STEREO AUDIO FOR TELEVISION : PRACTICAL PROBLEMS IN AUDIO POST-PRODUCTION TECHNIQUES

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Abstract

The advent of stereo television has created specific demands to the audio post-production facility. This paper presents the practical applications of a dubbing studio dedicated exclusively to mixing stereo audio programs for television. Time code synchronization versus sprocket synchronization in overall stereo audio post-production techniques is compared. Modified recording, transferring and mixing practices are suggested after an analysis of the problems encountered in the post-production process of several stereo television productions.

Résumé

L'avènement de la télévision en stéréo a créé des exigences spécifiques dans les services de post-production audio. La présent ouvrage explique le functionnement d'un studio dans lequel s'effectue le mixage des trames sonores stéréo pour la télévision. Les principes de synchronisation par code temporel sont comparés aux principes de synchronisation par rubans et film perforés. Après une analyse des problèmes rencontrés en cours de post-production de plusieurs trames sonores stéréo pour la télévision, on propose des techniques modifiés d'enregistrement, de repiquage et de mixage.

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CHAPTER ONE : STEREO TELEVISION

Multi-channel television sound (MTS) was authorized by the U.S. Federal Communication Commission in March of 1984. This date marks the arrival of stereo television broadcast to North America. At this time, the public had been viewing Dolby Stereo films for over seven years (about 500 Dolby Stereo films had been released), and hi-fidelity consumer products (videodisc players, hi-fi VCR players and compact disc players) were readily available. The audio conscious individual could set up a stereo hi-fi VCR player or videodisc player connected through a quality home sound system. This was an unprecedented audio/visual experience; high quality sound for image was now available in the home. The introduction of the surround sound decoders added a further dimension of realism to the consumer experience. Before stereo television broadcasting had even begun, a portion of the general public was aware of the quality available (for sound and image) in the home listening environment. These consumers immediately created a demand for stereo programming and television broadcast with quality sound.

The competition today for stereo television is stereo hi-fi videos (both feature film and music releases). It is no longer justifiable to accept poor quality audio for television because of the *"it will only be played on three inch speakers"* syndrome. Even if the majority of people are presently still watching mono television, there definitely is a growing audio awareness amongst the general public. Today's television productions are aiming at

quality stereo audio. Often the underlying reasons for this decision are the extended shelf life, and the marketability and future distribution of the product. In view of the new directions in both audio for video and stereo television, the post-production houses are placing an increased emphasis on high quality audio for television broadcast.

CHAPTER TWO : PHILOSOPHY OF MIXING FOR STEREO TELEVISION

The mixing techniques for stereo television are dependent on the budget and time constraints of the production. Seldom will a production have the luxury of a feature film mixing schedule. Nonetheless, videotape and film re-recording techniques are coming closer together. Still the question remains; how does one mix for the "postage stamp" image between two speakers?

Rather than localization of point sources, the stereo mix should create spatiality, depth and a greater degree of realism. Dialogue, on-screen effects and foley are mixed centre about 99% of the time. Depending on the location of the scene, stereo reverberation may be added. In certain specific cases panning can be used; for instance when a vehicle is passing by or when someone is walking across the screen and continues to walk out of the image. Care must be taken when panning the on-screen movement. Imagine the listener's living room with a 19" television set; the visual movement of a couple steps across the screen could audibly give the impression of the person walking a distance of ten feet! There are however, a growing number of consumers now viewing television on large screen (36" to 10 feet) projection systems. These home viewing conditions allow for greater flexibility in the panning of on-screen movement.

How do we perceive vision in relation to sound? The eyes will always focus the visual source directly, where the action is. This is incidentally,

where the camera is usually pointing. Audio works much more on the level of imagination. When we hear an ambience, the mind will easily visualize the scene. It is therefore important to be very careful with off-screen sounds which will never have any connection with the on-screen image. With these sounds, the imagination will create the visuals of the off-screen effects. This can confuse and distract the mind to the extent that the on-screen action may even be ignored.

The most effective stereo mixing techniques for the small screen are revealed when dealing with ambience, off-screen effects and music. With these elements one can mix for a very wide stereo spread. In fact the *"hole in the middle"* effect is usually desirable as it will amply be filled with the dialogue and on-screen effects. Directional cues for offstage action and sound effects add another dimension of reality. Imagine a horse galloping down a beach; the sounds can match the image with the waves located on the right, the hooves in the centre and the morning wind heard from every direction.

