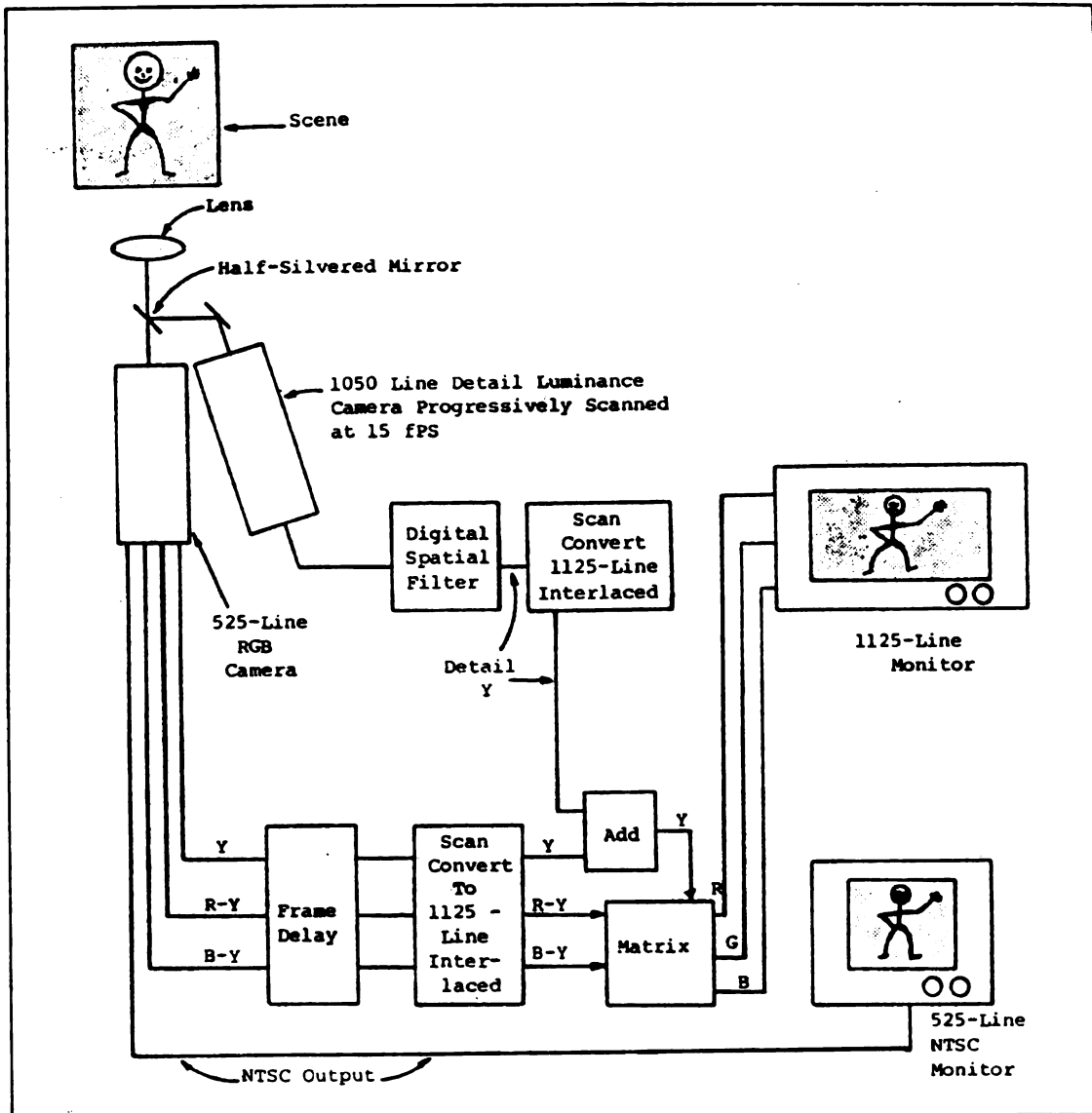
channel that does not disturb regular broadcasts. Another explanation for this system is that the HD-NTSC signal behaves just like the NTSC signal, therefore the signal can be restored on a NTSC recorder, edited in an NTSC studio, then transmitted over a single NTSC channel. By using the procedure, a TV set which is equipped with an HD-NTSC decoder will deliver an image with twice the vertical and horizontal resolution of a regular NTSC set. However, the Del-Ray Group admits that the NTSC signal will suffer slightly.⁷

New York Institute of Technology Compatible System (Figure 10)

This system was developed by Dr. William Glenn of NYIT. His concept involves supplementing a TV station's 6 MHz on-air signal with a 3 MHz augmentation channel from the UHF band.⁸ This system will operate on both NTSC and HDTV sets. In reality there will be two channels: one involving perception of detail and the other, perception of motion. On the other hand, Dr. Glenn has been developing a transmission system called VISTA (Visual System Transmission Algorithm). This system will provide a definition image of 1125/60 production standards. This will include 850 vertical lines and 700 horizontal along with a 5:3 aspect ratio. The viewer who owns NTSC sets will still get the same picture that they have been getting for years, this will be done by using the 6 MHz

The NYIT Compatible System

Block Diagram



Source: W. Glenn & K. Glenn, "HDTV Compatible Transmission System,"
SMPTE Journal, Vol. 96. No. 3, March 1987.

Figure 10

channel. For the people who own HDTV sets, an augmentation of 3 MHz will be added to the original 6 MHz channel from the UHF-band to capture the HDTV image.

There are some other systems that are being developed in North America such as high-definition-NTSC by North American Philips. This system will use one-and-a-half channels. The people with current sets will use one channel, and people with HDTV set will add the half channel for wider picture. Other systems are being produced by Zenith Electronics Group and Massachusetts Institute of Technology. At this time none of these systems have been fully tested, especially in hardware, with one exception - the Japanese system. The NHK system had been tested and according to Japan Broadcasting Corporation will start delivering HDTV shows to their citizens by 1990. For more information about the various systems and their differences see Table E in Appendix B.

All of these HDTV systems that have been mentioned have technical problems they need to overcome. There is one problem, however, that remains to bedevil the U.S. HDTV developments, and that is funding. Japan Broadcasting Corporation (NHK) along with Sony, Ikegami, Panasonic and others invested \$500 million in HDTV research and developments. If the U.S. government would help with funding, the question becomes, is it adequate in comparison with what the Japanese invested in their HDTV

system? And who will get what? Some of the U.S. systems are seeking broadcaster funding for: (a) HD-NTSC, a compatible system on a single 6 MHz channel, and compatible two channel 6 MHz + 3 MHz augmentation by William Glenn of the NYIT. The author believes, to overcome this funding problem, the U.S. industries should act as the Japanese. In other words, one adequate U.S. system should be selected and be funded all the way. The problem in the U.S. is the competition in those various systems. Mutual interdependence probably is the solution, which means to respect each other's existence in the market by investing the money into one system then splitting the pie.

HDTV Production Application

The previous section of this chapter dealt briefly with the history of television production and generally on HDTV technology and the various systems. The intent of this procedure is to familiarize the reader with the conventional production technology and the emergence of a totally new system in which the production techniques artistically and technically will be affected. From here on the research will discuss the focal point of this study and that is the effect of HDTV technology on video production.

A great number of articles have been written on HDTV from the technological and economic aspects, however, only

a few of these articles discussed the latest technology and its impact on production. The reason is that not enough actual high-definition production has taken place. Since there is little agreement upon HDTV standards there is no reason to produce an HDTV program knowing that it will be down converted for an NTSC release.

The articles that dealt with production, stated that HDTV image is as sharp as 35mm film, that is, HDTV resolution is comparable to the theatrical 35mm films. Other articles stated that HDTV wide aspect ratio will benefit sports since the entire infield will be covered at close range of the action.

Film Style Production/Post Production

Since HDTV possesses the quality of 35mm film, a few shows were here produced for primetime episodes such as ABC's "The Fall Guy" which was arranged by Glen Larson and 20th Century Fox for HDTV production. According to literature it seems that the flexibility of HDTV helps the filmmaker as well as the camera operator because of the ability to replay a take to see if there is a boom (see Glossary) in the shot. In film, there could be another week or so of production if such a problem went unnoticed.

