Producing in Surround Sound: A Creative Project

An Honors Thesis (HONRS 499)

By

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Abstract

Surround sound audio is fast becoming a new standard in the music industry. As a future
Record producer it is in my best interest to be able to mix in surround sound. This paper
document the three phases of my project, which include: remixing stereo into surround sound,
encoding surround sound audio into a final DVD project, and comparing available surround
sound formats in order to determine which format is best. I conclude by discussing the future of
surround sound in the music industry and suggesting steps required to ensure the format’s future.

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helpful during my research and implementation of my newfound skill.

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mixing and ensuring I had all the necessary tools to create this project.
In the fall semester of 2005 I completed the senior recording project of my Music
Technology Major. The result was a ten-track audio CD featuring the band, Raising Daybreak.
This CD was mixed in stereo sound, the current standard for audio in today’s marketplace.
However due to recent advancements in audio technology, newer formats have emerged.
Surround sound has become a new option for mixing audio and Ball State’s Music Technology
program provides all the necessary equipment for students to mix in surround sound. Because
this technology represents the cutting edge of audio mixing and recording, I would regret leaving
Ball State without doing any work in surround sound. For that reason I chose to remix my senior
recording project into surround sound. This project had three main phases: remixing the stereo
audio into surround sound, encoding the surround sound audio and creating a DVD, and
comparing the differences of various surround sound encoding formats. This project was an
amazing experience and as I begin my career in the music industry I will have an edge due to my
understanding of this new audio format.

Before I begin a formal discussion of my work, it is necessary to explain the basics of
surround sound. The term “5.1” describes the number of speakers involved in producing the
surround sound audio field. Stereo audio features two channels, played back over speakers
arranged in a traditional left/right arrangement. 5.1 surround features six channels of audio,
played back over speakers arranged in the pattern left front, right front, center front, left surround
(rear), right surround (rear), and the subwoofer. There are other formats for surround sound that
feature both more and less than six audio channels. They range from three channels all the way
up to eleven discrete channels of audio or more. 5.1 has become the standard primarily due to
the film industry and the popularity of the DVD format.
In film, the left and right channels are used to present any stereo effects that would be possible in a two-channel system. The center channel is used primarily for all dialogue and it is typically located behind the screen in a movie theater. This is done to give a stronger sense of realism, as if the words are actually coming out of the actor who is speaking on screen. The left and right surround channels are typically used for special effects or ambient noise such as a spaceship flying by in a Star Wars film, or birds chirping in the background of a park in a romantic comedy. Finally the LFE channel is used for all of those chair-shaking explosions and gunshots that are a standard in today’s Hollywood action films. These standards for surround sound in film are fairly rigid, and audio engineers in the film industry rarely deviate from these norms. In the music world however, these rules do not exist.

Because surround sound is such a new format in music, there is no standard way to mix musical elements in surround sound. Should the drums go in the surround channels? Should the vocals be placed in the center channel? These questions have logical answers, but they are not hard and fast rules. This opens up many creative possibilities, and mixing music in surround sound is only limited by the producer’s imagination. I was extremely excited about this new freedom, but I had no clue how surround sound audio was produced. Even before I had any knowledge of surround sound I knew my first goal: I wanted to make some element of music sound as if it was flying around the listener’s head. I started the first phase of my project with that goal in mind, and then I headed into the studio.

The Music Technology studios at Ball State have all the equipment necessary to mix in surround sound, and that technology revolves around Pro Tools. Pro Tools is the industry standard multi-track audio recording system that is run on a digital audio workstation, or DAW. These DAWs can be based on either a Macintosh or Windows operating system and in either
implementation the audio is recorded and stored on the computer’s hard disk. These systems allow for full creation of surround sound audio in a myriad of formats including the standard 5.1. Because my senior recording project was created with Pro Tools, I was able to convert the existing stereo mixes to surround sound versions without moving to a different studio. *Pro Tools Surround Sound Mixing*, by Rich Tozzoli, proved invaluable to me as I began my foray into surround sound. The knowledge I gained from this book made this project much easier and many of the surround mixing basics I will discuss were learned from Tozzoli’s book. In order to introduce several new terms, I will first discuss the basics of mixing in stereo. Then I will detail the surround sound mixing process.