When mixing in stereo instead of mono, a larger dynamic range is possible. Audible dialogue can be heard while maintaining relatively loud effects and music levels. The average SPL in the home is about 4-6 dB lower than standard theatre stereo playback. This lower SPL requires a narrower dynamic range compared to what is accepted in the theatre. The stereo width of the ambience and effects should, if at all possible, match the music stereo spread. A strange sense of perspective is created when music is the only element which is stereo.

The playback conditions where the final product will be heard should be taken into consideration. A great diversity in the home listening environments exists. There are varying quality audio systems, different amounts of ambient noise, assorted screen sizes, and even variations in the physical lay-outs of the audio system. Many situations exist where the speakers are set up asymetrically. Vastly different dynamic ranges and equalization curves would be needed to satisfy every playback situation. What "room" does one mix for? There are many levels of response to this question. The answer lies in the fact that, whereas good mixes will easily playback in a poor environment, the reverse is not true.

CHAPTER THREE : DEDICATED POST-PRODUCTION FACILITIES

For optimum results the mixer should work in an environment similar in size and acoustics to the average living room. The film re-recording theatre is considered too large a space for mixing television; the speakers and the screen are just too far away from the mixer. The smaller music studios are the right size and it is often these studios which are modified with the addition of image facilities and SMPTE time code synchronization systems. The final result is a stereo television dedicated mixing studio with interface between andio and video.

Compared to film re-recording theatres these stereo television dedicated studios have smaller image facilities with stereo speakers placed outside the dimensions of the image. Moreover, the monitoring is in a near field environment with a reasonably flat frequency response and wide range. The smaller rooms have less reverberation and can provide a small but accurate listening area when mixing two track stereo. Presently, discrete three channel hardware is alien to the vast majority of post-production studios dedicated to mixing stereo audio programmes. Needless to say, this will change when Dolby Surround decoders become more common in the home listening environment and consumers begin to demand for surround encoded programme material.

MONO COMBATIBILITY

The majority of north american viewers today are not yet listening to stereo television broadcast. Consequently the mono performance of the product must be satisfactory. Any time errors or level imbalances between the left and right channels of the stereo mix may result in a combined mono mix with coloured highs and missing bass, and a polarity reversal will result in deadly cancellations when combined to mono. The mono sum of a wide stereo mix will often have a distinctly altered balance. Material that has a wide spread will have a moderate reduction in level when played back in mono. The centre phantom image, on the other hand, will have a moderate build up. It is incontrovertible that these problems will not be readily apparent while listening in stereo, hence the mixer must be diligent in monitoring in mono. The use of phase and correlation meters as well as an oscilloscope is recommended. Assuming that the consumer listening in mono will have a poorer quality television speaker than the stereo listener, the mono viewer will definitely not hear all the subtleties of the stereo mix.

The problem of monitoring for mono compatibility will be alleviated when mixing for a Dolby surround format. The 4-2-4 matrix will reveal mono incompatibility problems because while common phase information will be produced hard centre, all out-of-phase information will be reproduced as hard surround and will be heard in the back speakers. Thus, whenever the centre track dialogue leaks into the surround speakers, amplitude and phase mismatches in the two transmission channels can easily be identified.

PHANTOM VS SOLID CENTRE

A phantom centre image is the result of equal amounts of a signal sent in phase to both the right and left channels in a two track discrete stereo mix. The accuracy of the phantom centre depends on the room acoustics, the speaker placement (wide or narrow), and the listener's position in relation to the two speakers. The most prevalent problem when listening to a two track discrete stereo mix, is the image shifting due to off-axis viewing. Centre dialogue, for instance, will appear to be localized on the right or left, depending on the viewers' position.

In the home listening environment, monitoring with two stereo pairs of speakers (ie the small televison speakers plus those of the home hi-fi audio system) improves the off-axis listening area. The only disadvantage with this technique is that the stereo width is somewhat compromised. Using the four speakers anchors the phantom centre and increases the number of good listening seats. When listening through only two speakers, there is no more than two or maybe three optimal listening positions. As effects are panned across from extreme side to side, a change in frequency response of the two speaker pairs will be heard. However disconcerting that it may be, the occasional frequency discrepancy in panned effects is offset by the improved off-axis listening area and a more stable phantom image. Home hi-fi speakers are invariably of better quality than the television speakers. The wide frequency range music and ambience will therefore be pulled out to a wider stereo by the home hi-fi speakers giving the

impression that the dialogue is more anchored to the band limited television stereo speakers.