A cameraman said:

There is no way it's not going to make you a better cameraman or cinematographer because you actually see what you're dealing with. You can't tell with a video assist what the quality is, but this is it, I am so conditioned to

getting a phone call from the lab at three or four in the morning to say that there's some problem that I can't sleep well. But with high-definition, when we played the tape back before we left the set, I knew I wasn't going to get a call in the middle of the night."⁹

The cost issue as discussed in the literature noted that HDTV is cheaper than film. A reason is TV programs are done faster and use less people on the set. For instance, on a film set you have the camera operator with an assistant to help him focus and an operator for the crab dolly crib. In the TV studio on the other hand, one person does all that. In fact, cost saving in crew expenses and reducing the shooting time were suggested as benefits of HDTV.

Another area in which high-definition electronic production improves productivity and reduces the elapsed production time is electronic production and post-production. Use of single-camera techniques saves almost 15% of total production cost. In addition, single camera techniques offer a great deal of artistic flexibility over the conventional three camera production. HDTV can be compatible with every video system, or transferred to 35mm film, or composited in real time. Finally, the special effects such as electronic matte techniques will be achieved at a lesser cost.

Primetime television shows represent yet another cost issue. Eighty to 84 percent of television prime-time shows are shot on film and post-produced electronically.

The main point here is that if HDTV could save money then HDTV could be another alternative for the network to reduce costs on primetime shows. The chart below (Figure 11) illustrates the network primetime production costs - costs that increase 16% every year. Hollywood produced over 1,700 hours of original primetime programming for three commercial networks alone, and each primetime hour costs between \$1.2 million and \$1.5 million.¹⁰

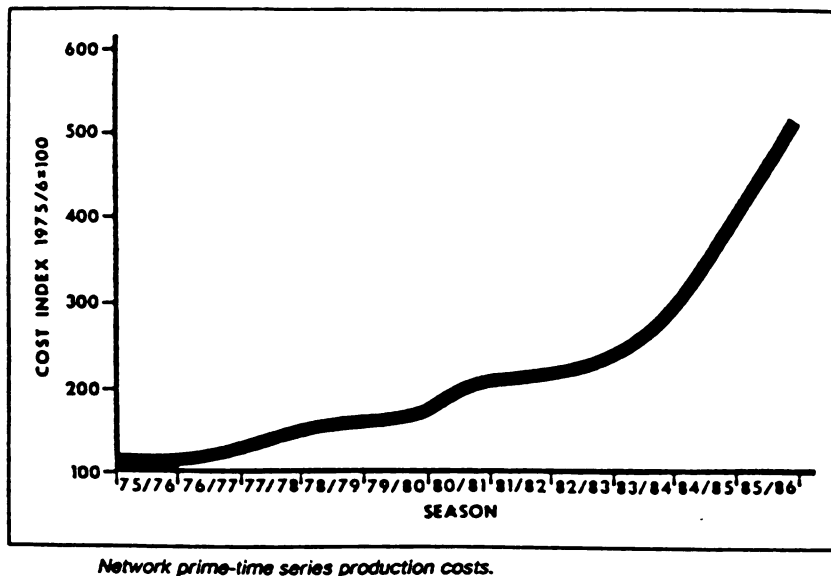


Figure 11
Source: SMPTE Journal, September, 1987

Since the networks are losing audience share to cable and the VCR market, HDTV will save them money without compromise in image quality and the networks can stay competitive. Another cost issue is the HDTV equipment: the capital cost of this equipment is high. Currently,

the HDTV VTR cost is roughly \$200,000, a camera costs about \$250,000 each and a color monitor is \$47,000. Further, the technology is changing rapidly, therefore the life of this equipment is relatively short.

HDTV Defects

Not every system is perfect. HDTV has some drawbacks the technology needs to overcome. The equipment is heavy and bulky, does not perform well in low light, uses a great deal of electricity, and cannot be used for high speed photography. The reason is there is no such thing as high speed video. High speed film, for example, refers to the degree of light sensitivity it possesses. The faster the speed of the film, the more sensitive to light it is. The slower the speed, the less sensitive to light it is and more illumination is needed to produce an image. In video, light levels cannot always be controlled which limits the shooting flexibility.

Besides the capital cost of this equipment, video editing systems require a level of technical training that many film editors do not possess. Despite these barriers, a few shows were produced through HDTV and down converted to NTSC for transmission purposes. For example, "Chasing Rainbows," a 14-part mini-series was produced by CBC (Canadian Broadcasting Corporation.) "Chasing Rainbows" went to production in March, 1986 and was completed in October, 1987. The reason for shooting in HDTV was

financial. The 14 part mini-series cost roughly \$11 million Canadian dollars which is almost \$600,000 U.S. per hour. This is much less than the budgets required for the programs produced for American television.¹¹

Another reason for using HDTV is that most of the production done by CBC is shot on 16mm film. The Canadian people wanted to know why their programs don't have the American look, which is the look of 35mm film. CBC does not have the budget to shoot on 35mm film. Therefore it was suggested to use high-definition instead of 16mm. CBC did not buy the equipment but went through hard times to convince Sony to rent the equipment at a low cost.

"White Hot" is a feature movie starring Robby Benson which was produced at Barry Rebo's HDTV studios in New York and is considered the first high-definition motion picture produced in the U.S. Prior to that RAI (Italian Production) produced "Julia and Julia." Three other companies on the East coast are producing commercial and music videos in HDTV. WTTW of Chicago has used HDTV technology for sporting events. All of the above shows except "Julia and Julia" were converted down to NTSC or PAL. "Julia and Julia" was converted to 35mm film for theatrical release.

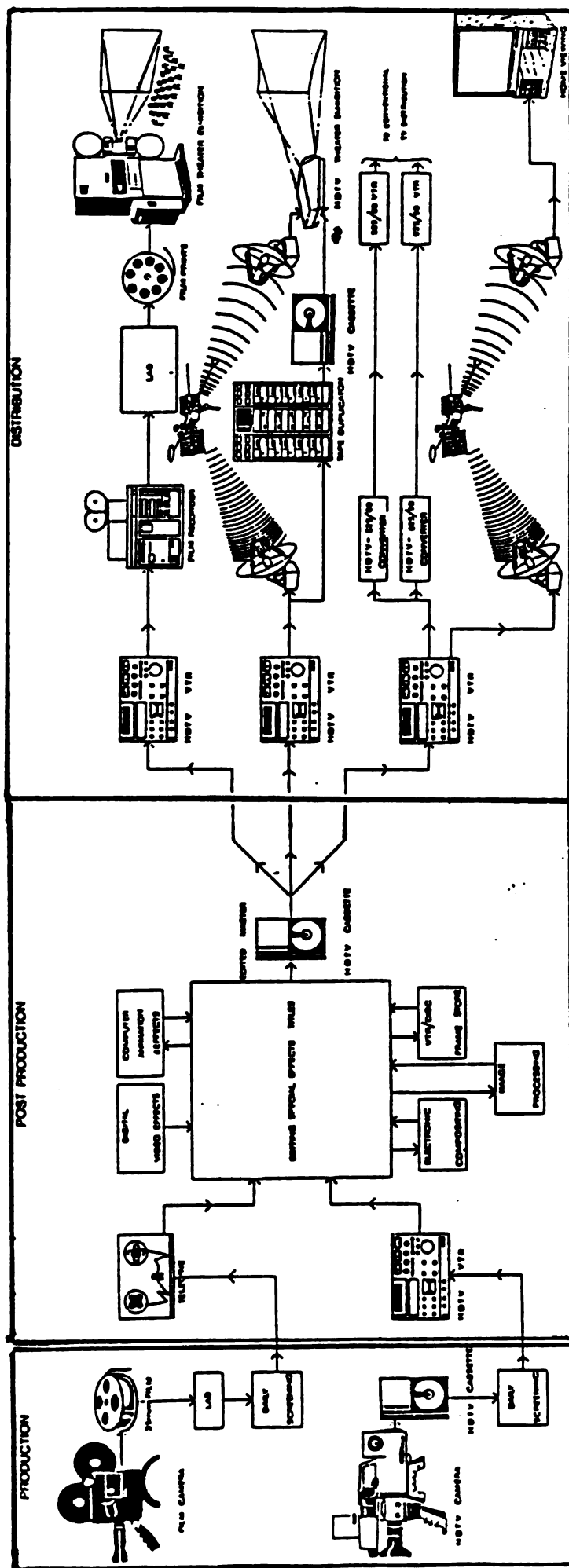
Finally some experts believe that in the future motion pictures will be delivered through DBS (Direct Broadcast Distribution). There will be no need for film

projects. This process is very hard to describe. This process, however, would be completely automated.