*Pro Tools*, by default, is a stereo mixing environment. This basically means that audio can be placed in either the left or right channel, or some combination depending on the desired effect. This placement of audio is known as panning and the effects created by this technique are known as imaging effects. If an audio clip is placed at equal volume levels in both the left and the right channels, the audio will appear as though it is radiating from the empty space between the two speakers. This is called a phantom image. As you pan from one side of the stereo field to the other, the volume level of the audio in one speaker decreases giving the illusion that the sound is moving from the left to the right side of the stereo field. This stereo field is like a blank canvas on which the producer paints his sound landscape. With skill and training this space can be fully exploited and there is almost no limit to the number of effects and dimensions that can be created in the stereo field. However if the desired effect is to make some element of music sound as if it is flying around the listener’s head, then surround sound will be a more effective environment. As I said, the Pro Tools system defaults to a stereo mixing environment, meaning that the sound output of the Pro Tools software is hardwired and routed to two speakers set up in
a stereo field in the mixing room. Altering these outputs is the first step in converting a stereo mix to a surround mix.

The complexities of rerouting the outputs of Pro Tools are vast, but fortunately the Music Technology Department’s faculty studio engineer, Jeff Seitz, understands those complexities. He has set up our studios with software presets that allow for switching the output of Pro Tools from stereo to surround sound. With Tozzoli’s book and Jeff’s help I successfully rerouted the Pro Tools outputs for surround mixing, but that was just the beginning. After converting the outputs I still had a stereo mix. I had panned each element of the song precisely where I wanted it in the stereo mixes, and that data had not changed. Even though the surround outputs were now active, my mixes were still playing back through just the left and right speakers. It was time to learn the concept of surround panning.

As I mentioned previously, in stereo mixing the audio can be panned to either the left or the right. Surround mixing adds two new elements to the technique of panning. Audio can still be panned left to right, but that concept is split into two dimensions: front left to right panning and rear left to right panning. The rear panning determines which side the audio in the surround channels will be placed. In addition to front and rear left to right panning, there is a pan knob that controls front to rear panning. The most likely place the average consumer has encountered this technology is in their car stereo. There are typically two knobs in a standard car stereo that control left to right and front to back placement of the sound. Surround mixing has far more complexities than your average car stereo, but the basics of moving the audio around are the same. In addition to the three panning knobs on a Pro Tools surround panner, there are four additional knobs that control where the audio signal is placed.
Each element of a song, be it vocals, guitars, or drums, is placed in a separate audio signal chain within Pro Tools called a track. Each track features its own panning section and when mixing in surround this panning section becomes a surround panner. In addition to the three positioning controls that were previously discussed, there are three knobs that control divergence and one knob that controls center percentage. The divergence knobs have values ranging from zero to 100 and they control how much of that track's audio "bleeds" into the other speakers. If the divergence is set to 100, then the audio will only come from the speaker designated by the panning position knobs. However as the divergence is set to values below 100, the audio signal will slowly permeate until it is heard to some extent in all five surround speakers. The center percentage knob was created primarily for film mixing as it controls how much of the audio in a track is heard from the center speaker. This is useful primarily for dialog in films. The final element of the surround panner is an LFE fader. This control decides how much low frequency content is sent to the subwoofer channel of the surround sound system.

With position, divergence, center frequency, and LFE controls the possibilities for shaping and placement of audio in a surround environment are endless. Once I understood these concepts, it was time to accomplish my first goal: the flying circle effect.

I located a track featuring one of my favorite guitar solos from my senior recording project. To begin my "flying circle" effect I panned the guitar solo into just the left channel. Pro Tools allows for real-time automation of virtually any control within the mixing environment. This means values like volume and panning can be pre-programmed into the system and the computer will perform the programmed effects in real time while the audio is playing back. For the first move of my "flying circle" effect I needed the guitar solo to move from the left front channel directly to the left rear channel. To do this, I set both the front and rear position panners
to their extreme left positions and then automated a timed movement of the front to rear panner which moved the audio perfectly from the left front to the left rear speaker. For the next part of my circle I needed the audio to move from the left rear to the right rear speaker. I left the front to rear panner in the 100 percent rear position, and I automated a panning movement from left to right using the rear position knob. The next part of the guitar solo’s flight path needed to go from rear right to front right, and I repeated the process from the first part of the path by setting both front and rear position knobs to their extreme right positions and automating a rear to front pan with the front to rear pan knob. To complete my circle I simply panned the audio in the front speakers from extreme right to extreme left, and my “flying circle” effect was complete. When I pressed play for the first time and heard the guitar solo fly 360 degrees around my head I was ecstatic. With this effect mastered I knew that I fully understood how to pan audio in surround. I was ready to tackle the rest of my project.