A more efficient solution would be a solid centre channel extracted from the two track stereo with a matrixing system. The Dolby Stereo MP matrix encoding/decoding process (which is used for feature films) specifically improves off-axis listening as well as adding another dimension with the surround sounds. Matrix encoding the two track mix for stereo television is becoming a viable option. The home viewer can listen to either the two track (left total, right total) mix or can extract three channels (left/right/surround) with a passive decoder or four channels (left/centre/right/surround) with an active decoder.

The passive decoders recover the surround sound by extracting the out-of-phase (L-R) information from the stereo pair. This out-of-phase information is delayed (depending on the size of the room) and processed with a modified Dolby B-type decoder to produce the surround output signal. The Dolby B decoding is used to improve the signal to noise ratio of the surround channel. The active decoder operates with essentially the same principles. However, there is an additional direction enhancement circuit to increase the apparent channel-to-channel seperation. This circuit is considered necessary when using a centre speaker. If only the simple sum (Lt + Rt) of a stereo pair was sent to the centre speaker, the overall stereo image would be considerably narrowed.

CHAPTER FOUR : PRACTICAL APPLICATIONS OF STUDIOS USING SMPTE TIME-CODE SYNCHRONIZATION SYSTEMS

Many post-production houses are in a period of transition. How do they adapt to the new directions in technology for both stereo television and audio for video? When working with sound locked to video, the technical considerations to contend with create fundamental changes in facilities and working practices. Time-code synchronization or sprocket synchronization? Random access digital editing or Steenbecks? Transfer rooms or lay-down suites? There are technical and creative implications dependent on every choice made. The policy of most studios is to adapt the new technology to both the existing hardware and to the proven, durable working processes. More often there is a mixture of old and new rather than a complete changeover to "state of the art".

SMPTE time-code tape systems offer a viable alternative to the established sprocketed 16/35 mm mag audio post-production process. This long-standing manner of working with sprockets (illustrated by the flow chart in Figure 1) is supported by existing hardware and professionals well versed with the technology. However, advances in the graphics and animation of video editing capabilities has lured the film world to the on-line suite.

	IMAGE	SOUND (SPROCKETS)
LOCATION	16/35 camara stock	1/4" location rolls - pilot tone
TRANSFERRING	work print----------	A&B sound (identical mag copies)
	sync rushes - edge numbers put on A&B	
EDITING	work print and B sound PICTURE EDITING	A sound to vaults
	cutting copy picture and sound---------	SOUND EDITING
		cutting copy picture to slash print
		INTERLOCK
		MIX
	NEG CUTTING----------	OPTICAL TRACK
	test print from original	
	test print from dupe	

Figure 1 - Film Production Flow Chart

The electronic post-production process synchronizes multi-tracks to video using time-code whereas mechanical post-production maintains synchronization of the dubbers and projector with physical sprockets. The advantages of time-code synchronization are flexibility and speed. With multi-tracks and a VCR locked together, there are faster shuttle and wind capabilities and the image can be accessed at a much higher speed. Re-synchronization is quick because a time-code reference is available at every point, this alleviates the need for 100' sync marks on reels of sprocketed mag.[1] The "smart sprocket holes" of time-code systems allow for events (auto-location, pre-set rollbacks, set record in and out points, offsets) to be programmed, finely tuned and stored.

Once all the stock is prepared, the mixing process occurs in a compact, autonomous working area; this permits greater all around flexibility. Threading a multi-track is much quicker than preparing multiple dubbers. Since there are fewer reel changes and less stock (a few multi-track tapes rather than numerous mag reels) to physically handle, a lot of time can be saved.

In the audio post-production process there are many stages where SMPTE time-code synchronization may be introduced. The location sound itself may be recorded with time-code, thus the audio can be conformed directly to the image via time-code synchronization. In some productions,

[1]Instead of always returning to the start to check if sync is maintained with all the dubbers, sync marks provide the opportunity to verify the sync visually at specified intervals. The sound editor will make these sync marks on the sprocketed mag and film at precise points (ie every 100 feet).

