exploring

SOUND DESIGN FOR INTERACTIVE MEDIA

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WHAT IS SOUND DESIGN ANYWAY?

What is sound design? How important is sound design to a visual and nonvisual experience? Where does it all begin? Sound effects originated in the theater. The effects of these sounds were to reinforce, to a large extent, the sounds of natural phenomena such as thunder, rain, and footsteps off stage. After a period of time, theatrical sound effects became more and more sophisticated, which produced better and more convincing sounds. Large mechanical devices were used for this purpose and required a large amount of space during the live performances.

In the 1920s, radio advanced the use of sound effects. At first, most radio was broadcast live using the same types of machinery used in theater to produce sound effects. By the mid 1920s great steps were taken in the direction of recording sound. Better electronic microphones and recording technology allowed sound effects to be recorded onto a medium and reused. The library of sound was thus created. The sound effects included natural sounds of the outdoors, cars, machinery, animals, planes, and people. This added a streamlined workflow to the process of radio production. It also eliminated the need to have multiple sound effects artists on hand for a broadcast.

In the late 1920s, sound was introduced into the moving picture. There was debate whether this was a good thing at the time. Some critics felt that the dimension of sound was not part of the film experience and that it should be left silent. This, of course, did not last very long as the public could hear and feel the impact sound had on the experience of watching a film. This opened up a whole new world for sound to explore, but it came with technical and aesthetic points that needed to be understood. Because film is a linear art form, sound had to be synchronized at specific points in the film in order to convince an audience. Originally the sound effects track was recorded live as the film was being projected onto a large screen in a recording studio. The synchronization was, more or less, done by eye. Because multitrack recording was not available, all of the effects had to happen during the screening of the film and recorded. Imagine if this was the case today.

In film, the sound effects track is compiled of many tracks layered together and mixed to form a dynamic, organic soundtrack. The sound effects track is really made up of many different types of sound objects created in many different ways. There are hard sound effects, which make up most of what is associated with the on-screen action and usually require synchronization, and background sound effects, which need no real synchronization and create the atmosphere and context of a scene. The background track should not have any conspicuous sounds that interfere with any foreground sounds. Ambience tracks are considered background sound effects, although ambience now has a special place among sound designers and is treated with more care than in the past. The next layer of sound in a sound effects track is **Foley** sound effects. These resemble the original way of recording sound effects to picture. Foley artists or Foley actors create the sounds for a picture as it is rolling. They act out footsteps, squeaks, squashes, clicks, clacks, and a multitude of other sounds that are directly synchronized to the picture. The name itself comes from a man named Jack Foley (1891-1967) who invented

Foley sound effects as we know it today. One interesting point about Jack Foley was that he used to record all of the sound effects in one take on one track. If a scene was being worked on, he would run through all of the sound effects, all of them, in one take. This is unique in that multitrack editors do the same today. He was a firm believer that the person performing Foley sound effects had to act and get into the role. He felt, which is quite true, that it made a big difference in the sound.

Foley sounds are recorded in a Foley studio, which contains various types of surfaces and textures for the actors to interact with. Gravel pits, sand pits, and concrete pits are some of the floor pits that are usually in a Foley studio.

Sound effects that need to be created are called **designed sound effects**. This type of sound effect is needed when there is no natural recording or sound in nature that can compare to the desired sound, like the sound of spaceship engines or other futuristic sounds.

At the end of the 20th century came another innovation for sound to explore. Video games originally had very basic digital sounds, like those of Ping Pong, for example. Around the mid-1990s, however, sound became an integral part of the game state and the need for greater and greater sound and gear was necessary. The sound effect process is relatively the same for games as for film, except there is essential programming that is needed with it. The sounds need to be prepared in order to be incorporated into the game engine. The sound programmer is responsible for this, but as will be seen, things are changing.

The sound designer's job today is more high-pressure than it was in the past. One of the main reasons for this is the increased interest in audio sound quality and the transformation of the home entertainment system to include a minimum of 5.1 surround sound. People are hearing better and better audio. In film it is expected that the absolute highest quality sound be delivered. In game production, the sound effects track and music track are gaining in importance, and the quality, although not as high as in film, is getting better and better. As of this writing, the game industry has higher gross revenue sales than the movie-making machine in Hollywood. That has opened a few eyes and a few ears. People are spending a lot of time in front of their consoles and computers playing games. Naturally, sound should support this fully immersive environment. This trend of high-quality audio has trickled down to web-based media. The expectations are becoming just as high for the web sound designer as for the game sound designer. It is not there yet, due to bandwidth considerations, but it is on the horizon. Keep your ears open, here it comes.

In the big, wide world of sound design, it may be difficult to accurately pinpoint the definition of sound design. It seems that everything related to sound is called sound design. This is not true at all. A sound designer's job is multifaceted; this is true, but it is not all encompassing. The primary job of a sound designer, in the visual world, is to create an overall sound character for the

project. Sound designers are brought in during the pre-production phase of a project and are informed of the threads of plot, story, or project expectations (at least they should be brought in this early). From this information, a design of the sound landscape is produced. The entire soundtrack is organically designed to support the thematic material presented in the visual side of the equation. The design of the overall soundtrack, with all of its components, is vital to your job as a sound designer. Usually you will perform your own mixes and contribute greatly to the sound effects themselves. One thing is for sure, sound designers are not just sound effects creators. The job is much more higher order than the micro aspects of creating sound effects, which has its own set of complicated needs. There is an aesthetic behind each project, film, or interactive scenario and the sound is an integral part of that aesthetic.

The best way to develop your skills as a sound designer, no matter whether it is in the linear visual field or the nonlinear visual field, is to study what is and has been done in film. Using film as an example, we can discern convincing and unconvincing sound situations more readily than any other type of medium for a few reasons. Film has been around longer than television, video games, or any other type of moving visual media. Sound for picture started with film and an enormous amount of attention has been given to it. In short, the best sound design created is that which is related in film. The principles and theories behind sound design for film and sound design for interactive environments is basically the same. Even though nonlinearity has an added layer of abstraction, namely the spontaneous connection and triggering of various sound events, it still deals with the principles of sound for moving picture.

What Is Heard and What to Listen For?

There are three essential parts that make up a complete soundtrack: dialogue, music, and sound effects. All sound for moving image falls into these three categories. They are all individually mixed together and finally mixed into a single file. If there are specific problems with levels or effects, the individual sessions must be revisited and balanced. In some larger scale operations, a broader mix of all of the tracks may occur, leading down to a single file.

Breaking the Tracks Down

The first thing you have to do when starting a study of sound and picture, and this may seem obvious, is to listen to and hear the separation of dialogue, music, and sound effects tracks in a film. After a period of time, it will be noticed that there are three distinct audio tracks. In feature films, the separation can be seamless if properly mixed. Television, on the whole, has many holes to exploit in the audio track. This is not to say that the sound crews are not professionals; on the contrary, they are performing miracles most of the time when considering the budget and time constraints as well as possibly limited hardware resources. Listen to any sitcom that has a laugh track and focus on the dialogue. The difference in vocal texture and the laugh track will be sorely apparent. Compare this to the live audience situation with hosts like David Letterman or Jay Leno. The audience sounds dynamically mix with the host; naturally, they are in the same space as the host, even with all of the microphones.

In film, the three sound categories are, many times, occurring at the same time. The craft of mixing these together as well as planning for possible trouble areas, like masking and cancellation, takes many years to master, but do not be afraid, you will get there sooner than you think. When you hear a film with a good soundtrack, it is hard, sometimes, to appreciate how good the sound is for the very reason that you do not realize it is there in the first place. A great example of this is the soundtrack for the "Lord of the Rings" trilogy. The power, emotion, and precision of the entire soundtrack is amazing. Sound designer David Farmer achieved greatness with this trilogy. With that said, listen to any one of the movies and focus solely on the sound. Farmer is not the only one responsible for the sound in these films; you will be surprised at the size of the sound crew.