As I stated earlier, surround sound mixing for film has several rigid rules, but surround mixing for music does not. To gain some perspective I listened to a few surround sound audio mixes on the market today. Many of today’s albums are being released in a format called Dual Disc, which features a standard audio CD on one side of the disc, and a DVD with special features on the other side of the same disc. I purchased “The Beautiful Letdown” Dual Disc by the band, Switchfoot because it featured a 5.1 surround mix of the entire stereo album. As I listened to each song on the album I began to hear several similarities that mirrored suggestions made in Tozzoli’s book. The vocals, bass guitar, snare, and bass drum all seemed to be panned to the center channel while the guitars, cymbals, toms, and other special effects were panned into the left and right front channels. The surround channels were used for reverberant special effects that make the listener feel as if they are sitting in the same room with the band while they are
playing. Finally, the subwoofer or LFE channel adds just a little extra power to the low end of the instruments. I took these guidelines to heart as I started mixing my surround project, and I was able to produce a much more immersive experience than I could with my stereo mixes. I also tried to add some special surround panning effects to each track, and if you listen to the mixes you will hear a few guitar solos fly around your head. The remixing of the stereo sessions into surround was just the beginning of my project, but before I move on I want to discuss some of the advantages of mixing in surround versus mixing in stereo.

When mixing in stereo, you only have two speakers in which to present your music. This means you have to cram a drummer, a couple guitarists, a bass player, a string orchestra, some keyboard special effects, and also a vocalist into this two speaker sound field. In addition to fitting all of these elements into the mix, you have to make sure they do not cover one another up. Obviously the art of mixing is far more difficult than the average consumer realizes. Surround sound formats like 5.1 open up a new world of possibilities because now the guitarists, bassist, and drummer can each have their own speaker in the sound field and still leave room for the vocalist in the center channel. Going from stereo to surround sound when mixing is like being able to get out of a car and stretch your legs after a long road trip. As I mixed I realized I could add many more subtle effects to each instrument and they would all still be heard because of the wider sound field available in surround. Each element could also be a lot louder because the mixes now utilized six speakers instead of just two. Overall it was amazing to hear the differences of each song as I shaped them from stereo into surround. Some of the songs sounded relatively the same, while others sounded profoundly better in surround than they had in stereo, namely “Try Again” and “Increasing Emotion.” These two songs benefited greatly from the
larger sound field available in surround, and it was wonderful to experience these mixing
differences firsthand.

Once I had completed mixing each song into the surround sound format I faced the next
phase of the project: encoding to DVD. Encoding is simply the process of translating an analog
audio signal into a digital signal that can be recognized by a DVD or CD player. When mixing
in stereo, Pro Tools allows you to perform what is called a “Bounce to Disk” function. The
result of this function produces an audio file identical to what is found on any commercial audio
CD. This file can then be opened up in any standard CD burning software on the computer
system, such as iTunes or Windows Media Player, and an audio CD can be produced in a matter
of minutes. However burning audio to a DVD requires several additional steps, and there are
many different options available. In order to fit six separate channels of full-quality audio onto a
DVD they must first be compressed. This type of compression uses computer algorithms to
remove extraneous data from the audio while preserving the original sound quality. The data
removed is deemed extraneous because it pertains to frequencies that the average listener cannot
hear. By eliminating audio content at these frequencies, the compression algorithms create
smaller files while retaining fidelity. Some algorithms function better than others, and several
methods of compression are currently available for surround encoding.

The Dolby Digital compression and encoding format is the standard for 5.1 surround
sound. Almost every DVD movie in the consumer market features a Dolby Digital 5.1 surround
sound track. This format is very appealing to film producers because it takes up such a small
amount of space on the disc. Dolby Digital encoding can take an audio file that is 120
megabytes in size and compress it down to just twelve megabytes. That is one-tenth the original
file size with supposedly no loss of audio quality. If there is more room on the DVD, the
producer may opt to use a different encoding format with a smaller amount of compression and a higher audio quality. The format typically used in this instance is DTS (Digital Theater Systems). The same surround sound audio that is twelve megabytes in size when using Dolby Digital compression becomes a 41-megabyte file if using DTS compression. Often size does matter when producing a DVD for film, as a standard DVD only has 9.4 gigabytes of space on which to place all audio, video, menus, and any other special features to be included in the DVD’s production. For my purposes, audio is the primary focus, so I was able to include both Dolby Digital and DTS versions of every song, as well as the original stereo tracks.