the location sound is recorded with a pilot tone. This 1/4" can be transferred with time-code added. The process is similar to the transferring of the A and B mag rolls with edge numbers. If the location sound has been linked with time code, as in the two processes described above, then the decision has been made to edit the sync sound with electronic synchronization rather then the physical "cut and splice" method. The post-sync recording; foley, ADR and music can be recorded with time-code, hence again eliminating sprocket synchronization and physical "cut and splice" editing. Digital editing of sound effects will use electronic synchronization systems. The mag tracks of the conventional "cut and splice" editing method can be transferred to multi-track machines for mix-down with time-code synchronization. Lastly, a final mix recorded on sprocketed magnetic tape can be transferred to the master audio/video. For example; the transfer of the sprocketed mag audio to the 1" video master with the Rank-Cintel flying spot scanner.[2]

Effective post-production with time-code systems is dependent on careful planning and preparation. There are technological, logistical and creative considerations to take into account when choosing between time-code based or sprocketed post-production techniques. The transition to electronic audio post-production is not straightforward due to the fact that some established procedures are simply easier and more effecient with the sprocketed techniques. The following two examples reveal how time-code post-production techniques have been introduced to the overall post-production process.

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[2]A Rank-Cintel flying spot scanner is used to make a video master from a film print.

"THE WONDERFUL WIZARD OF OZ" - CINAR PRODUCTIONS

"The Wonderful Wizard of Oz" is an animation series consisting of 52 half-hour episodes and four feature length films. The decision was made to completely redo the music, effects and post-sync audio tracks for the Japanese animation. The final product included French, English and international stereo mixes which were sold to RCA and distributed by Columbia Pictures Television.

The editing process was done in the conventional manner; auditing 1/4" ambiences and effects, transferring desired sounds to 16 mm mag, and physically cutting and splicing the mag to build the final tracks. For the foley sessions, the post-sync effects were recorded using film projection synced to a 35 mm mag recorder. Utilizing the rhythmo-band method, the post-sync voices were also recorded on sprocketed mag. The music was recorded and mixed down directly on multi-tracks while employing a time-code system to maintain sync with the 3/4" video cassette.

To prepare for the final mix, all the sprocketed mag tracks (foley, effects and post-sync voices) were transferred to a 24-track with time-code to maintain the sprocketed sync. For the first few episodes the music mixes were transferred to 35 mm mag to be re-synchronized with the image and spliced in the tracks. These tracks were then transferred to the 24-track in preparation for the final mix. The task of re-synchronizing the music to image was redundant since the music had already been synced to the image via time-code during the music mix-down. In subsequent episodes, the

music mix was laid down with time-code synchronization directly on to the 24-track prepared for the final mix. This eliminated the two generation transfer and the time consuming process of editing the music 35 mm mag.

The first step in the mixing process was the completion of the pre-mixes. Due to the availability of studios, the voices were stereo pre-mixed to sprocketed mag using film re-recording techniques. Later, the dialogue pre-mix was transferred on to the 24-track in preparation for the final mix. From this point on, the post-production process never returned to sprocketed synchronization. For all subsequent mixing, a 24-track and an 8-track were slaved to the 3/4" video cassette. The pre-mixes and mixes were recorded and Dolby-A encoded in stereo onto four tracks of the 8-track. Often sound effects were "dropped in" wild from a 1/4" tape machine during the mix.

Two 24-track tapes were needed because of the large number of edited sound tracks. The first 2" tape consisted of all the sound effects, stereo ambiences and foley; these often filled the available 22 tracks. These tracks were pre-mixed on to four tracks; two stereo pre-mixes separating the transient and steady state effects. The stereo music, stereo pre-mixes (dialogue, ambience and effects) and the narration comprised the second 2" tape which was used for the final mixdown. The final stereo master mix was recorded Dolby encoded on tracks 2-3 and 5-6 of a 1" audio tape. Two tracks comprised the stereo dialogue and narration while the remaining two tracks were the stereo ambience/music/effects. Finally, the audio was joined with the video when transferred, Dolby-A encoded, on to the two audio tracks of the 1" video master C-format.

"VIVALDI" - SOCIETE DU RADIO CANADA

"Vivaldi" consists of two 60 minute shows which were shot separately for the English and French versions. Sub-titles and language dubbing were used, respectively, for the German and Italian versions. The production was mixed for two track discrete stereo even though the scheduled airings in Canada (SRC for the French version and CBC for the English) were to be broadcast in mono.