Notice all of the different positions needed for a sound crew on a large film. With games and web work, the crew amounts, many times, to the enormous size of one: you. Logically, the

Table 6-1. The sound crew from "Lord of the Rings"

Sound Department for Lord of the Rings	
Bruno Barrett	Garnier-assistant sound editor
Ray Beentjes	Dialogue editor
Beau Borders	Sound effects editor
Christopher Boyes	Sound re-recording mixer
Nick Breslin	Dialogue editor (as Nicholas Breslin)
Brent Burge	Sound effects editor
Jason Canovas	Dialogue editor
Hayden Collow	Sound effects editor
Meredith Dooley	Production assistant: sound
Corrin Ellingford	Boom operator
David Farmer	Sound designer
Nick Foley	Sound recordist
Mark Franken	Dialogue editor
Luke Goodwin	Assistant dialogue editor
Mel Graham	Assistant sound effects editor
Michael Hedges	Sound re-recording mixer
Simon Hewitt	Foley artist
Phil Heywood	Foley artist
Lora Hirschberg	Additional sound re-recording mixer
Mike Hopkins	Supervising sound editor
Paul Huntingford	Foley artist
Mike Jones	Temp mixer
John Kurlander	Scoring mixer
Martin Kwok	First assistant sound editor
John McKay	Temp mixer
Polly McKinnon	Dialogue editor

Table 6-1. The sound crew from "Lord of the Rings" (cont.)

Sound Department for Lord of the Rings	
Adrian Medhurst	Foley artist
Peter Mills	Foley editor
Timothy Nielsen	Sound effects editor (as Tim Nielsen)
Martin Oswin	Foley artist
Hammond Peek	Production sound mixer
Angus Robertson	Foley engineer
Jurgen Scharpf	DVD audio remastering
Michael Semanick	Sound re-recording mixer
Nigel Stone	ADR supervisor
Matt Stutter	Assistant sound editor
Gary Summers	Additional sound re-recording mixer
Ted Swanscott	Sound mixer
Addison Teague	Sound effects editor
Craig Tomlinson	Sound effects editor
Ethan Van der Ryn	Supervising sound co-designer
Ethan Van der Ryn	Supervising sound editor
Chris Ward	ADR recordist
Chris Ward	Assistant dialogue editor
John Warhurst	Assistant sound editor
Justin Webster	Assistant sound effects editor
Dave Whitehead	Sound effects editor
Chris Winter	IT support
Katy Wood	Foley editor
Toby Wood	Assistant scoring engineer
Gareth Bull	ADR recordist (uncredited)
Ian Tapp	ADR recordist (uncredited)

larger the scale of a project, the more sound crew members are needed, but it does not always work out this way. At the beginning stage, this is good news. Where else are you going to learn the ropes?

It also helps to listen to older films as well. Before the massive explosion of sound in film, say around the late 1980s, the soundtrack was generally treated with much less respect as far as the budget is concerned than it is today. A movie like "Saturday Night Fever" or "The Magnificent Seven" have soundtracks that can teach many things about dialogue replacement, sound effect content, and specificity, as well as mastering the final soundtrack.

Once the three bands of audio have been discerned, move onto a more detailed approach to listening. For now, just take in all of the sound on the soundtrack. This will clearly distract you from the story or virtual environment, so choose a film or game that you have experienced.

Things to note are combinations of sounds, groupings of the three sound spectra, and isolated sounds without accompanying sound support like an individual door squeak without music or dialogue. This takes some practice and it may annoy those around you for the basic fact that you will not be paying attention to the story but solely to the sound. Eventually, these skills will translate into your own work.

Sound and Image

There is a definite and intimate connection between the visual world and the aural world. Our everyday lives are filled with both of these constantly. Many times the sound of objects around you is taken for granted and not noticed. A walk down a city street will contain hundreds if not thousands of sounds. These are part of the sound landscape but when you hear a car screech, even if it is not near you, your ears tend to perk up and take notice. The sound stands out and is visualized, without the visual context with which to reference it. The brain instantly tries to draw a visual reference object with which to attach the sound, that is after it has signaled you to be careful and not get hit by the vehicle if it is near you. The surrounding sounds are not necessarily important at that point. When the car screech occurs, there is an added sound placed by your imagination: that of the crash. Even when there is no crash, the ears are expecting to hear one and place a sound in the place of silence. This interesting phenomenon can be used as a form of sound manipulation in the visual media. A great example of defeated expectations is in "Star Wars Episode II: The Phantom Menace" in which Obi-Wan is being chased by the bounty hunter through an asteroid field. The bounty hunter launches a missile at Obi-Wan's spacecraft and misses, hitting an asteroid. The missile is actually a sound device that uses sound waves as its source of destruction. The interesting thing occurs, and this is with a stroke of genius, before the explosion. The entire scene becomes silent for an instant and then the pang of the explosion. Two things have happened here. The silence preceding the explosion builds an incredible amount of anticipation. In this case, the ear knows there will be an explosion but is not ready for the actual sound texture of it. When the sound texture is given, it is really something unexpected and original. This explosion occurs twice in the scene. The second time had to occur to give the ear the real sugar of the sound. Now that the ear knows it is coming, it can focus on the entire sonic event and savor it. Brilliant stuff!

A sound designer needs to know how to play with the ear and create audio illusions for the visuals. In film, there is rarely heard the actual sound of an event on screen concerning sound effects. A punch to the body rarely sounds like it does in the films. The illusion of power and contact are created to fill the needs of the thematic material in the story. This happens with many sounds on screen. The sound and image are intertwined in the overall illusion of the scene.

Sound Imagery and the Sound Sculpture

A great way to understand some of the subtleties of how sound can affect and support the visual is to actually work without using an image at all. Sound sculptures or sound landscapes can create imagery with the impact of sounds. Working with sound in this manner sharpens

PROFILES

Pierre Schaeffer

Pierre Schaeffer (1910–1995), was born in Nancy, France, and like many of the leaders and pioneers of electronic music, he had no formal musical education. He received his diploma from L'Ecole Polytechnique in Paris. He had an apprenticeship at the Radiodiffusion- Television Francaises (RTF), which led to a full time job as an engineer and broadcaster. During World War II, he was a member of the French resistance against the German occupation.

After his promotion at RTF, which occurred quickly, he was only 32, he convinced the RTF corporation, which coincidentally was under the control of the German occupying forces, to start a new branch of study, namely, the science of musical acoustics with himself as the director. At the RTF, he had various resources available to him including phonograph turntables, disc recording devices, a direct disc cutting lathe, mixers, and a large library of sound effects records owned by the studio, a good way to start experimenting with sound. After some naming issues, the new studio was finally named Club d'Essai.

After many months of research and experimentation, Schaeffer was drawn to the possibility of isolating naturally produced sounds, creating objects out of them. This would lead eventually to the term "**musique concrete**" which meant that the sounds were based on natural sounds recorded and played back in a musical context.

Pierre Schaeffer was a seminal figure in shaping the electronic sound and music fields of study and research. In 1995, he died in Paris of Alzheimer's disease. He was remembered as the "Musician of Sounds."

your skills as a listener and develops your surgical technique with sound. Acousmatic sound, a term coined by Pierre Schaeffer, is sound that has no visually identifiable source.

Acousmatic sound can be created from source recordings of natural events or recordings of events that do not have a specific context, leaving it up to the listener to focus on the sounds themselves and not necessarily connote them with an object or message.

Sound sculptures are collections of sounds organized in a way as to convey a story, emotion, setting, feeling, or any other form of inner expression. If this sounds like music, it is. Music is constructed by organizing pitches in such a way as to create a musical aesthetic even if the aesthetic is defined in the music itself. A lot has happened in the 20th century concerning pitch and its organization, or lack thereof, and basically at the end of the day, the concept of organized pitch as music is still left standing. Composition and organizing sounds organically is an enormous field of study, as can be imagined, and can reveal many things about how you organize sounds for your own projects.