To encode my files in the Dolby Digital format I utilized software from Apple Computer known as A.Pack. In Pro Tools I performed the “Bounce to Disk” function mentioned earlier. The result was six audio files, one for each channel of surround sound. I then imported those six channels into Apple’s A.Pack, adjusted my desired settings, and compressed all six files into one Dolby Digital AC3 audio file. This new file was then imported into Apple’s DVD Studio Pro and made a part of the final project. My method for encoding my tracks into the DTS format was similar. I again used my six discrete audio files from Pro Tools, but instead of encoding using software on the same computer I utilized a new technology available at Ball State’s VIA II lab. From the Music Technology studios, I was able to connect via Ethernet to the VIA II lab where Brian Peters maintains a network-based DTS encoder. I sent the files to the encoder via Ethernet, and then remotely told the encoder to start compressing the files. When it finished I was able to download the newly created DTS file over the Ethernet connection and import it into my DVD Studio Pro project. This technology is extremely valuable to Ball State and I hope to see more students using it in the future.
In the course of this project I taught myself the basics of DVD Studio Pro in order to produce a professional looking and sounding DVD. I added a few extras, such as a music video the band shot this past winter, and a direct link to their website, but the focus remains on the new 5.1 surround mixes. The final phase of my project was to compare the two different encoding formats I chose for compressing the surround sound audio and decide if either format was superior. I took my completed DVD into the Music Technology Studios’ critical listening room to do my comparison test.

I specifically created the DVD in a manner that allows the listener to switch between the various audio formats at the push of a button. This proved to be quite useful to me as I did my comparison test. I began with the Dolby Digital format. The most noticeable aspect of this format seemed to be the exaggeration of the audio within the center channel. Everything I had panned to the center channel seemed to be louder than I wanted it. When encoding into the Dolby Digital format, one of the available settings is to increase the volume of the center channel. Although I specifically did not use that option, it seems some sort of amplification took place in the encoding process. This would prove quite useful for film, as it would make the dialogue louder and clearer, but it was an undesired effect for my 5.1 mixes. Despite that drawback, the Dolby Digital format seemed fairly close to what I had mixed in the studio until I listened to the DTS version.

When I pressed the button on the remote to switch to the DTS version of the same song I was in complete shock at the quality difference. Everything about the DTS version seemed better than Dolby Digital. All of the musical elements were louder, clearer and sharper. I had assumed a subtle difference in quality due to the lighter compression used in the DTS format, but I had no idea the difference would be so profound. There was no overemphasis of the center
channel and the mixes sounded exactly like they did in the studio when I was working in Pro Tools. Everything also seemed much louder, and there was no distortion of the sound despite the increase in volume. After listening to the track in DTS format, the Dolby Digital format was clearly inferior. Many of my peers have heard about this difference, but few of them have experienced it firsthand. It is amazing, and my personal recommendation is to always use DTS if you have the option.

I learned a great deal from my final project and I am excited to share this information with my peers and anyone who will listen. With my new skills I will be a more valuable asset to employers and I will be able to take on more advanced surround projects with clients who desire surround mixes. To conclude, I want to briefly discuss the future of surround sound audio in the music world. Obviously film standards are rigidly set, and the future of surround sound in the film industry is quite clear, but the music industry is not quite there yet. The Dual Disc format and other surround sound versions of popular albums are not selling as well as record labels would like, and because sales are low, the future of surround sound in music seems to be very unstable. The biggest hurdle for surround sound audio is the availability of technology to the consumer. With the development and variety of home theater systems, consumers can easily watch a DVD in surround sound with a system purchased for less than 100 dollars from the local Wal-Mart, but consumers do not typically listen to music in front of their televisions while sitting on the couch. The key is to target consumers where they are listening to their music.

The car has become one of the primary listening environments over the past several decades, and the invention of the iPod has created a whole new concept of continuous listening. One look around Ball State’s campus will show that at least one out of every ten students is listening to music while walking to class. Several car manufacturers are implementing 5.1
surround sound systems into their vehicles, but these systems have not become mainstream and are typically a high-priced option, not standard equipment. I believe that advancements in surround sound headphones may decide the fate of surround sound audio formats. If Apple releases an iPod capable of playing back surround sound audio effectively within the next two years, then I believe the surround sound audio format may be saved. If not, I believe surround sound may be relegated to film and the surround sound audio format may be lost. There have been recent advancements in the online delivery of surround sound, but it seems very few producers are implementing this new technology. Maybe consumers are not ready to fully embrace the surround sound format for music, and maybe stereo sound is here to stay, but I believe change will come. Just as we have progressed from VHS to DVD and from records to tapes to CDs, I believe we will progress beyond stereo audio into surround sound formats, and with what I have learned in the course of this project, I will be ready to produce when that change takes place.
Bibliography