Similar to the previous example, the "Vivaldi" production only used time-code based technologies during the final mixing process. The entire editing process was accomplished on sprocketed mag using the "cut and splice" method. The prepared sound tracks; stereo music, effects, location dialogue, narration and post sync voices were transferred to two 24-tracks, hence leaving sprocket synchronization for a time-code synchronization system. In the first pass of the mixing process, music and effects were pre-mixed on to four tracks (two stereo pairs Dolby-A type encoding) of the 8-track. The final mix was accomplished in the second pass; again two Dolby-A encoded stereo pairs with the dialogue and narration separated from the music and effects. This four track audio master was then transferred to 16 mm mag stereo, Dolby-A encoded. With the Rank-Cintel flying spot scanner the mag stereo master was transferred to the 1" video master C-format. The English and French versions then dropped another generation in the preparation of a final master with timings for the commercials. The Italian version also dropped another generation when transferred into PAL C.

It is obvious that neither of these productions, "The Wonderful Wizard of Oz" or "Vivaldi" fully exploited the electronic post-production process. Only the final mixing process was accomplished with a time-code tape system.

CHAPTER FIVE : PROBLEMS ENCOUNTERED IN THE "REEL" WORLD (WHEN YOU LEAVE THE SPROCKET HOLES BEHIND)

SMPTE time-code based technology is not yet completely transparent. Due to the complexity of the system, the possibility of error increases at every stage. Considering the time pressures involved, good planning and preparation are of upmost importance to optimize the use of time-code synchronization systems.

RECORDING

When a multi-track/VCR synchronization system is used in the final mixing process, there are advantages to both sync and post-sync recording using time-code as a reference. The time consuming process of transfers, "cut and splice" editing and retransfers can sometimes be eliminated. In any case, pre-production planning is a necessity in co-ordinating the audio post-production process to eliminate any redundant practices.

There are some productions which use multi-track recording techniques for their location sound shoots, an example being the one hour drama "The Dumb Waitor" directed by Robert Altman. These 8-track sync tapes are ideal for electronic editing since all the tracks can be monitored simultaneously in a "lay down" suite. The advantages that the electronic editing has over either the Moviola or Steenbeck sprocketed editing are twofold. First; is the ability to monitor all eight tracks if necessary; and second, is for the high quality of the monitor.

On location MS recording of dialogue, effects and ambiences is a valid technique which allows for flexibility in the final stages of the stereo mix. Careful post-production planning and communication is required to ensure that the MS tracks do get decoded to left/right stereo at the desired stage of the post-production process. It has happened that the MS tracks arrived to the final mix already decoded (during the transfer process) to a left-right discrete, therefore excluding any possiblity to adjust the perspective of the MS recording.

The recording of post-sync sound (foley or dialogue) directly onto multi-tracks, using time-code as a reference, allows for uncomplicated monitoring of several tracks at once. In addition, multi-track recording can possibly save a generation in transfers and eliminate one stage in the overall audio post-production process. During the rhythmo-band process of recording dialogue the 16 mm rhythmo-band itself is projected. This technique links sprocket synchronization with the time-code synchronization of the VCR and multi-track.

It appears inequivocable that electronic editing of digital audio will transform the post-sync effects recording and editing process. Numerous advantages such as; quick access, ease of spotting effects, electronic looping and editing with adjustable cross fades, zero generation loss, and the flexibility of sampling, duplicating and processing the sounds in the digital format are becoming evident. Nevertheless, some attributes of the established post-production processes are still preferable. A case in point is the inadequacy of sampling sounds on synthesizers to build the foley tracks.

In the production "The Wizard of Oz" the decision to use a digital synthesizer for all sound effects was reversed after hearing the final results of the first few episodes. The movement and footsteps were simply not convincing. After the foley artist redid the post-sync effects with conventional recording techniques, the dimension of realism added by the human element returned and improved the quality of the overall product.

TRANSFERRING

Greater attention to quality control in the transfer process is needed if the final mixdown uses a time-code multi-track/VCR synchronization system. There is a high potential for troubles when the edited 16/35 mm mag sound tracks are transferred to multi-track machines in preparation for the final mix.

During the mixdown in a re-recording theatre the dubbers are used in real-time to play back the 16/35 mm mag sound tracks. Therefore, problems such as a dirty tape head, an intermittent patch chord, audible wow in a dubber or a missing track (ie only the edge track patched when both edge and centre are needed) can be fixed in real-time causing little delay to the mixing process.