In order to create a sound sculpture, sound assets are needed. The best scenario is to have all of the assets recorded originally. This tends to yield the best results as far as quality of sound is concerned, but for the beginner, library sounds will work fine. Sound sculptures are not created out of thin air. They need some kind of intention behind them. Collecting sounds without an end goal will sound like a misguided attempt with no forethought. Think of something simple, like waking up and going to your workstation to begin a new sound sculpture. This simple scene can lead to many interesting sound events. Literal interpretation is not very convincing, although it may create imagery on its own. Think of the thought processes as one gets out of bed, the increased heart rate when coffee hits the system, the excitement and anticipation of invention, and so on. Get creative. The same old footsteps and creaking bed are nice, but that is just the surface. Focus the listener on the actual sounds, not what the sounds mean in themselves.

This creative experiment is achieved by processing and manipulating the audio assets collected for the piece. Usually raw recordings or sound library objects never enter the piece without some form of manipulation acted on them and when they do, they have been professionally recorded.

The time frame can be anything you desire, but remember the impact of durational sound on a listener. The ear can get tired, just like the brain can. Start with a 3- to 5-minute piece. Work methodically and patiently. Remember the words "it is good enough" do not exist. What are you waiting for? Get to work.

Images are directly influenced by sound reinforcement. These two separate entities combine to create something more valuable than each on its own. Just turn the sound down during a tense moment in a film. It becomes saggy and deflated. There are interesting differences in the way we perceive objects visually and perceive them aurally. When something is seen that we do not want to look at, we simply close our eyes. This can protect us from sights that we are not interested in viewing. The ears do not act the same way; we cannot turn them off. They are always open to whatever enters them.

Our ears have the ability to perceive sound in ratios. The octave is a ratio that is recognized by the ear, whereas the eyes do not perceive ratios of light and they cannot define specific bands of light when they are mixed together. The ear can clearly define separate frequencies. The intervals and chords discussed in Chapter 5 are an example of this. If we heard all sounds mixed together the way sight combines light ray reflections, there would be no such thing as music.

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The field of focus is also different. Your eye focuses on a point directly in front of them. Your peripheral vision is clouded. When an object enters the field of view, the eye instantly directs itself to the object. It is not perceived by looking at something else, other than the object. The ear is omnidirectional and can pick up sounds all around the head location as well as define, with a certain amount of accuracy, the location the sound came from within the omnisphere of perception: aural depth perception.

Images exist in space. They physically occupy a space and require a certain amount of time for the transmission of the message or content they provide. Sound exists in time alone. In order to perceive sound, space is required for the compressions and rarefactions to occur. You could say that sight and sound are polar opposites, and maybe that is why they work so well together.

Diegetic On-screen and Off-screen Sound

In film there are basically three types of sound parameters within the spectrum of all sound which may be acknowledged: **on-screen**, **off-screen**, and **nondiegetic** sound. **Diegetic** sound is that which is present on the screen and is part of the direct communication of the story. The same is true for interactive environments. There can be diegetic on-screen sounds like someone speaking, and you see their mouths moving, or the sound of an on-screen train. That same train may be heard off-screen and is never visualized in the scene but it is part of the on-screen story. This is called diegetic off-screen sound. Off-screen sounds can be further broken down into two categories: **passive** and **active**. Passive off-screen sounds are those that create a sense of environment and space. They also act as sound bridges across edit points, thereby smoothing and securing a transition. Active off-screen sounds create a situation of curiosity regarding the source of the sound itself. When a doorbell is heard, it is natural to want to see who or what is behind the door. This is considered active.

Nondiegetic Sound

Nondiegetic sound is sound that exists outside the on-screen story and events. It is basically all of the sounds not heard by the character or not produced by an event in the story. Music and voiceover are examples of nondiegetic sound. **Michel Chion** brings up an interesting point in his book *Audio-Vision*. Although the book is more than a decade old, he states that there are more than just three areas of screen sound when considering aspects such as sounds from phones, sounds from people when they have their backs to the camera, and so on. These considerations are still being discussed today. They create a wonderful area of the sound discipline to explore but basically it all still boils down to the three fundamental aspects of sound and image.

All of the three areas of sound we have discussed fall into a single category, that of **on-track**. All of the sounds on a film track are considered on-track. **Off-track** sounds are those that are assumed but not heard in a story, like the assumed sound of the car crashing sound mentioned above. Another example is when one person is talking to another, but only one side of the conversation is heard. Sounds that are buried by other sounds are also considered off-track,

whereby the sounds are assumed but not heard because of some other louder sound covering it up. This is known as masking.

Synchronization and False Synchronization

Although the synchronization process is mainly for linear media, it can have an impact on nonlinear, virtual spaces as well.

Synchronization is the process of connecting a sound event with the action of a visual event. A door closing, a balloon popping, and a car horn are examples of synchronous sound with a visual cue. The effect of sound sync creates the virtual reality of the everyday experiences. But even with our natural surroundings, things are not always in synchronicity. The physical laws of nature dictate, as discussed in Chapter 1, that the speed of sound is much slower than the speed of light. Therefore, if enough distance exists between a sound source and the listener, there will be a discrepancy in the synchronization of the sound with the image. Sometimes this is called for in a scene and sometimes it is not. It really is up to the producer, director, and anybody else involved with the decision making for a project or film.

The real question about syncing sound to image is whether the effect is supposed to represent reality or to create the illusion of the reality presented. The choice is made by the sound designer and then pitched to the decision makers.

False synchronization is also used in linear visual media. This occurs when the sync point is obscured by another event or cut in the scene. This happens more often than may be thought. When a scene builds to a climax, the ear starts to expect a resolution. If this anticipated resolution is provided but not on the climax of the visual image, then a false synchronization has occurred. The resolution is given on a transitioning theme or cut in the film. Imagine that a plane is shot down during a World War II dogfight. The camera view is in the cockpit. As the plane loses altitude, we see the earth coming closer and closer. The expectation is that there will be an explosion of some kind. When the time of impact has arrived, the scene cuts to a train passing in front of a steel mill. The sound of the explosion and the train, on the cut to the train, creates a release and a transition at the same time but does not supply the graphic of the plane crash. This can have some interesting effects. As a sound designer, it is your job to inform the artistic director or film director of these ideas and try to hold on to them.

In nonlinear spaces, like games and virtual spaces, synchronization has a different meaning. Triggers set during game play define the sync points, and location identifiers set in motion various music and soundtrack intensities. When a first person perspective view moves forward, you may hear footsteps. This is a form of synchronization even though you do not see the footfalls. When you fire a gun in a game space, a trigger was set up so that when you virtually pulled the trigger, a sound as close to synchronization as possible was created. Most new machines can handle the audio but if the amount of data gets to be too large, there may be some choking, or **latency** in the sync. In other words, the sounds are not synchronized to the image, making a middle layer of abstraction, namely your computer, responsible for the transmission of sound

during an action or movement. Interactive environments require that the sound designer think both linearly and nonlinearly, but the same basic design mechanisms exist when actually building the sounds.

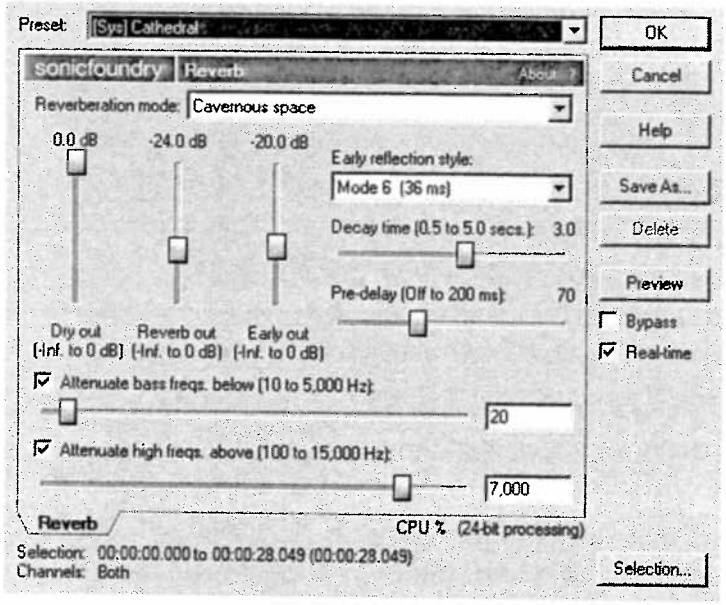


Figure 6-2

A typical software reverb window.