According to Mr. Craig Tanner, business manager of HDTV video system (Sony Communciation Product Corporation):

Even further into the future satellite distribution to a large number of theaters using one HDTV tape player would send a motion picture to hundreds of thousands of theaters simultaneously. It appears obvious that film print will no longer be distributed to theaters, since cost savings would be significant."¹²

Figure 12 is a model which shows the steps of production whether in HDTV or film, the distribution process to home viewers and via DBS to film theaters instead of projectors.



Model of a future HDTV production system in which action can be shot with comparable quality on either film or tape.

Figure 12

Source: SMPTE Journal, March, 1987

CHAPTER III METHOD AND MATERIALS

I. Introduction

Prior to delineation of results and discussion, it is necessary to examine the methods by which data for this analysis were gathered and how it was analyzed. Most of the data that pertained to the controlling statement were derived from four experts. These experts experienced high-definition technology in the production field and that makes them qualified to discuss the issue. To ensure confidence, it will be appropriate to familiarize the reader with each expert.

A. Mark Blandford

Mr. Blandford is a writer and director who resides in Toronto, Canada. He is the co-creator of the mini-series "Chasing Rainbows" which was shot in high-definition. He acted as the executive producer and one of the three directors for the same show. Recently, he resigned from the CBC and started working at DayStar Productions in Toronto, Canada.

B. Glenn DuBose

Mr. DuBose is a writer and producer at WTTW of Chicago. He borrowed HDTV equipment for ten days and

produced the first HDTV pilot by a local U.S. television station.

C. Ron Yergovich, WTTW Chief Engineer

He was recommended by Mr. DuBose to talk to on issues that are related to high-definition television from a technical point of view.

D. Charles Pantuso

Mr. Pantuso is a consultant for HDTV and regular TV. He started his career in 1971 at a local TV station in San Antonio. He then worked for an educational station in Houston, Texas. From there he moved to New York and spent 8 years working for ABC. He acted as the director of engineering for Northern Light and Picture Corporation and finally he was one of the producers in the mini-series "Chasing Rainbows."

2. Materials

This research contains two types of materials that have been collected through different sources: primary source materials and secondary sources.

a. Primary Sources

The primary sources are the most comprehensive and valuable materials that have been collected to conduct this study. The data were collected through interviews in two different formats. The first format was the personal interview. It was conducted

in Toronto, Canada with Mr. Blandford in which twenty minutes of selective scenes from "Chasing Rainbows" was played.

The second interview format was conducted by telephone. The telephone interview with Mr. DuBose of WTTW of Chicago and his chief engineer lasted almost an hour-and-a-half. Finally, the last telephone interview was with Mr. Pantuso which lasted two hours. All of the above interviews were taped without any objection by the producers as long as they were strictly for educational use.

b. Secondary Sources

The secondary materials included the examination of the National Association of Broadcasters (NAB) documents, and a review of the literature which involved articles from magazines, journals and newspaper reports. A few books published by NAB were obtained, although they discussed only the technical aspects of HDTV and its future implementation outside the television medium. All of the previous sources were gathered through library research including Infotrac and other databases, reviewing government documents, the social science collection and finally publication guides and indexes.

3. Analysis

The method that was used to analyze the data was by reading the articles as well as reviewing the documents and reports, then by taking notes on every article that established a production result or effect through the use of HDTV. Using these notes the author formulated and designed the questionnaires with the approval of the committee members. (See Appendix A.)

The questions were constructed to cover almost every aspect of the production/post-production procedure which the literature failed to confront. On the other hand, some questions were constructed by quoting an article to examine the reaction of the producers since they have experienced HDTV in actual production. Although the producer's opinion could be extreme or moderate, every one of them assumed it is too early to give definite answers or even talk about specialization in HDTV from the production standpoint.

CHAPTER IV RESULTS AND DISCUSSION

I. Introduction

Chapter Four is the heart of this study focusing on data analysis and results. As a reminder, this research was designed to explore the effect of high-definition technology on production techniques in video. In general, the literature disagrees with specific outcomes that were generated from the interviews. Since the acceptance of high-definition by producers will depend mostly on financial viability and technical parameters, the researcher established two main issues to be discussed. The first issue is the technical parameters in HDTV from the production standpoint; comparing HDTV and film, both technically and artistically. The second issue is the alleged cost reduction which most literature mentions as asserting savings in video over film cost in two areas: equipment cost and production cost. The above issues will be discussed and argued from the point of view of the literature and from the perspective of the producers who experienced high-definition in actual production.

1.1 Technical Issues

Before this research goes any further, the researcher believes that there is a need to mention and describe two defects in the current system of NTSC. These defects degrade the image quality and are therefore a production problem.

The first defect is called cross color which is viewing bizarre color patterns, for example, on a TV anchor's jacket. This is the result of mixing high-frequency luminance and chrominance information in the same composite signal. In other words, the NTSC encoder system is designed to combined the three color signals RGB (Red, Green, Blue) together with the brightness into one signal, and the luminance and chrominance interfere with each other.

The second problem or defect is cross luminance which is color information leaking into the luminance channel especially on monochrome television sets. In HDTV things are different according to Mr. Pantuso. The RGB colors in HDTV are transmitted separately so the defect by encoding or low chroma bandwidth will not occur. The minute you downconvert HDTV to NTSC, however, the problems are back. Pantuso added that there is another alternative which exists in the current NTSC system. This alternative is called CAV (Component Analog Video). CAV is designed to keep the colors and brightness fully separated. There are

more reasons to use CAV which include the possibility of achieving better chroma key effects and acting as a first step in the evolution of component digital studio systems.

The research chose "Chasing Rainbows" as a technical production overview. In this section, the researcher shared production facts from the literature and analyzed HDTV from the producer's perspective.

A. Image Quality

The literature indicated that the HDTV image is comparable to 35mm theatrical film. Because of its high resolution, HDTV will allegedly replace film production especially in primetime television movies. Furthermore, the wide aspect ratio is another good quality because from the physiological point of view the eye was intended to see horizontally. From the image standpoint, there are mixed reactions from the producers. Mr. Blandford believes that HDTV has a good resolution, but does not have the film look. In addition to that he believes that the best distribution to the viewer is film to NTSC. Since everybody likes the film look so much, he is thinking of producing his shows through HDTV, standard converted to 35mm, then go through a processor and put it onto NTSC. He thinks this plan will have the look of film.

Mr. Blandford also discussed another area, that of wide aspect ratio. He said it is a good thing to have but

what is the use of transmitting the signal through NTSC? Mr. DuBose of WTTW agreed with Mr. Blandford in regards to the distribution and aspect ratio. In regards to the image quality he believed that the image does not look like film but certainly looks much better than NTSC. Furthermore, he stated that he has never seen a skin tone so realistic and with such well-defined texture as in HDTV.

Mr. Pantuso spoke of image quality. He believed that the HDTV picture is much sharper than film although film people hold the opposite view. Mr. Pantuso's technical explanation relied upon the fact that the film's resolution is hidden by many things, such as the fact that the film is moving all the time where it does not register properly and the fact that though film has 2,000 lines per picture, the actual resolution is nearly close to NTSC's 525 lines which is definitely lower than HDTV's 1,125. Moreover, the film picture comes 24 times per second which means that the shutter is closing off light half of the time, the other half it does not matter what the focus on the lens is since there is no picture.