When mixing with a multi-track/VCR sprocketless system, this is definitely not the case. The fault must be corrected by re-transferring the problematic tracks. It must be decided whether the offending sound is poor enough to warrant the disruption in the mix for the retransfer. Additionally, one must determine if the problem did indeed result from the 16/35 mm

mag to multi-track transfer. To complicate matters, the time needed for the retransfer is dependent on the availabilty of a dubber. Due to the fact that, all the tracks are on the same multitrack reel (1" or 2"), during the transferring process all of the tracks must be taken away. The only means of continuing the mixing process is to start on another reel; if there is one prepared. This time-consuming disruptive problem will be eliminated when the "cut and splice" editing process is replaced by electronic editing in "lay down" audio post-production suites.

Due to the many stages (transfers, re-transfers, pre-mixes and final mixes) in the audio post-production process, the sound master tracks drop many generations. This causes noise build-up and increases distortion, tape saturation, and cumulative frequency response errors which dull the overall sound quality. To insure against the main problem of excessive noise build-up the techniques of maximal track loading, high level pre-mixes, noise reduction and machine to machine transfers (only monitoring through a console) are used. Mixing in stereo further complicates the process by adding the problems of level imbalance, time delay shifts between channels, polarity flips and gap scatter between adjacent stereo pairs on multi-track machines. With the many intervening generations, accumulative errors will result in poor stereo imaging. Misaligned tape heads are often the main cause of the problems with even small azimuth errors resulting in deadly cancellations after a few generations.

A further problem is caused by transferring between video formats. Significant delays in the video signal can be caused by scan conversion equipment (ie NTSC to PAL, PAL to NTSC). Great care must be taken to

match the audio to have the same delay, otherwise lip-sync errors will occur. Often audio delay devices are used for this purpose.

At the last stage, the final stereo mix is transferred to the two audio tracks of the 1" C-format video master. Since videotape oxides are optimized for helical scan recording, compromises are made in the audio performance. The thin oxide coatings, which are good for video recording, cause distortion in audio in the low frequencies. Accurate high frequency recording is difficult because of the slow tape speeds. The small dynamic range limitation is caused by the narrow track widths. Dolby noise reduction is highly recommended to increase the dynamic range. The head azimuth has inadequate or no adjustments at all, because of this accumulated azimuth errors are common. Due to the fact that the audio tracks are located near the edge of the tape, there are problems with tape damage and dropouts. This is further complicated by wow and flutter inaccuracies. From the above information it is obvious that the audio tracks on the 1" video cannot approach the quality of a dedicated audio recorder. In fact, products from the consumer hi-fi VCR market can have audio performance equal or better than the 1" professional video. The analog audio on the 1" master is an extreme weakness in the overall post-production process.[3]

[3]There have been recent developments in encoding digital audio video machines. At the 1986 NAB Convention in Dallas, Sony Corp. announced a new digital audio encoding system for its 1" C format machines. The videotape can be encoded with (i)one NTSC video, (ii)three linear audio channels and (iii)two digital audio channels. Since existing machines already encode (i) and (ii), compatibility will be ensured for the analog audio tracks. The first digital video recorders (D-1 format) were also introduced at the same show in Dallas. The digital video machine has four channels of digital audio recorded in the center of the tape, a control track, a time-code track and a spare analog track.

MIXING IN SYNC

Owing to the complexity of the overall audio post-production process, time-code synchronization is not 100% dependable. Many of the problems encountered in the mixing process are due to time-code irregularities. Drop-outs on the time-code track, mysterious glitches in the synchronization software, and even totally missing time-code, all occur in the daily use of time-code synchronization. Although sprocket synchronization is slow and incapable of much more than transport controls and simple go-to commands, it definitely is constant and reliable. The performance of time-code synchronization varies greatly; from being extremely fast and efficient to a point where one is sure that the system has a "mind of its own". With sprocket synchronization the lock-up time, with the mag recorder up to speed, can be practically guaranteed after 10' in 35 mm footage. Time-code synchronization lock-up time, on the other hand, is inconsistent. The variance dependent on the interaction of all the elements (multi-track machine transports, synchronization software) of the particular system employed.

When mixing with sprocket synchronization all the elements are in sync with each other at all times. A technique often used in the mixing process is to check the tracks while playing the system in reverse at regular speed. Even though the frequency response of a dubber played in reverse is not entirely accurate, tracks are often adjusted for levels and for rough equalization settings. As a matter of fact, film mixers become incredibly adept at analyzing backward sound. In comparison, with time-code

synchronization systems, the machines are synced together only in the play mode; in all other transport modes each machine operates independently. This provides for faster shuttling capabilities but does not allow "reverse" mixing. Some new time code synchronization systems have recently developed variable speed synchronization which plays from 1/3rd to 3 times play speed while locked. However, this is only in the play "forward" mode.