Spatial Considerations

The illusion of space is one of the great tools sound designers possess. Large spaces do not sound like small spaces. Tiles and hard walls do not sound the same as rugged, dry wall textures.

Distance and proximity can be created by using reverb, echo, and certain filters that make it appear to be reflective. There are many software simulators that create the illusion of space, but basically they deal with the amount of reverb added to a sound. The more reverb, the bigger and more reverberant the space. There are exceptions of course, like big spaces that are not very reverberant, like a large office or an orchestral recording studio.

An explanation is in order concerning some of the terms used in the screenshot above. Notice there are three sliders: **dry out**, **reverb out**, and **early out**. The dry out indicates the amount, or level, of unprocessed signal that will be combined into the output signal. The reverb out gauges the amount of processed signal that gets mixed into the output, and the early out indicates the amount of **early reflections** that are processed into the output mix. Early reflections are the first reflections heard in a space. Usually this is the first reflection and gives the listener an accurate idea of the actual space they are in. Many times the first reflections are those that only bounced off of a surface once and then went to your ears. Echo can create an even larger space, usually outdoors, like the echo of a large canyon.

Reverb, echo, and EQ, along with ambience, can create the illusion of just about any space in existence, or at least those that have been measured.

The Texture of Sounds

A sound can give the impression of weight or texture. A thin glass sound gives the impression of a light glass object and a thick glass sound could represent a heavier glass object. But what it really comes down to is the frequency spectrum being used to create the illusion. Lower frequencies represent heavier or thicker objects, and high frequencies represent light thin objects. It is not all cut and dry, however. Many frequencies make up a sound object. They do not all fall neatly

into high-, mid, and low-frequency ranges. It is necessary to adjust the EQ in order to change the profile of the frequency spectrum to satisfy the needs of the visual and the overall mix.

Sounds are defined by their acoustic characteristics: water, wind, leaves ruffling, footsteps, and so on. All have certain characteristics. These textures and characteristics can be recorded or created through the use of some imaginative recording techniques and processing.

Sound textures are crucial to emulating an environment or visual object. It can also work in reverse. A sound that is contrary to a specific visual object can have a certain comical or ironic effect.

Focusing the Ear

Usually many sounds occur at a single time during a film or game scenario. Focusing the listener's ear can be a tricky proposition but is nonetheless desirable. A common way to focus a sound in a scene is to mentally reduce surrounding effects down to a few basic sounds that represent the action of the story. Think of it as a camera's point of view only for sound. The **point of audition** is the focal point for the listener to concentrate on. The creative point about this is that many different sounds can be the source of focus. This leaves the door open to invention and creativity. The camera angles, zooms, and pans can have a direct influence on the focus of the sound in linear film. In interactive spaces, particular sounds can draw the participants into areas of a virtual space where they would otherwise not have gone. A scratching at a door down a hallway invites a user to investigate. The door did not ask to be opened; the sound initiated the curiosity to open it. Linear and nonlinear visual event sounds can have different intentions, by either provoking action in a virtual space or reaction in a film, but the sounds themselves are built the same way technically. If focusing a sound is going to occur, the frequency band of the sound should be analyzed against the rest of the soundtrack or sound effects track alone. With that knowledge, you can accentuate frequencies that will stand out above the rest or are made more conspicuous within the file.

Walter Murch made the point that, within a single scene, only two sounds can be heard and understood at a time. As sound designers, this is an important point to remember. In interactive environments, there is no such thing as a scene, but the same principle remains. If you are moving through a virtual hallway, for example, the sounds of your footsteps are considered background sound. A monster growling in front of you and a whisper from behind you constitute the two primary sounds. If a third prominent sound occurred, the ear would have to set a priority to the two which have the most impact on the virtual situation. Think about this when you are listening.

Sound changes what is seen. This can be in a film or in an interactive space. The effect and power of sound on image can be astounding if in the right hands. The sound designer must consider all of the options available as well as consult with the artistic director for suggestions and approval. Underestimating the power sound has on the visual experience is what separates the amateur from the professional.

Study examples of sound and image in both film and virtual interactive spaces like games. Note what is going on. Pick up a game that has some interesting sound, like Doom 3, and use all of the cheat codes to move through the levels without focusing too much on the game play itself. "Listen" to what is going on in the game space. Then play the game and see how effective the sound is in the game space. Things to note are context, quality of sound, and sound placement, and whether they are convincing or not. Note whether specific sounds have more impact on the visual than others. Happy gaming!

The Ear

In order to manipulate a listener it helps to understand something about the mechanism that responds to sound waves: the ear.

The ear serves two functions: to maintain equilibrium of the body and to receive and convert acoustic pressure waves into a form that the brain can recognize.

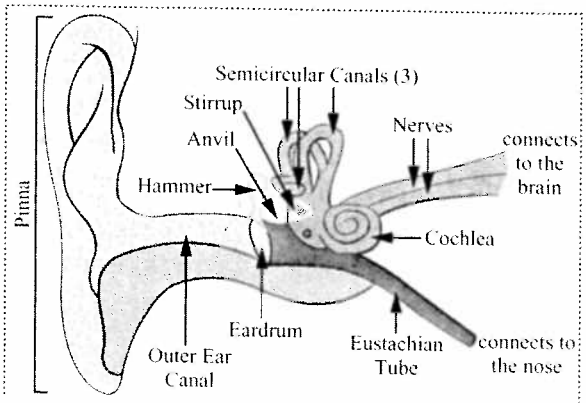
The ear is a unique organ in that it is partially outside the body and partially inside. The outer part of the ear is called the **pinna** or earflap. The pinna contains ridges that focuses middle to high frequencies coming into the ear. This, coincidentally or not so coincidentally, is roughly the same range of the human voice with harmonics. The pinna also acts as a location detector. The sound, which surrounds a person, can be discretely isolated by the ear. The location of a sound is achieved by detecting slight differences in resonant characteristics of the sound. Once the sound passes the pinna, it moves toward the **auditory canal**. The auditory canal acts as an amplifier. Sound signal strength is boosted to a level strong enough to make the eardrum, or tympanum, vibrate. The canal is approximately 1 cm in diameter and about 2.5 cm long. At the end of the auditory canal is the eardrum, or tympanic membrane. All of these components make up the **outer ear**.

The middle ear is an airtight chamber between the outer and inner ear. The **eustachian tube** leads away from the ear to the throat. Air must be able to move through the eustachian tube in order to equalize air pressure on either side of the eardrum. If the air in the eustachian tube is unequal, the eardrum becomes distended. This usually occurs on flights. The act of swallowing temporarily equalizes the pressure, better known as "popping" your ears. Three bones act as a lever system to convert sound pressure waves into mechanical energy. These bones are called the **malleus** (hammer), **incus** (anvil), and **stapes** (stirrup). These are collectively called the ossicles.

The malleus is connected to the tympanic membrane, which receives the vibration. This energy sets the ossicles in motion, ending at the stapes. The stapes is connected to the oval window, which is the interface to the inner ear. The signal strength is again increased in order to set the oval window in motion. The inner ear contains fluid that requires a certain minimum amount of vibration power to produce waves.

One interesting thing about the middle ear is that it has a built-in defense mechanism against very loud sounds. Muscles in the middle ear contract when the volume gets too intense. This

contraction squeezes the bones together, thereby disallowing them to vibrate as much, and reducing the intensity of the mechanical energy reaching the oval window. When the muscles get tired, they relax and hearing damage may occur at that point. The process is more complex than stated here, but it should give you an idea of how the mechanism works. The ear is amazing.