On the same subject of image quality, Mr. Pantuso and Mr. Blandford believe there is nothing wrong with the NTSC picture. The problem lay in the transmission and reception areas. Mr. Pantuso strongly believed if any average human being goes into a 525 studio environment and

watched the output of a 525 Ikegami 323 camera which is run through RGB to a 525 35-inch monitor and next to it a 35-inch HDTV monitor connected to an HDTV camera, he will not be able to tell the difference. Mr. Pantuso continued by saying that the viewer does not know the real look of the NTSC picture because of the over-the-air broadcasting and reception which degrades the quality of the signal.

B. Equipment Performance

The dawn of a new system is not always perfect. The literature mentioned a few problems with HDTV equipment such as: HDTV equipment is bulky and heavy; the medium's relatively slow speed compared to film; the equipment does not perform well in low lighting; and finally, HDTV requires a great deal of electric power. All the previous problems were agreed upon from the producer's point-of-view.

There are more drawbacks, however, to HDTV that were discovered through the actual production of "Chasing Rainbows" and the WTTW experimental production. According to Mr. Blandford and Pantuso, "Chasing Rainbows" was designed to be produced with a single camera production technique because of its artistic flexibility. By using Sony second generation HDTV camera (the first generation was prototype), three main problems emerged.

The first problem was that the Sony HDTV camera with its big viewfinder was designed as a studio camera to be

used with other cameras. Because the monitor on the camera was black-and-white and the image is so small, the camera operator had enormous difficulties composing the shot. The second problem which was shared by Mr. DuBose is the focus. The focus in HDTV is so critical. In comparison with film, there is always a focus puller beside the camera operator. His job is to measure the distance between the actor and the camera, then automatically adjust the lens on the set while the camera operator is moving. Since "Chasing Rainbows" is a film-style production and the crew is film-oriented, the producer wanted to have a focus puller on the set. However, the equipment did not allow this and they ended up focusing from the remote truck on big screen. According to Mr. Blandford, this discourages the filmmakers from adopting the new technology.

Finally, the HDTV camera has no safe area as is found in 35mm film. "Chasing Rainbows" was intended to be released on NTSC which is 3:4 aspect ration. HDTV cameras are 3:5 aspect ratio. This means that you have to be careful in framing the shot. To understand this interesting point it is important to understand the safe area of 35mm film. The aperture (the opening of a lens through which the light passes) of the film camera is 3:4 aspect ratio. If a film is produced for television release, the camera operator does not use the entire 3:4,

he uses 3:4 subset of the aspect ratio which throws out the top and bottom of the picture. To capture the right information, all 35mm film cameras have lines on the viewfinder glass, which tell the operator where to shoot. This is very important when, for example, a boom microphone is about to come into the shot, the film operator can see it before it gets into the part where its going to be projected, and he can tilt down or wave it out.

In existing high-definition cameras there are no lines and the camera operator in "Chasing Rainbows" was used to seeing things on his viewfinder. However, as soon as something such as a boom microphone appears on an HDTV finder it is already in the shot. This created a lot of problems for the camera operator, therefore, Mr. Pantuso went to a company in Canada which built something called Safe-Title-Generators. The Safe-Title-Generators contain an electronic line to be used on monitors to determine whether the picture is in the right place. Mr. Pantuso said that this company makes custom designed generators based on the buyer specification.

Another area of technical drawback is the problem of HDTV camera registration. The Chief Engineer of WTTW experienced this problem. He said that the state-of-the-art NTSC cameras have computer setup with a pattern internal to the lens, on which the NTSC camera registers

itself. HDTV cameras also have computer setup. However, the computer that is doing the registration still needs an external pattern since there is no pattern internal to the lens. Based on this fact, the registration ended up on the chart. He said that the most difficult problem is preventing wind and movements as well shadows on the chart. HDTV cameras take more time to register. The average NTSC camera registration is 5 minutes. HDTV takes actually 30 to 40 minutes. Color balancing is the same between HDTV and NTSC cameras. Mr. Pantuso agreed with that, but he added that today's NTSC cameras are technically better than 1,125 HDTV cameras in certain regards such as: NTSC cameras are quieter and shoot in low light. Eventually Mr. Pantuso believes that HDTV cameras will be better than the NTSC 525.

Another area that was discussed was the weight of the equipment that limits the portability and maneuverability of the camera in comparison to 35mm equipment. The producers of "Chasing Rainbows" were aware of these problems, so they designed the show around that fact. Mr. Pantuso said if "Chasing Rainbows" had asked for a helicopter shot, it would have been a problem. He added that it could be done if you have the money to rent a huge helicopter capable of carrying the generator, VTR and camera. To explain this point, the video shoot always needs a VTR connected by cable to the camera and at least

to one monitor. High-definition equipment is heavy, especially the recorder, which has to record so much information in comparison to an NTSC recorder, that no technology has been invented yet for small recorders that can go with the camera. The HDTV digital recorder that Sony sells is about 5-1/2 to 6 feet high, 2 feet wide and 2 feet deep and weights about 300 pounds. These facts limit the flexibility and the portability of the HDTV equipment.

C. Learning the Technology

Finally, how much do film people need to know to be able to work with HDTV? The literature failed to mention this area although it is very important because it combines the technical knowledge of the video people with the artistic creativity of the film people. According to Mr. Blandford, video people do not have artistic ability. Because he is so artistic, he hired film people to produce "Chasing Rainbows." Mr. Blandford strongly believed that the creative perspective is more important than technical proficiency with equipment. Mr. Pantuso had the same reaction but slightly differently in some ways. He believed, first of all, that high-definition technology is not hard to learn. Nevertheless, to produce a high-definition picture that has the same emotional impact as a motion picture is an artistic issue, not a technical one. In fact, the techniques one needs to accomplish that are

There was discussion and the possibility of the sale of the land was discussed. The land was not sold.

1. The Board of Directors of the Corporation has the honor to acknowledge the receipt of your letter of the 10th inst. in relation to the proposed amendment to the Charter of the Corporation.

2. The Board of Directors has considered the same and has decided to recommend to the stockholders of the Corporation that they vote in favor of the proposed amendment.

3. The Board of Directors has also decided to recommend to the stockholders of the Corporation that they vote in favor of the proposed amendment to the Charter of the Corporation.

4. The Board of Directors has also decided to recommend to the stockholders of the Corporation that they vote in favor of the proposed amendment to the Charter of the Corporation.

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very hard to learn. Moreover, video people do not use these techniques because they are not interested in video as an artistic medium. On the other hand, film people do not understand the technology for video or film well enough to take the film image and know what they need to do in video to achieve the artistic look. Mr. Pantuso ended his discussion by saying that the increase in resolution is not what makes film look better than video, the secret is the way lights are handled. The fact is that when you overexpose the film, you will get rid of artifacts, however when you overexpose in video you will get a lot of problems. Therefore, where film works and video fails has nothing to do with resolution whatsoever.

Finally, from the technical point of view, there are some things that one can do on film that can't be done on video. One example is high speed film which provides the cinematographer with good exposure latitude, however, in video there is no such thing as high speed tape yet. Some movies that were produced in high-definition used 35mm film for some scenes because of the need for high speed film which is more sensitive to light. The best example of that is "Julia and Julia" by RAI. According to Mr. Pantuso, "Julia and Julia" is a good technical movie to watch (available at video stores). The movie was shot on HDTV and converted to 35mm film for theatrical release, but the video cassette is down converted from HDTV to

NTSC. If you watch this movie, you will be watching pretty much a video picture, but there are some scenes shot on film because they needed a high speed film. Furthermore, there are some scenes where they used four cameras but they could not afford four HDTV cameras, so two of the cameras were film cameras.