Adjusting sync irregularities is problematic when using time-code synchronization systems. Film mixing has the advantage that it is very easy to change the sync of one dubber with respect to the others. The particular track to be adjusted is simply taken off of the interlock system, the rest of the tracks are moved to the desired point, and then the adjusted track is put back on interlock. An advance/retard unit is used for finer adjustments. This device sends extra impulses to the stepping motor to adjust the sync to 1/10th of a frame.

Although it is a more complicated procedure, shifting tracks is possible when using time-code synchronization systems. The process requires the use of more than one multi-track machine. If, for example, the final mix is recorded on six tracks (music, effects, and dialogue stereo pairs) of an 8-track recorder, then an adjustment of an effect can be accomplished in two ways. When the effect is the only element being recorded at that specific moment, then simply an offset is needed on the multi-track with all the edited sound tracks. Only the effects stereo stem will be recorded with the

desired offset track.[4] If there is more than one effect present, then the track to be adjusted needs to be transferred, with the offset, to a track on another multi-track machine (the spare track on the 8-track used for the final mix, or a 1/4" machine with time-code synchronization capabilities). Since the final re-synchronized effect will have lost two generations, the use of noise reduction is recommended.

A limitation when mixing with multi-track machines locked to video is the necessity to use the sync playback head for the sound tracks to be mixed. To have the playback of the final mix in sync to picture, the time code and the final mix are read from the playback head while the elements of the mix are read from the sync playback head. Unfortunately, the frequency response of the sync playback head on some multi-track machines is not up to par with the actual playback head. Figure 2 illustrates when to use the sync and playback heads in the mixing process. To remain in sync, the simple rule of thumb is to always read the time code track and the monitored final mix track from the same head.

[4]The effects stereo "stem" refers to the premix of the stereo effects tracks. Before the final mix, an effects stem, dialogue stem, music stem and ambience stem may be prepared.

	Tracks	Time Code	Final Mix
Monitor final mix in direct	sync head	sync head	sync head
Monitor final mix in playback	sync head	playback head	playback head

Figure 2 - Use of Sync and Playback Heads in the Mixing Process

HOUSEKEEPING

Material identification and communication during the various stages of the audio post-production process is extremely important in facilitating a smooth final mix. Stereo productions complicate the mixing and editing in the sense that there are many formats available for the tracks. Figure 3 indicates some of the possibilities of one-, two- and three-track recordings on 16 and 35 mm mag. Diligent labelling is needed so the tracks can be set up on the proper machines and patched accordingly. It is best if the sound editor takes care to prepare the tracks so as not to mix the formats on the same final prepared track. Mono elements should not be cut on the same tracks as stereo elements because the mixing process would be needlessly complicated by constantly switching between the two different routings required for mono and stereo tracks. Similarly, unmatrixed MS stereo tracks

should not be intercut with two track discrete stereo tracks, due to the different set-ups required during the mix. With proper planning the sound tracks will be transferred onto the 24-track machine in the same order as on the cuesheets. Consequently the 24-track channel meters will lined up with the cue sheets and the relative console mixing positions.

1 TRACK	2 TRACK	3 TRACK
mono 16 mm	stereo 16 mm	stereo + mono combine
mono 35 mm	stereo 35 mm (1-2)	35 mm (1-mono, 2-3)
	stereo 35 mm (2-3)	35 mm (1-2, 3-mono)

Figure 3 - 16 and 35 mm mag Stereo/Mono Formats (Note that the stereo may be two track discrete or MS recordings)

For large productions or series the user bits in the time-code can be utilized to label the reels. These labels are exceptionally efficient since any piece of time code on the entire tape can be used to identify the particular reel. This housekeeping feature was important with the production "The Wonderful Wizard of Oz" as a total of 272 multi-track tapes (2" and 1") were used. An example of labels stored in the user bits for this production is shown in Figure 4. Note that the french term for "reel" is "bobine".