6-3

The human ear

The inner ear is surrounded by the hardest bone in the body: the temporal bone. Within this bone there are many tiny passages. In the middle of this bone is the **cochlea**. The cochlea is shaped like a snail's shell with an unrolled length of about 3.5 cm. In fact, all rolled up it is about the size of your pinky fingernail. Within the cochlea is the basilar membrane. This membrane vibrates according to the frequencies received by the outer ear and sends them on to the auditory nerve. Loosely connected to the inner part of the basilar membrane is the organ of the Corti which contains approximately 20,000 tiny hair follicles. Different follicles are affected when different frequencies are received, and these make the basilar membrane move, thereby allocating specific follicles or groups of follicles to separate frequencies. This follicular motion sends signals to individual fibers on the auditory nerve. The fibers of the auditory nerve do not go directly to the auditory cortex. They are mixed together and processed at various stops along the way. The signal identifier in the brain and how the brain processes sound as recognizable objects is outside the scope of this book, but is, nonetheless, an interesting topic.

Protecting your ears is important if you want to keep sharp hearing. Prolonged exposure to loud sounds causes permanent hearing loss, like, for example, working outdoors at airports with improper headgear. Industrial factory workers are also at risk of hearing damage caused by noise pollution. Even small amounts of exposure to very loud sounds can cause damage, so treat your ears carefully.

The Physical Effects of Sound Events

Sound can have a profound effect on human physiology. Lower frequencies up to about 65 Hz directly affect, through resonance, the lower regions of the body, namely the legs, pelvis, thighs, and lower back. This can have an influence over certain physical and emotional centers of the body such as having an influence on the sexual and digestive components. Keep this in mind when working on your sound maps. The mid range frequencies affect the mid section of the body, particularly the mid and upper chest. The higher frequencies affect the higher parts of the body, ending with the neck and head. All of this is can play into your sound design when spotting and actually creating it.

Sound can also affect body temperature, pulse rate, breathing, and sweat glands. Amazing how something that is not smelled, seen, or touched can create such physiological enhancements. Soft tranquil music decreases heart rate, body temperature, and circulation, whereas loud, beat-centered music increases it. These particulars can be used to great advantage by a sound designer, depending on the scene.

All of these little aspects of sound contribute to an overall organic, convincing sound effects track. It may take a while to be able to fully use some of these devices, but that comes with time.

Sensitivity

The most sensitive part of the hearing range is around 2000 Hz to 5000 Hz. This critical band is where the ear responds the most effectively. The human voice lies directly in this range. Outside of this band, although the ear can pick up the frequencies, they are not as pronounced. With this in mind, mixing sounds against the human voice can be tricky if the sounds occur within the critical band. Certain characteristics need to be accentuated within the sound in order for them to be heard but not disrupt the dialogue tracks, unless that is desired. Careful consideration of the clarity of the tracks is essential.

Sound Perception and Sensation

One of the most interesting things about sound is its influence on visual perception. There are many types of listening modes we participate in when experiencing a multimedia project or film. The physical effects of sound also play an important part in visual media. Although a large field of study, it is important to grasp the fundamental concepts behind sound pereception and sensation.

Modes of Listening

According to Michel Chion, the author of four must-have books on film sound: *La voix au cinéma, Le son au cinéma, L toile trouvée: La parole au cinéma*, and *Láudio-vision*, or *Audiovision*, which is the only one translated in English to date, there are three distinct modes of listening: **causal listening**, **semantic listening**, and **reduced listening**. Causal listening is the most common. This type of listening requires that the listener hear a sound and from that sound figure out what the cause or source of the sound is. An example of a sound that signifies a source would be the sound of a finger tapping on a thick book. The sound can signify that it is a thick book and determine whether the pages are thick themselves or not, possibly indicating the age of the book to a certain extent. With visual support, this would be made clear. Without visual support, the listener would have to draw on a catalog of sounds created from a lifetime of aural experiences. The accuracy of causal listening is extremely precise within a certain limit. This limit is explained by the human's ability to recognize the source of sounds but not exactly define it, such as a dog barking. This sound would be recognized as a dog barking but the type of dog would not be precise. On the other hand, a person's voice is highly distinguishable, and the cause would be accurately estimated. This leads to the conclusion that there are two types of causal listening: unique and general.

The effectiveness of causal listening for a sound designer should not be underestimated. It can be used as a deceptive device as well, misleading and cajoling the listener.

Semantic listening, according to Michel Chion, refers to a code or a language to interpret a message. The most commonly used code is the spoken language. This type of listening is extremely complex and has been the fascination of linguists for some time. The principal behind semantic listening is the determination of phonemes and the variation in which they are pronounced while sending the same understood message.

Reduced listening refers to the listening to sound without any connotation or cause behind it. Sounds as isolated objects. This is the foundation of what is called electroacoustic music or acousmatic music. Pierre Schaeffer was one of the leaders in this field, as mentioned above. Sounds used without context, meaning, cause, or connotation leads the reduced listener into an area of focus otherwise not found. This type of listening does not come naturally. It takes a fair amount of concentration over extended periods of time and, initially, can be exhausting but in the end will sharpen the ear to such an extent that sounds become strategic. To achieve this is one of the most cherished skills a sound designer can have.

Focus Points

The ear is an amazing device. It can select sounds out of multiple sounds and focus down on them. In nature this is quite natural and most people do it without thinking. However, to convey this sense of focus in an interactive environment or film is another story.

In an audio soundscape, there is a foreground and a background. Many times in an interactive environment the sound is purely background. When a sound does surface above the background it is usually because its frequency band is distinct from the background frequency band or the dynamic volume of the foreground sound overrides that of the background.

This requires a bit of experimentation, but the payoff is fantastic. The effectiveness of detailed sound design, usually subconsciously, enhances the overall immersive space.

The Speed of Sound Objects

Sound can only be sensed and understood if enough time is given to the ear to pick up on it. Why is this important? If a scenario or environment rapidly changes, there needs to be some consistency within the distinction of sounds. The rapidity of the movement in the virtual space or linear edits of a film can cause the interpretation and cognition of sound objects to be blurred.

The human can sense sounds at different speeds.

Table 6-2. Sound sensory chart

Sonic Event	Time Needed to Sense Sound (seconds)
Sound	.001
Pitch	.013
Loudness	.05
Timbre and Consonants in Speech	.1

Sound Design Pre-production

When a project is proposed, there are a few things that need to be immediately addressed. Length of the project, fees for the project, and most importantly, the topic of the project. Following is a rough outline to guide the sound designer through the initial stages of pre-production.

A Rough Outline

The sound design process for interactive environments as well as web-based projects starts with a working concept. This concept can be anything from a design document to the mood the director or producer has in mind. Once the initial plan is established, there should be a basic sound character in your mind. A thorough understanding and research of the project concept follows the initial impression you have and the project is then "spotted" for sound or places where actual sounds are planned at specific key points. At this point, a **sound map** is created indicating the polar opposites or consistencies of the general project. Sound effects creation and design fill out the process before asset placement is commenced. A sound map is simply a visual or verbal description of the key polarizing characteristics of a projects concept. Sometimes it is a graph-like chart that shows tension and release or other parameters set out by the project, and other times it is a two-column page with the positives and negative characteristic sounds and how they will organically relate to the project. Writing these down can save time when production starts.

It all starts with an idea.

Story, Design Document, Website Proposal

When a new project is proposed, for example, a web site, one of the first things that should happen, besides talking to the artistic director or creator, is to read through the proposal design document and get a feel for what the message is going to be for the site. The character of sound should reveal itself, in loose terms, by reading through this document. If it is a game design document or a script, the text will need to be reviewed with the team leader or director as well as being spotted for sound or conceptualized for sound.

This document defines the parameters of the entire project, or in a film, it is the screenplay. Once a clear understanding is achieved, it is time to spot the document for sound.