"Julia and Julia" is a good technical movie to watch because it shows what HDTV transfer to video looks like and one can see the intercut with film transfer to video for comparison purposes. On the other hand, the Barry Rebo movie, "White Hot" was shot on HDTV, transferred to 35mm film and from 35mm film down to video cassette which is the output of HDTV transferred to film and back to video.

1.2 Cost Reduction

This is the most important issue that decision-making will depend on down the road. The research will focus on the two types of cost: the cost of equipment and production costs, or video cost versus film cost. There are many contradictions revolving around the production costs since it is a central issue for the broadcasters and film makers. Therefore, the researcher will spend a short time on equipment costs and devote the rest of the time discussing the production costs.

A. Equipment Cost

The literature stated that the capital outlay of HDTV equipment is one of its drawbacks. There is no objection on that point from the producers since they experienced the high cost of HDTV in production. Every producer in film or video knows HDTV is very expensive. There are three main HDTV studios where filmmakers can rent equipment: the 1125/60 HDTV studios of David Niles, Barry Rebo's HDTV studio and finally Zbig Rybczynski of Zbig Vision. All of these studios are located in New York. These people bought their equipment from Sony in order to produce/post-produce using HDTV technology and to make money by renting this equipment. As a matter of common sense, renting this equipment is very expensive and even if you can afford it, there is not enough equipment to go around in comparison with how many productions for TV and film are in process. Though Sony is not in the rental business, after strong pressure they rented equipment to the producers of "Chasing Rainbows," as a test for the equipment's performance.

Based on the fact that the individual has to capitalize his technology, Mr. Blandford and Mr. Pantuso talked about the cost to rent HDTV equipment vs. film equipment. To rent HDTV equipment from David Niles, one is compelled not only to rent the equipment, but also the people to operate it as an extra charge. In other words,

David Niles is not going to let you take his equipment without one of his engineers.

Mr. Pantuso gave this researcher figures for comparison between HDTV and film equipment. The cost of renting an HDTV camera, one VTR and a truck with an engineer costs \$7,500 a day, while in film you can rent a PanaVision Gold camera (which was used in shooting "Indiana Jones and the Temple of Doom" and "Empire of the Sun") with six lenses, tripod and everything that comes with it for only \$700 a day. This is 10:1 difference. It is true that film stock is more expensive than video tape, but the new HDTV tape costs \$1,000 per hour which is close to the price of film. Furthermore, the HDTV equipment is very expensive to buy and Hollywood loves to rent without the need for capital outlay. According to Mr. Pantuso, if you want to buy a HDTV 20-inch monitor, which is the smallest you can buy, besides the camera monitor, it will cost \$4,700. Consider the price if one needed another monitor on the set, another in the remote truck and yet another in the producer's office to preview a program!

Furthermore, the Sony digital HDTV VTR costs \$400,000. The Sony 1,125 HDTV camera with an average lens costs \$450,000. The HDTV lenses start from \$120,000 to \$200,000. As a matter of fact, you can buy the best quality 525 camera with much better lenses, such as long lens or wider aperture, for less than \$120,000. Yet one

can buy a good quality camera for \$35,000 to \$40,000. The issue here is if one wants to capitalize in HDTV, it will change the whole structure of paying for equipment and technology.

The most difficult challenge in HDTV technology today is that the equipment changes with such tremendous speed. In fact, before you pay it off it is obsolete. On the other hand, movies are being shot with PanaVision cameras which were built 10 to 15 years ago. Mr. Pantuso added that Barry Rebo's equipment is not compatible with the new standard that was agreed upon by SMPTE (Society of Motion Picture and Television Engineers), and therefore needs to be replaced for a cost of roughly \$2 to \$3 million dollars.

B. Production Cost (HDTV vs. Film)

This is the most important factor in high-definition today. Broadcasters have high hopes in the new technology where production cost savings without compromise of quality is foreseen. For many years, broadcasters have been looking for a way to lower the production cost so more profit will be created and still retain the same quality as film. According to the literature 84 percent of the primetime shows of the big three networks (ABC, NBC and CBS) are shot on film in order to maintain a competitive edge over cable and the VCR market. HDTV may

be an alternative to reduce the cost of production and maintain the film quality. According to the literature, there are so many areas in which you can save money by using HDTV. The research will focus on each of these areas and analyze them in comparison with the producer's opinions and remarks. The secondary materials stated that HDTV can save on crew expense and reduce shooting time. In other words it takes less crew to shoot in HDTV. For instance, in 35mm film besides the cinematographer, there is the camera operator, the assistant (focus puller) and crab dolly grip while in HDTV, according to the literature, one person can do all of that. Mr. Pantuso disagreed. He said two things: first of all, HDTV may not reduce the number of people and second, if HDTV reduces the number of people it does not mean you will save money. For example, on a film set you have the cinematographer, the camera operator and the focus puller who make an average of \$25 per hour. In an HDTV shoot, you have the camera operator, a cable puller and a good video engineer who is not only artistically and technically qualified but has to keep his eyes on the monitor all the time in order to keep the image in focus. (If you recall, the HDTV camera cannot be focused on the set, the focus has to be done in the truck.) In reality, these engineers make an average \$100 per hour, and you may have to pay them more to do extra work.

The second area in which cost reduction is argued relies upon the fact that tape is cheaper than film. Mr. Blandford agreed in general terms but he believed that people are comparing apples to oranges. He said it all depends on how extensive the special effects are. The more intensive the special effects, the more HDTV makes sense. Mr. Pantuso explains it from a different angle, he said last year "Indiana Jones" cost \$110 million dollars, while the "Nice Girls Don't Explore" film was done also last year and cost \$1.2 million dollars. Now the question is how much does 35mm film cost, \$110 millions or \$1.2 million? When you compare film to video, you have to be specific, such as the length of the movie, the special effects, and how many cameras you are using. When John Huston shot movies, for instance, he shot the scenes all the way through, did the cuts only for the scenes he wanted and shot 30 percent less film than the average cinematographer. On the other hand, "Perfect Strangers" on ABC, is shot on film with three 35mm cameras running all the time, using a lot of film. If you are comparing the cost of the camera and the cost of the film, HDTV is more expensive based on the earlier data and if you are comparing film to video cost, today HDTV video costs \$1,000 per hour which is close to the cost of film.

The third area of cost reduction is in post-production where special effects and titles are done

faster and easier in HDTV. In addition to that programs on video are easier to convert to broadcast format. Moreover, high-definition gives the producer the ability to replay a scene to see if there is a problem and that reduces the delivery time for the program. In general, the electronic post-production of HDTV has its greatest applications in film studios. According to Mr. Pantuso, nobody said that one cannot shoot on film and post-produce on video. In fact, most of the films that are made for TV are shot on film and post-produced electronically. Therefore all the savings that accrue from post-production have nothing to do with shooting in video. In other words, you cannot compare the cost savings of editing and post-production.

Mr. Pantuso added that most of these studies are done by TV people such as CBS who never shot film before. According to the literature, CBS shot the movie "Innocent Victim" in HDTV. Their study compared HDTV to 35mm film, and they saved 18 percent. Table F (Appendix B) summarizes the internal study by CBS for the above and below the line costs. Mr. Pantuso believed that this result is not accurate since CBS used three of its engineers free of charge, and these people would have been paid if it was through a film union shop. Moreover, they own the HDTV equipment which was not included. These

facts show that the study was done from a subjective point-of-view, not an objective one.

The real savings that CBS had in "Innocent Victim" was because it was a video shoot not film and they did not have to follow teamsters union rules. If you are shooting 35mm film, there are certain rules as to the type of person who can drive a truck and pull cable and the lunch break that one must have on the shoot. These rules are much more restrictive in film than they are in video and because of that CBS saved money. There is a real savings if made-for-TV dramas are shot in HDTV and one does not have to negotiate with unions and teamsters.