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1) fx-amb tracks (2")----------FABOB1CA Feature A, Bobine 1, 1rst 2"
2) dial-mus-narr-pre-mix (2")--- FABOB1CB Feature A, Bobine 1, 2nd 2"
3) pre-mix amb-fx---------- FABOB1CC Feature A, Bobine 1, 1rst 1"
4) final mix (1")---------- FABOB1CD Feature A, Bobine 1, 2nd 1"

Figure 4 - User Bit Labels for "Wizard of Oz"

HARDWARE CHANGES

A very helpful tool, specifically used in mixing documentaries, is the pre-scan unit. This device allows for a two second visual cue announcing the arrival of sound. The dubber is equipped with the pre-scan audio head 48 frames before the playback head. The only way to take advantage of the pre-scan when mixing with multi-tracks is to play the mag to be transferred on a dubber with a pre-scan head, and then record both the track and the pre-scan audio on two tracks of the multi-track. Subsequently, during the mixdown procedure the pre-scan audio from the multi-track will feed the visual indicators. The drawbacks of this process are that two tracks are needed in the transfer and the sound must be recorded, at some stage, on sprocketed mag.

A much needed technology is an easy, inexpensive method of adding wipes to a 3/4" videocassette.[5] Often the telecine process is completed before an editor has had the chance to mark in the wipes. The mixing process is therefore made more difficult, since the very helpful visual wipes are not available. Not all productions will re-do the telecine copy. In one particular production, the sound editor split the tracks for all the perspective changes (ie interior/exterior). This was helpful, but the wipes were still missed.

ERGONOMICS

When dealing with a time-code synchronization system the ergonomic set-up of the controls can be awkward. Often the transport controls (including the record-in and record-out) can be accessed either from the remote controls of the master (usually the videocasette) or from the synchronizer keyboard. For locating an image, the remote master is used because of the ease of shuttling with the thumb wheel. However, the synchronizer keyboard is often used for the record-in's and -out's, go to's and other programmable "smart sprocket" functions. The lay-out for easy visual and manual access to all the controls is important.

To perform a record-in several steps must be taken; i) put the system into play, ii) check the direct/playback levels (ie switch in and out), iii) watch for the lock to sync indication, iv) punch into record. Considering that all this must be accomplished while watching the image and matching the

[5]Wipes are a visual cue which indicate the scene changes and dissolves to the mixer. When using film for image, the sound editor will draw in the wipes with a marker or a grease pencil.

audio direct/playback levels; the lay-out of the controls, meters and sync indicators is important.

Another important aspect in the transferring process is the preparation and planning necessary to facilitate accurate scheduling. It is obvious that the transfer of the edited 16/35 mm mag sound tracks to the multi-track machines must be completed before the mixing date. Equally clear is the necessity to have the tracks ready before the transfer is made. In a world where tight schedules and absolute deadlines are the norm, this added transferring process does cause problems. No longer can the sound editor work continuously up until the morning of the final mix, nor can assistant editors be working on other reels during the mix of another reel.

Once all the tracks are prepared and transferred to the multi-track, the actual mixing becomes an autonomous procedure. Patching and threading of the machines is often done in the actual studio by the mixer. Since there is no need to communicate to the machine room (ie where all the dubbers are in a film mix) problems in the mix can usually be identified more quickly. A change of reels is quick, requiring only the threading of a few multi-track tapes and the loading a VCR. However, since the set-up is usually performed by the mixer, the often needed ten-minute reel change break is alleviated. The mixer must take care not to become over fatigued. Being an autonomous procedure overtime and weekend bookings are easily facilitated. As well, there never is a conflict with sharing of dubbers between other re-recording theatres. Mixing with time-code synchronization systems requires much concentration; some energy must always be dedicated to confirming sync and watching out for time-code problems.

CHAPTER SIX : CONCLUSION - FUTURE TRENDS

Audio post-production facilities will continue to modify both hardware and working processes to accomodate SMPTE time-code sychronization systems of increasing complexity. Encoding audio for video and stereo television programmemes with Dolby Surround will be the prevailing tendancy. As HDTV earns acceptance as an alternative media for 35 mm motion picture production, entire productions may never have a sprocket hole in either the image or the sound. Disk based systems for sound editing (and mixing) will replace "cut-and-splice" editing techniques. Dolby SR, digital audio encoding systems for the 1" C-format video machines, D-1 and D-2 Format Digital Videos will greatly improve the quality of the audio tracks on the final master. EDTV Enhanced Definition TV (ie super VHS and Beta-ED video formats) will continue to sensitize consumers to high quality audio and video. Undeniably, audio is no longer the poor cousin of the video industry.

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Ray Carnovale, CFTO - TV, Toronto

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