"Spot" for Sound Effects

"Spotting" for sound is simply gaining some ownership to the design document or screenplay. This is the process of literally writing down aural ideas as the reading occurs. Usually your first impression is on target, sketched out in your rough sound map, with the outcome expected from the project. Get a pencil and start recording as many ideas as can fit on the page, between the lines, in the margins, and on the back of the page if necessary. Later this will save many hours of planning, even if it is in a rough sketch condition.

Defining Sound Effects and Sources

Once the general sounds are defined in the document, it is time to start detailing what the sounds are and where they are to be found. Options such as sound libraries and live recording have to be planned. This requires that the sound designer be familiar with certain sound libraries and recording techniques. Recording advice is given in Chapter 2 but becoming familiar with sound libraries requires some time with your headphones or monitor system. There is no way to implant a certain sound in your ear if you never heard it. A lot of listening is required. So, when you think you have accomplished a lot of work regarding sound design on a particular day, get up and listen to a few sounds from your library.

Keep in mind that if you cannot afford a sound library yourself, many libraries have them or can get them for you. There are also countless online sites with free downloadable sounds, albeit not of high quality, and fee-based sounds for usage and collection.

A good idea would be to start collecting sounds for your own sound library as soon as you read this sentence. Record, collect, purchase every sound you can get your hands on, even if you never use them in projects, they can combine to create other sounds in future work.

The Sound Blueprint and the Approval Process

Once the sound effects chart has been decided, it is time to have the work approved. Lay out the sounds in a cohesive way, usually in two columns labeled at the top with a list of words describing the sounds in each column, just like the word sound map except that these are almost finalized sounds. The two columns differentiate the most striking differences and contrasts in the project. This is the first step in creating a clear design construction for the overall sound direction for the project. If there is no clear contrast, divide the categories using frequency ranges, types of sounds used, and any other characteristic that can be defined.

Technical Playback Considerations

The world of the Internet contains as many audio configurations on user's machines as there are machines, or so it seems. When creating the initial plan for the sound design, consider what the playback devices will be. If the project is a game, then what platform or platforms will the production be for: Xbox, PS2, Nintendo, PC, Mac, or something else? If it is for the Internet, then bandwidth and the average playback system will have to be sufficient for the criteria decided upon. Compression formats also need to be considered with regard to bandwidth. In film Dolby, THX, DTS, and all of the other theater standards need to be realized before any final mixing or detailed work can be commenced.

These considerations should not be taken lightly. The sound objects created from this decision will have a profound effect on the overall mix. Be careful to get this information correct. It could save countless hours in the studio or at your desk.

Once the platform, initial intent, and general sound design concepts have been acknowledged and approved, it is time to start production of the audio assets. It is always a good idea to consult on a regular basis with the composer of the film, game, or interactive environment. Many times this is not possible because of time constraints or other political pressures that are unseen, but try to contact the composer of the project anyway. If you are going to be the composer, it should all be under control. This consultation can avoid sound and music collisions and dangerous combinatorial results. Clashing sounds during a mixing session will be addressed and fixed, but it is nice to have some warning ahead of time so that you can adjust your sound output. Dialogue, music, and sound, in that order, are how things are usually mixed for film. In games, it is slightly different because there is usually not that much dialogue and when there is, it is not covered up with music and sound effects.

The real fun starts with the production phase.

Sound Design Production

The production phase is where rubber meets the road. This is where all of the assets are collected, created, processed, or otherwise prepared for entry into the project.

Sound Asset Collection

With a detailed sound map and a clear idea of the content, you can start the process of asset collection. As stated above, this can come from sound libraries or source recordings. Either way, there will probably be a fairly large amount of them. From this large pool of sounds, most will be cut away from the list and saved for another day.

A sound object usually falls into two types: single and mixed sounds. More times than not they are mixed, so with this in mind, accommodations should be made for the multiple sounds needed to create a sound object. The accommodations mentioned above are primarily concerned with time. The results of combining audio files, such as processing, clipping potential, and other anomalies are going to occur if not watched during the creation stage of a sound effect. The point is that sound creation can take an enormous amount of time. The process of selecting sounds and generally laying them into the track is just the beginning. Once the sounds are finalized and synced up in a linear project or tested in a nonlinear project, they need to be mixed at a proper level. Mixing can take as much time as creation if the mixer is not used to the task. In some cases, it is a good idea to get someone else to do the mix, if your mix will be less than fantastic or your ears are tired.

It is also smart to have another pair of ears listen to the rough mix of sound assets in the project. This type of constructive criticism is valuable especially if the reviewer is someone you respect.

If there is going to be a music track, then the final mix is incredibly important. The music and sounds need to mix without clipping, in the first case, without masking each other in any way, unless specified by the boss, in the second case, and the sound effects must appropriately sup-

port the music, harmonically and intervallically, again if that is approved by the decision makers. Again, if possible consult with the composer. Usually, they have a pretty clear picture of the harmonic and melodic content of their own music.

Inventing Original Sounds

Originally recorded sounds are the best solution for any project. They sound better, are more fitting for the scenario, and are more original in the end. There are times when the project leader will demand high-fidelity sound effects. This necessitates the use of original sounds in conjunction with those in the sound designer's library.

There are basically two types of sound effects used in motion pictures and interactive spaces: small subject and big subject sounds. The small subject sounds are like glasses clinking, paper being crumpled, door squeaks, footsteps, cloth movement, and human noises, such as sneezing and coughing. These are usually recorded in a studio or by Foley artists. Most likely, you will be doing most of the recordings. If you do not own a studio, which probably is the case, a small quiet place will have to suffice until you can afford a small whisper room or isolated studio chamber.

Big subject sounds are usually sounds that need to be recorded outside. These include explosion, gunfire, crowds, cars, planes, trains, and machinery. If the producer has decided to go with original sounds, such as those mentioned above, then a session needs to be organized that may include permissions and legal clearance. Make sure you cover your bases. Under professional big budget situations, a **sound designer, sound effects editor** or a **sound effects recordist** is called in for the job. On a typical game budget or web job budget, these sounds need to be gained through some invention. Most times these sounds will be retrieved from prerecorded libraries but it is wise to have the "chops" to go out in the field and do some recording yourself. How do you get the sound of an airplane or train? They could be designed from sounds that are not source sounds to begin with. A few techniques (listed in filmsound.org) can be used to alter the sound shape of recorded source sounds which do not necessarily represent the sound effect desired. This list used to apply to the analog recording process; today they are all possible with software and digital processing.

When the opportunity to record out of doors exists, it is wise to examine examples of what the pros do. To start, more than one recording device is usually on site for different sound perspectives. A bullet shot and impact would be a good example. One digital audio tape (DAT) machine, Nagra, or hard drive recorder could be placed near the actual gun shot and one recording device could be placed near the object to be impacted, like a plank of wood. The combination of these sounds would be effective, but if another recording device is placed under the bullet shot, recording the sound of the bullet passing, it would make the sound even more convincing. College students can check out gear from their multimedia or audio departments. Plan a session and book the gear. Grab your friends and go out and get some good sound effects. There are many great solutions to recording and creating your sound effects. Use all of the available tools at your disposal including your brain.

Creating original sounds requires experimentation, a lot of experimentation. Use your imagination and see if your ideas are practical. If it is raining, troubleshoot the situation and get the recording. Do not let inclement weather or other meaningless obstacles get in the way of the work at hand.

Sound Processing

Altering or enhancing sounds to fit a scenario is like working on a sculpture. The sounds need to be shaped to fill the need. This shaping can occur through the combination of sounds, mixing together to form new sounds, or sounds processed to a certain degree, again forming a new sound. Ben Burtt, the sound designer for "Star Wars," had some very creative ideas about getting the specific sounds that George Lucas wanted. This kind of ingenuity is par for the course as a sound designer but do not expect to be a Ben Burtt tomorrow. Next year, maybe!

Below is a table of the sounds from the original "Star Wars" motion picture trilogy: Part IV, V, and VI and how they were constructed. Keep in mind that this is a predigital world that he worked in, for the most part. This information and much more about "Star Wars" sound can be found online at filmsound.org.