From the experience of Mr. Pantuso, however, in "Chasing Rainbows" he believed that if he had to do what he did in "Chasing Rainbows" for the rest of his life, it would be unionized in no time because of the abuse. The shooting day is usually 12 to 14 hours, but in "Chasing Rainbows" it was 16 hours. One person who worked for Mr. Pantuso while he was away doing the post-production used to wake up at 5:30 a.m. and pack up the mobile, drive to the location, unload the mobile, set up the camera and load the tape. At the end of the shooting day, he packed up the mobile, drove back to the studios, unpacked the mobile to do the transfers to NTSC because of the off-line editing -- and he was making only \$35,000 a year. As a

matter of fact, no one will do that job for that amount of money even for a test project.

According to Mr. Pantuso, Dick Stumph, the director of Universal Studios did an internal study and he found out it was more expensive to shoot in HDTV. Mr. Stumph got hold of the CBS study (Table F), circled the miscalculated figures and mailed it back to the editor telling him that he didn't know what he was talking about.

On the subject of special effects, Mr. Pantuso believed that HDTV saves money because of the ability to create the effects you want by using the blue-screen mattes. This technique reduces set construction costs and increases the production value. Mr. Blandford was very happy with the blue-screen because without it, he could not have created Montreal in 1919 with his small budget. As producer, Mr. Blandford was happy with the outcome despite some technical problems such as the inability to create shadows.

On the playback issue, Mr. Blandford said this is an excellent benefit in HDTV, where one can replay a scene instantly and retape if there is a problem. He did comment, however, upon the fact that you can replay the tape and see if your scene has some problems. He said because you see it, you have to control the crew because everybody wants to be in command. Before you know it, you will be directing by command and this is very dangerous.

Since one could see the previous scenes, the actors wanted to see it, and when they saw it they started second guessing. To control that Mr. Blandford made a rule in which actors were allowed to look at the screen once they had wrapped up for the day.

On the other hand, Mr. Blandford continued, the director of "Julia and Julia" had a larger budget than "Chasing Rainbows," which was \$10 million for the 14 hours mini-series while "Julia and Julia" had \$10 million for one movie. So the director of "Julia and Julia" would look at every shot with actors and get feedback which is great if you have the time and money.

Mr. Blandford talked about costs in general by saying nobody can predict the cost yet because a whole base of experience does not exist yet. In every production the learning curve is a factor, as the curve goes up HDTV will become competitive with 35mm film. He does not believe that anybody, including himself, could speak with full authority on the cost of HDTV because the critical mass of experience has not yet been reached. Only if one has a broad base of experience, can one then speak with authority on the subject. For example, he said, I can take a film script (35mm) and give it to a production manager or line producer and after answering a few questions regarding the script and stars, the production manager can provide below the line budget data which is

almost accurate. Mr. Blandford does not believe that there is anybody who could do that in HDTV, again because the critical mass of experience has not been reached yet.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

This research was conducted to explore the effect of high-definition technology on production techniques in video. A lot of materials were found that were relevant to HDTV from technological and economic aspects, but a very few articles were written about HDTV in the production field. Based on that, the researcher found that there is a need to look at HDTV from the artistic and technical boundaries within which production techniques will be affected. Since high-definition image is often compared to 35mm film, the researcher was compelled to include a discussion of film to a certain extent. The secondary materials were obtained from articles found in various magazines and some of these articles, as well as books, were obtained from the National Association of Broadcasters (NAB).

Because the materials on HDTV in production were very limited, the author started looking for primary sources. The search for primary sources was done through some articles which wrote about TV productions as being produced or already produced through high-definition

technology. In fact, very few programs were produced because of the high cost of HDTV equipment. Two of these shows were "Chasing Rainbows" by CBC and the HDTV pilot by WTTW of Chicago. Based on these shows, the researcher interviewed four experts who used HDTV in actual production. The methods in which the secondary sources were gathered was through the library Infotrac and other data bases such as governmental guides and indexes.

The results of this study were accomplished after the interviews and analyses were done. The researcher found two types of results that affect the production techniques.

1. Technical Effects

For HDTV to be practical, the industry needs to work on flaws that were discovered in actual production. These were:

- (a) HDTV cameras cannot shoot in low light,
- (b) The equipment is heavy and the maneuverability and portability of the cameras are very limited in comparison to 35mm film cameras.
- (c) Focus is critical in comparison to film. HDTV focus cannot be done on the set, but only from the remote truck.
- (d) HDTV uses a great deal of electric power.

2. Cost (HDTV vs. Film)

In this study, two types of cost were found: HDTV equipment cost vs. film equipment cost and the cost of HDTV vs. film in production.

- (a) Capital outlay is a drawback in HDTV where in film one does not have to capitalize.
- (b) Costs for renting HDTV equipment are much higher than film equipment. HDTV costs \$7,500 a day while in film it costs only \$700 a day.
- (c) Film is more expensive than regular video, but the new HDTV video costs \$1,000 per hour which makes it close to film costs.
- (d) No one can yet predict the cost of HDTV production because the critical mass of experience has not been reached.

HDTV Advantages

HDTV has a better resolution than NTSC but it does not have the film look. Electronic cinematography post-production is where HDTV will be widely used because special effects can be done faster than in film where there is a waiting period due to film processing. Furthermore, by using blue-screen mattes, set construction costs are reduced in addition to an increase in production value. However, there are some problems with HDTV mattes because of the blue fringing at the matte line, the fast

movement being restricted, and finally, the inability to create shadows.

Conclusion

The objectives of the study were met within the boundaries of the available sources. In other words, the author thinks that the production field in HDTV is not widely used due to the cost and this limits the research findings. So far only four movies have been produced in HDTV: "Chasing Rainbows" (which is considered the longest production experience in HDTV with 350 hours of production), the "White Hot" movie by Rebo studios,. "Julia and Julia" by RAI, and finally, the "Innocent Victim" by CBS. These four movies are not enough to fully represent the effects of HDTV in video. In fact, the author believes that HDTV is going to take quite some time to become practical, especially since there are a lot of standards being proposed in high-definition technology.

Studying these proposals is going to take time which in turn is going to delay the application of HDTV. On the other hand, the equipment is so expensive to build only a few companies will be motivated to build it. On the film side, the film making community is happy with film as a creative medium. The craftsman can take a scene, edit it and create an artistic special effect. That cannot be done in video. Furthermore, the film makers believe that HDTV technology does not appeal to their creative ideas

because it is too much like video. Concerning the cost issue, Hollywood can rent any equipment needed, thus minimizing capital outlay. However, in the video industry, such capital outlay is essential.

Recommendation

There are a lot of areas where HDTV can be researched, such as the implementation of HDTV and fiber optics and the distribution of HDTV via DBS (Distribution Broadcasting Satellite). In fact, it would be a good idea to replicate this research after a few years when HDTV will be more practical and it will be easier to support the findings without any predictions. Finally, the electronic post-production is another area to research in which broadcasters and Hollywood will be using new HDTV digital systems for computerized graphics and effects.

ENDNOTES

ENDNOTES
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GLOSSARY

GLOSSARY

Above-the-line.	Budget category for the artistic and creative elements in production.
Aperture.	The opening of a lens through which the light passes. The aperture is measured in f-stops.
Aspect Ratio.	The proportion of screen width the its height. The aspect ratio of NTSC is 4:3 and advanced television is 3:5.
Below-the-line.	Technical and production cost of program which includes equipment and technical personnel.
Boom Microphone.	Microphone with a long arm to enable the mike to stay out of the camera range.
Chroma Key.	The process of inserting the image from a video source into a picture from another.
Composite Signal.	A complete video signal including sync pulse.
Contrast Range/Contrast Ratio.	The difference between the brightest and darkest portion of a picture.
DBS - Direct Broadcast Distribution.	It is a type of stationary-orbit satellite with a transponder capable of transmitting a high power signal over a broad geographic area.
Field.	It is a half of a frame. Two fields are interlaced together to produce a frame or a complete video picture.
Fill Light.	Used to eliminate shadows created by hard key light.

Frequency. The number of complete cycles per second of an electrical signal referred to as Hertz (Hz).

Interlace Scanning. Television image is composed a horizontal lines of picture information which are scanned in pattern from left to right and from top to bottom.

Key Light. The main light on a subject or scene.