Mix and Mastering the Effects Tracks

The final stage of production is mixing and mastering the sound objects. In film, the re-recording process integrates all of the elements together and mixes them into a composite sound-

Table 6-3. Sound effects design in "Star Wars"

R2D2	Half of the sounds are electronic and the other half are vocalizations, water pipes, and whistles
Imperial walkers	A machinist's punch press along with the sounds of bicycle chains dropping on cement
Light saber	An old TV set along with the hum of a 35-mm projector mixed together
Laser blasts	A hammer hitting the wires of a radio tower
Tiefighter	An elephant's bellow altered in various ways
Speeder bike	A P-5 Mustang airplane and a P-38 Lockheed Interceptor combined and mixed
Luke Skywalker's landspeeder	The sound of the Los Angeles Harbor Freeway through a vacuum cleaner pipe
Chewbacca	The sounds of walruses and other animals combined together
Ewokese language	The combination and layering of Tibetan, Mongolian, and Nepali languages

track. In interactive environments, each object should be mixed in its own right. The sound programmer then takes the assets and incorporates them into the game engine or virtual space.

Currently there are options for composers and sound designers to work more closely with the programming side of the equation. Many times the control of assets is taken out of the hands of the sound designer and put into the hands of the programmer. This is the way it is for now.

Music, Sound Effects, and Dialogue

The integral parts of a soundtrack are the dialogue track, the music track, and the sound effects track. These three entities need to be properly mixed and placed in order for effective transparency and clarity to exist. The soundtrack should support the visual content and story line at all times. If a sound or clip of music comes through from the background, it should be meant to be conspicuous in the story line. If the music adapts to the movement of character in a virtual space, drawing attention to itself, it should be meant to. In other words, drawing attention away from the story or visual content through the use of aural distraction can disrupt the user's flow, either in the linear sense or the nonlinear sense. In the case that the distraction is needed or suggested, then it should be done.

A solid mix, smooth transitions, and credible music and sounds make up a rich and interesting soundtrack. The supervising sound editor is usually responsible for all of the assets, the final mix, and the overall outcome of the sound on a project. The sound designer may be called on to perform these chores in lower budget or smaller situations, which means that some knowledge of these three integral audio assets—dialogue, music, and sound effects—are necessary.

The Importance of Music in Linear Visual Content

Music has a magical effect on the emotions. It can provoke happiness, fear, anxiety, peace, tranquility, hostility, sadness, and just about any feeling in the emotional pallet. How this is accomplished is up for debate, but one thing is certain, music can completely influence a visual experience.

We have all experienced the power of music in film. Movies with outstanding music tracks have the impact of making the music a character in the story. A recent example of this would be the score of the "Lord of the Rings" by Howard Shore. The themes permeate the story on a level that transcends the literal storytelling, thus creating an identity all of its own: the Mordor theme, Frodo's theme, and so on.

Evoked emotions are everywhere in this trilogy. No visual can capture the emotional content of the scene after Gandalf's supposed demise in the "Fellowship of the Ring" like music can. The delicacy, orchestration, and pure economy of a line are beautifully crafted in this particular scene. No doubt, the whole score is amazing and there are many highlights to mention. An older example of how music can form an identity in the film is in "Jaws." That two-note theme

that John Williams composed is so simple yet creates a level of fear that is more than the sum of its parts. As mentioned in Chapter 5, dissonant intervals create a sense of uneasiness. The "Jaws" theme is built on the interval of a minor second, one half step. This is a very dissonant interval and the melodic usage of it along with the heart beat imitation of its rhythms taps into the very fabric of human physiology. It is amazing what two notes can produce when supporting a visual. At the beginning of the movie, a girl is attacked off the coast of a beach by a shark. The music grows and grows until the attack, and first-time viewers are petrified in their seats. But if we take a closer look, the shark is never seen during the approach and attack. The music track created all of the character of the shark, and the low lighting and camera angles, especially under water, created the visual fear factor. No shark was seen! Amazing.

If a nonlinear project requires cut scene linear material, remember the effect music can have on the visual content. Get yourself a composer or consult with the project leader to determine the best composer for the job and start working with him or her. You are not expected to be able to compose the music, but you are expected to know how music can influence visual meaning.

Separation of Frequencies

There are three general bands of frequencies that are all subdivided into discrete bands. The low, middle, and high bands are separated loosely into the band widths listed in Table 6-4.

These frequency bands need to more or less be separated in the final mix of a soundtrack. If the music contains low frequencies and the dialogue contains low frequencies, then there is the potential of masking. The worst-case scenario would create ambiguity between the music track and the dialogue track. The sound effects track usually has a pretty wide frequency spectrum. This spectrum can enhance the other sounds or block them to some degree. If a situation arises where the music and dialogue tracks conflict with the sound effects track, then the sound effects track needs to be equalized, band limiting certain frequencies, enabling the other tracks to fill in the holes. The mix can also alleviate some of the problems encountered when soundtracks collide regarding frequency.

Pay close attention to the separation of frequencies in an overall soundtrack. While sound effects construction is underway, consider the frequency bandwidth of the particular sound. This may eventually have to be altered to accommodate the rest of the soundtrack.

Table 6-4. Bandwidths of the three general frequency bands of the audio spectrum

Bands	Frequency Range
Low bands	20 Hz (ca.) to 250 Hz (ca.)
Middle bands	250 Hz (ca.) to 4000 Hz (ca.)
High bands	4000 Hz (ca.) to 20,000 Hz (ca.)

Creating Consonance and Dissonance Within a Soundtrack

In Chapter 5, the ideas of consonance and dissonance was introduced. Certain musical intervals combine to form consonant and dissonant traditional intervals. This harmonic base is carried through today in film scores as well as other places in the composition world. Separating frequencies is

important for clarity and precision, but how do these three entities combine as a structure unto itself? Do the sonic events, regardless of the visual "underscore," create consonant or dissonant sounds? Is the combination of sounds pleasant, abrasive, or offensive? The devil is in the details. If there is a scene in which a girl is kissing a boy, the sound effects that surround this moment, as well as the music, must support this emotional expression. Sounds, which create friction within themselves or with the music track, must be avoided in this circumstance. At this point, realizing something as simple as "that combination sounds good to my ear" or "that combination sounds harsh to my ear" is fantastically important. Classifying these into consonant clusters and dissonant clusters helps create the sound character for the film. The same theory can be said for sound and music in combinations regarding virtual spaces. Harsh sounds raise your level of tension and pleasant or nonaggressive sounds relax the tension. Do you see the potential for misleading and fooling a user in a virtual space? There is much work to be done with these concepts regarding games and interactive virtual spaces. It is hoped that these and many more great ideas will come out of them.

Intervallic Relations in Music and Sound Design

Intervals in music play an important part in conveying emotion and setting. These intervals combined with other intervals create harmony. The treatment of music can be applied to sound design as well, albeit in a much looser fashion. According to Friederich Marpurg (1718-1795), in an attempt to categorize mood states, progressions, rhythms, and harmony into acoustic equivalents, there is a defined emotion attached with an acoustic expression. Some of the categories are not specific emotions but rather are more personality traits.

Some of this is a little outdated. That is to be expected. In a more modern context, specific intervals have been described by music and sound therapists as well as by theoreticians and musicologists as containing emotional characteristics. These play directly into how music and sound influence visuals. Musical intervals can be broken down into specific frequencies, but what is more important is the distance that makes up each interval. In the previous chapter, it was seen in the intervallic multiplier chart how base frequencies could be calculated to get certain intervals. If the same method is applied to sound, some interesting results occur.

The intervals presented below are the generally accepted characteristic emotions created by standard Western intervals. These are also found in David Sonnenschein's book *Sound Design The Expressive Power of Music, Voice, and Sound in Cinema.* In fact a plethora of information regarding the inner meaning of music and sound can be found in this book. I would suggest this book as part of your permanent collection as a sound designer.

Sound effects can be as simple as putting sounds together and dropping them into a linear or nonlinear project. But more attention can and must be given to sound effects, especially when a specific mood or atmosphere is being set. Creating an interval out of the sounds that make up a doorknob turning or the combination of a truck passing and the squeak of a stroller in the street can directly influence the message of intention of the scene or interactive space.

Table 6-5. An older view of how acoustic sound can influence emotional states

Acoustic Expression of Emotional States by Friederich Marpurg (1718–1795)	
Emotion	**Expression Associated with Emotion**
Sorrow	Slow, languid melody; sighing; caressing of single words with exquisite tonal material; prevailing dissonant harmony
Happiness	Fast movement; animated and triumphant melody; more consonant harmony
Contentment	A more steady and tranquil melody than with happiness
Repentance	The elements of sorrow, except that a turbulent, lamenting melody is used
Hopefulness	A proud and exultant melody
Fear	Tumbling downward progressions, mainly in the lower register
Laughter	Drawn out, languid tones
Fickleness	Alternating expressions of fear and hope
Timidity	Similar to fear, but often intensified by an expression of impatience
Love	Consonant harmony; soft flattering melody in broad movements
Hate	Rough harmony and melody
Envy	Growling and annoying tones
Compassion	Soft, smooth, lamenting melody; slow movement; repeated figure in the bass
Jealousy	Introduced by a soft wavering tone; then an intense, scolding tone; finally moving and singing tone; alternating slow and quick movement
Wrath	Expression of hate combined with running notes; frequent sudden changes in the bass; sharp violent movements
Modesty	Wavering, hesitating melody
Daring	Defiant, rushing melody
Innocence	A pastoral style
Impatience	Rapidly changing, annoying modulations

Table 6-6. Harmonic intervals and emotional characteristics

Interval	Emotional Quality
Perfect octave	Completeness, openness, unity
Major seventh	Spooky, eerie, off-center, strange
Minor seventh	Expectant, suspenseful, full but unbalanced
Major sixth	Peaceful, balanced
Minor sixth	A bit sad, soothing
Perfect fifth	Power, centering, strength, victory
Tritone	Horror, terrifying, scary
Perfect fourth	Ethereal, lightness, transparent, clarity
Major third	Neutral, hopeful, resolved, nonabrasive
Minor third	Uplifting, relaxed, positive feelings
Major second	Unresolved, unsettled, unpredictability
Minor second	Unclear, tense, anxious, uneasiness
Perfect unison	Peace, strength, calmness, security

An example would be to calculate an interval for a set of sounds. Using the intervallic equivalence chart, figure out what the interval of a perfect fourth above 40 Hz would be. This frequency is not in the normal spectrum of accepted musical notes in the equal temperament system, so basically you are dealing with a sound outside of this musical world yet adhering to its proportional rules.

If we consult the chart, we see that by multiplying 40 Hz by the ratio equivalent, which is 1.33483, the result is 53.3932 Hz. Now this is awfully precise, too precise for our ears, so if we reduce this to something like 53.4 Hz we will have achieved roughly the same thing when dealing with sound, not music. The trick is to adjust a sound, which will be combined with the 40 Hz sound, to equate something close to 53.4 Hz. This is a very low interval and extremely muddy. If we raise the 53.4 Hz frequency up two octaves:

53.4 + 53.4 + 106.8 = 213.6 approximately

6-4

53.4 Hz multiplied by 3 yields the frequency two octaves above the fundamental frequency.

Two octaves above the 53.4 Hz frequency in combination with the 40 Hz frequency has the same effect as the original fourth because of octave equivalents. The separation of the octave still preserves the interval. This sound might be more attractive now with a little more high end accentuated. The sound would have to be checked against the rest of the soundtrack during the mix to see if any adjustments needed to be made regarding the separation of frequencies, but now you have a group of sounds that follow, more or less, the emotional state of the scene.

All sound can be equated to a core frequency by using a spectrum analyzer. A sound effect will contain a certain band of frequencies more concentrated than others. This band yields the core frequency for the sound.

Every sound can now be equated to an interval, and that new sound interval can be combined with music to create a truly organic sound experience. It requires a lot of extra sit-down time but it is well worth it in the end. Not every sound effect will require such an extensive workover, but it does open up some great possibilities.

If you thought you had a lot of work to do before reading this last passage, you now realize the untapped potential of using theoretical music approaches applied to sound. The results are better than you think for putting in all of that work. Again, not all sounds need this kind of attention, but generally the more work you put into sound design, the greater the rewards when it all comes together.

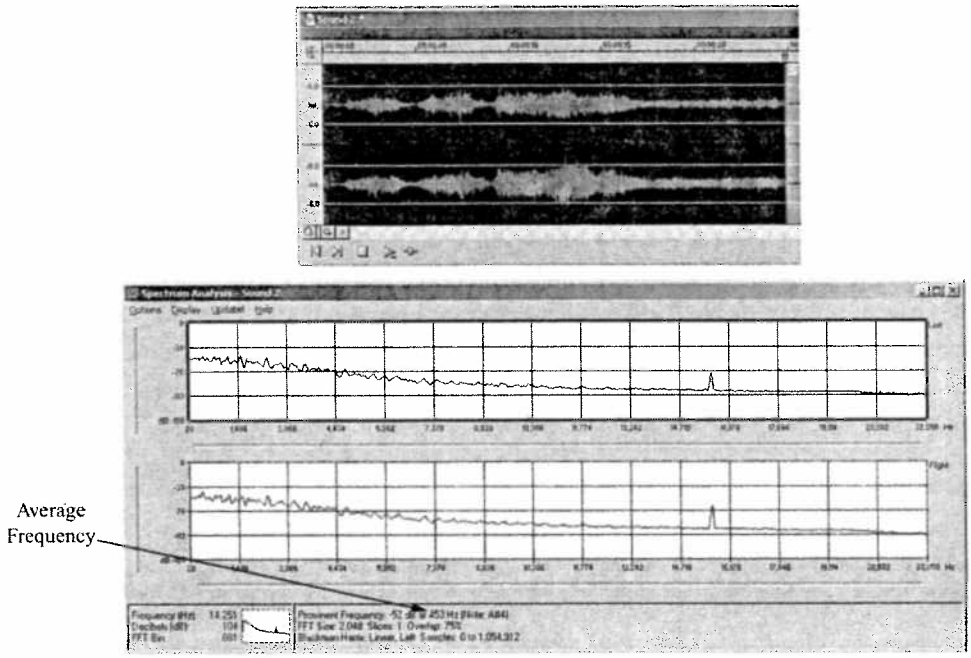


Figure 6-5

The core frequency of a sound effect through a spectrum analyzer.

SUMMARY

The creation and application of sound effects into a virtual environment or linear visual media, like film are similar processes. To study sound design for film is, in fact, studying the same concepts as those for interactive spaces. There are slight considerations concerning nonlinear connection points or overlaps, but the general rule of sound construction remains the same. Practicing the art of sound effects design is a task not to be taken lightly. The amount of time is considerable for the very reason that options are literally limitless and the techniques need to be experienced before committing to a project.

Working with the above concepts will enable a sound designer to build a solid body of work for the visual media. The knowledge and techniques presented are to be fostered over time. Giving time to understand and absorb the concepts is vital to achieving the goal of becoming a professional sound designer.

in review

1. What is the emotional significance attached to intervallic relationships and visual content?
2. What is the difference between on-track and off-track sounds?
3. Describe the usefulness of a sound map.
4. What are Foley sounds and where are they used?
5. Given a 230-Hz tone, what would be the frequency of a tone a minor third above it?

exercises

1. Create a small sound clip of 15 seconds. Combine three to five sounds together in some organized way as to create clarity and precision of intention. Process the sounds however you like. Render the file at CD-quality audio in your favorite file format.
2. Compose a sound sculpture lasting 3 to 5 minutes. Use all and every sound you can get your hands on, but do not use musical sounds like songs or instrument sounds. Work solely with sounds.