Kinescope. A television recording program from a monitor using 16mm film.

Monochrome. Black-and-white television.

Multiplexing Analog Components. Refers to any system where the components of a video signal are processed and transmitted separately.

MUSE - Multiple Sub-Nyquist Sampling and Encoding. This system was developed by NHK for satellite broadcasting of HDTV signal. It comprises the 30 MHz HDTV signal down to 8.1 MHz. 8.1 MHz still twice the size of NTSC spectrum.

PAL - Phase Alternate Line. This is a video standard of 625 scanlines and 25 frames per second used in Europe.

Resolution. The degree of clarity of a picture. The higher the resolution the sharper the image.

SECAM - Sequential Couleur a Memoire. Television standard used in France and several other countries.

Tilt. Vertical movement of the camera.

Tripod. A 3-legged camera mount.

UHF Frequency. A radio frequency spectrum in the range of 300 MHz to 3 GHz. Includes TV channels 14-69.

VHF - Very High Frequency.

A radio frequency in the range of 30 MHz and 300 MHz includes TV channels 2-13.

APPENDIX A
QUESTIONNAIRE

APPENDIX A
HDTV QUESTIONNAIRE

A. Quality

1. Based on the fact that HDTV has more resolution, how does it affect colors and detail patterns?
2. What are the benefits and drawbacks to wider aspect ratio?

B. Technical

Some shows have been produced using HDTV technology. Yet these shows had to be transmitted through NTSC systems to NTSC home receivers, therefore:

1. How do you rate the picture quality on home receivers?
2. How is the HDTV signal recorded? Do you have to have a special VTR or do you record the signal on standard VTR? In addition, what kind of tape format do you use for recording an N\HDTV signal?
3. What is the best to viewer from distribution standpoint?
 - a. HDTV to NTSC
 - b. 35mm to NTSC
 - c. NTSC to NTSC
 - d. 16mm to NTSC
4. In terms of color, the NTSC encoder system is designed to combine the 3-colors signal with the brightness into one signal and transmit it. In the case of HDTV, will it be the same process or could the 3-colors be recorded separately and transmitted to avoid color signal interference as its exists within the NTSC system?

C. Camera and Lenses

1. HDTV camera portability compared to 35mm film camera. It is said that TV cameras always need a cord to a camera control unit which is connected to a monitor and at least one VTR. Do you see this as a portability problem? On the other hand, if you are working on a single camera production whether in a studio or on location, do you think the maneuverability of the camera is limited?
2. Does the HDTV camera come equipped with dolly, crane and counterweight pedestal?
3. Since an HDTV camera has a wider aspect ratio, how will it affect the graphic design?
4. Due to the fact that people still watch shows on NTSC TV receivers, how does the HDTV camera operator compromise in framing the shot?
5. How do HDTV cameras perform in the different types of lenses in terms of speed of the lens, resolving power, clarity and expense?
6. Could you use a 35mm film lens with an HDTV camera or are there special lenses for HDTV cameras as well as filters?
7. What about the HDTV depth-of-field in comparison to cinematography?
8. How sensitive is the HDTV lenses to the light?

D. Lighting

1. To fulfill the technical requirement of the HDTV system, how much light would a normal setting need?
2. Today's television cameras can produce a brightness or contrast range of 20:1. Is the HDTV contrast range more or less than the NTSC?
3. Do you need special lighting equipment for HDTV setting?

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E. Production/Post-production decisions

1. It is said that high speed film provides a good exposure and greatly reduced the amount of light and air-conditioning needed on a typical set. In your production, how did HDTV rate in cost savings in this area?
2. You can rent just about anything for film expect HDTV equipment. Do you see the capital outlay of equipment as a drawback? On the other hand, if you buy HDTV equipment and then the next year the same equipment will reach the market as updated equipment with minor changes or having more capabilities, could you sell your equipment back to the company without a huge depreciation?
3. Are there enough operators such as camera and video editors to do the job? Then keeping in mind that most editors i.e, "film editors" do not possess the knowledge of the new technology, how high is the training quality needed?
4. When you produced your shows who did the editing, a film editor? Did the editor spend much time editing due to the new equipment?
5. How did HDTV perform in special effects and animation. Was the director able to record a shot and preview it?
6. How did you record the HDTV sound: digital or analog and why? Were you satisfied with the quality of special audio effects (if you did any)?
7. What kind of programs will mostly benefit from HDTV and why?
8. In general, what are the advantages and disadvantages of HDTV? How did it affect your decision-making in terms of budget, time frame and distribution?
9. On today's TV sets, viewers can tell the difference between a program shot on tape and a program shot on film. For example, "Three's Company" vs. "Cheers." The "Cheers" image quality is sharper than "Three's Company." In using HDTV could the viewer tell the difference?

10. From a subjective point of view, how does the image look different from:
- a. NTSC and HDTV
 - b. HDTV and 35mm film

APPENDIX B

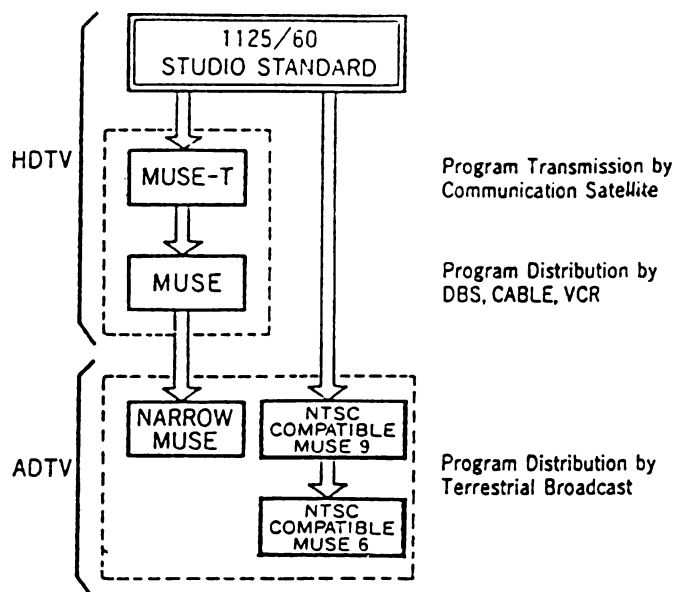


Figure 5 The Structure of The MUSE Family

Table D Characteristics of ADTV Systems

Family member	Band-width	Compati-bility	Resolution*	Digital audio	Aspect ratio
Narrow-MUSE	6 MHz	simulcast compatibility	1010	4 ch	16:9
NTSC-Compatible MUSE-9	9 or 6 + 3 MHz	signal compatibility	750	4 ch	16:9
NTSC-Compatible MUSE-6	6 MHz	signal compatibility	750	2 ch	16:9

* Horizontal resolution for still portion of picture (lines/picture-width).

Table E
Comparison of Some Advanced Television Systems
and Their Characteristics

<u>System</u>	<u>Broadcast Bandwidth Needed</u>	<u>Add'l Equip. to get on NTSC recvr.</u>	<u>Reso- lution 2xNTSC (2)</u>	<u>Aspect Ratio Wide-Hi</u>	<u># of Scan Lines (3)</u>	<u># of Sound Channels (1)</u>	<u>Status</u>
MUSE	9+ MHz	converter	Yes	16:9	1125	4 digital	Air-demo
MUSE-9	6+3 MHz	none	No	16:9	1125	?	Experi-
MUSE-6	6 MHz	none	No	16:9	1125	MTS	mental.
Narrow- MUSE	6 MHz	converter	?	16:9	1125	digital	
N.A. Phillips	6*+6 MHz	none	No	16:9	P525	MTS + dig.	Experi- mental. Demo to industry.
Glenn (U.S.)	6*+3 MHz	none	Yes	15:9	P1125	MTS + ?	Experi- mental. Demo to industry.
Bell	6*+6 MHz	none	No	12:9	I525	MTS + ?	Experi- mental.
Del Rey (U.S.)	6* MHz	none	Yes	14:9	P525 or I1050	MTS + 2 dig	Theory.
NBC	6* MHz	none	No	16:9	P525	MTS	Experi- mental.
NTSC (U.S. Broadcast Standard)	6 MHz	--	--	12:9	525	MTS	In use
HDTV (Production studios)	30 MHz	--	--	16:9	1125	4 digital	In use

* These 6 MHz signals are "standard" NTSC signals. Where an additional signal is used it is an "augmentation" signal with HDTV signal information.

NOTES:

1. The NTSC multi-channel TV sound (MTS) system includes 2-channel analog stereo sound plus a second audio program (SAP) (monaural). There is a fourth channel not normally available on home receivers.
2. One attribute of what is generally called HDTV is static resolution twice that of NTSC, both vertically and horizontally.
3. "P" stands for progressive scan: all lines in the picture are scanned each time the beam sweeps the screen. "I" stands for interlace scan: current NTSC receivers alternately scan odd and even lines in an interlace pattern. Done properly, progressive scanning gives a clearer picture.

Source: Kenneth R. Donow, "HDTV: Planning for Action"
(Washington, D.C.)

Table F

PRODUCTION COST: 35m FILM VS. HDTV

BELOW THE LINE

	Film	HD	Saving
Second Unit	3,700	3,700	0
Set Design	6,000	6,000	0
Set Dressing	29,500	29,500	0
Armored Car	116,000	94,000	22,000
Set Destruction	51,000	51,000	0
Set Operations	25,000	21,000	4,000
Property	15,000	13,000	2,000
Wardrobe	23,000	20,000	3,000
Makeup & Hairdressing	12,000	10,000	2,000
Electrical	30,000	25,000	5,000
Camera			
Director of Photography	5,200	4,500	700
Camera Operators	4,000	3,500	500
Extra Operators	1,400	0	1,400
Assistant Cameramen (2)	6,400	5,500	900
Extra Assistant	900	0	900
Camera Rental vs. HD Equipment	6,500	8,000	<1,500>
Purchase	600	500	100
Crane Rental	260	225	35
Dolly Rental	600	0	600
Negative Selection	25,860	22,225	3,635
Camera subtotal			
Sound			
Mixer	4,800	4,000	800
Boom Man	3,200	2,700	500
Cable Man	2,700	2,300	400
Transfers — Dailies	1,300	0	1,300
Transfers — Effects	80	0	80
Transfers — Reprints	750	0	750
Transfers — 1/2" Magnetic Tape	65	0	65
Transfers — Music	200	0	200
Transfers — Optical	210	0	210
Sound Effects Recording	850	0	850
Cost Of Above Using HD	0	300	<300>
Transfers — 1/4" Magnetic Tape	75	75	0
Sound subtotal	14,230	9,375	4,855
Studio Transportation	20,000	17,000	3,000
Special Equipment	3,800	3,800	0
Location Transportation	27,000	23,000	4,000
Location Express	\$28,000	\$25,000	\$3,000
Special Effects	8,000	8,000	0
Post Production Sound	22,000	22,000	0
Stock Shots	700	700	0
Film/Tape			
Negative Raw Stock	12,500	3,000	9,500
Leader	25	0	25
Magnetic 1/2"	50	0	50
Magnetic Stripe — Spliced	650	0	650
Magnetic Stripe — Unspliced	210	0	210
Magnetic Full Coat	160	0	160
Cost of Above Using HD	0	200	<200>
Magnetic 1/4"	150	0	150
Mag. Reclaimed Single Stripe	800	0	800

	Film	HD	Saving
1/4" Transfer To Mag. Single Stripe	1,650	0	1,650
Film/Tape subtotal:	16,195	3,200	12,995
Laboratory			
Develop Negative	4,300	0	4,300
Temperature Reversal Dupe Print	1,500	0	1,500
Daily Prints (Color)	6,800	900	5,900
Develop Negative Sound (35m)	325	0	325
Answer Print (35m)	4,200	0	4,200
Answer Print (16m)	700	0	700
CRI	3,000	0	3,000
Cost Of Above Using HD	0	3,200	<3,200>
Release Prints	1,300	1,000	300
Sales Tax	1,050	30	1,020
Laboratory subtotal:	23,175	5,130	18,045
Opticals	13,000	2,500	10,500
Editorial			
Supervisors (Production Company)	1,750	1,750	0
Film Editors	12,000	6,000	6,000
Assistant Editors	6,000	0	6,000
Apprentice Editors	1,000	1,000	0
Negative Cutting	3,000	0	3,000
Online VTR Assembly	0	3,650	<3,650>
Video Tape Stock	0	200	<200>
Sound Effects Editing	12,000	12,000	0
Music Editing	3,500	3,500	0
Projectionist	900	0	900
Projection Room Rental	650	0	650
Coding	900	3,400	<2,500>
Editorial subtotal:	41,700	31,500	10,200
Production Staff	25,000	21,000	4,000
Publicity	600	600	0
Administrative Expense	2,800	2,800	0
Fees & Stage Rental	25,000	20,000	5,000
Extra Talent	17,000	15,000	2,000
Total Below-The-Line	625,260	506,030	119,230

ABOVE THE LINE

Screenplay	48,000	48,000	0
Producers Unit	170,000	145,000	25,000
Cost	430,000	370,000	60,000
Music	19,000	19,000	0
Royalties, Commissions	17,000	17,000	0
Taxes & Insurance	11,500	11,500	0
Total Above-The-Line	695,500	610,500	85,000

TOTALS: 1,320,760 1,116,530 204,230

SUMMARY OF BUDGETS

	Below-the-line	Above-the-line	Total
35m Film Production	\$625,260	\$695,500	\$1,320,760
HD Production	\$506,030	\$610,500	\$1,116,530
Savings	\$119,230	\$85,000	\$204,230

Source: Variety, October 5, 1988

Table G

		NUMBERS OF RECEIVERS			
COUNTRY	50Hz	60Hz	COUNTRY	50Hz	60Hz
North America			Australia	6,800,000	
United States		163,000,000	New Zealand	1,100,000	
Canada		17,000,000			
Mexico		9,000,000	Africa		
			Algeria	1,600,000	
Central America		1,500,000	Egypt	2,300,000	
			Morocco	1,200,000	
Caribbean			South Africa	2,500,000	
Cuba		1,700,000			
Others		1,500,000	Europe (west)		
			Austria	3,500,000	
South America			Belgium	3,000,000	
Argentina	6,800,000		Denmark	2,200,000	
Brazil		35,000,000	Finland	2,000,000	
Chile		3,000,000	France	20,000,000	
Colombia		2,100,000	Germany (West)	25,500,000	
Peru		1,500,000	Greece	2,000,000	
Venezuela		3,300,000	Ireland	1,000,000	
Others		1,900,000	Italy	16,000,000	
			Netherlands	5,100,000	
Asia			Norway	1,500,000	
China	11,000,000		Portugal	1,700,000	
(People's Rep.)			Spain	11,400,000	
China		7,000,000	Sweden	3,700,000	
(Rep. of)			Switzerland	2,400,000	
Hong Kong	1,500,000		United Kingdom	21,500,000	
India	2,500,000				
Indonesia	5,500,000		Europe (East)		
Iran	2,400,000		Bulgaria	2,300,000	
Saudi Arabia	4,200,000		Czechoslovakia	5,000,000	
Turkey	5,700,000		Germany (East)	6,800,000	
			Hungary	3,300,000	
Japan		35,000,000	Poland	10,000,000	
Korea (South)		9,000,000	Rumania	4,500,000	
Malaysia	1,700,000		U.S.S.R.	96,000,000	
Pakistan	1,300,000		Yugoslavia	4,500,000	
Philippines		3,000,000	Others	400,000	
Thailand	3,500,000				
Vietnam		2,800,000			
Others	5,700,000				
			Total TV receivers worldwide:	at 50Hz:	324,600,000
				at 60Hz:	297,100,000
					621,700,000

(The only countries listed separately are those having at least 1,000,000 receivers.)

The field rates in use in various parts of the world, and the number of receivers estimated to exist in those locations.

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