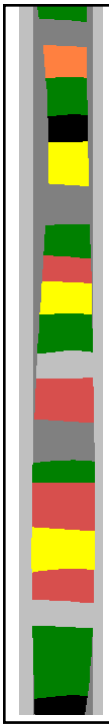
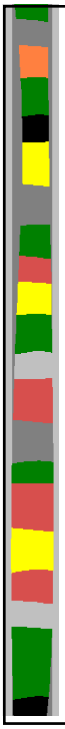


The Game Development Process

Audio Creation

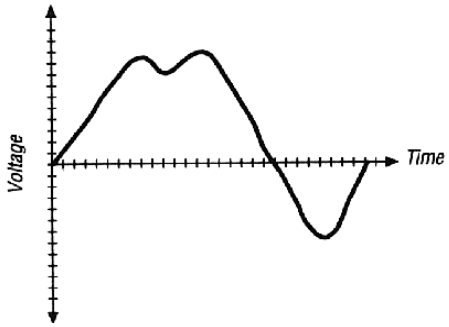


Topics

- Computer Audio Technology
- Music Guidelines
- Audio Process Guidelines

Digital Audio

- Sound produced by variations in air pressure
  - Can take any continuous value
  - *Analog* component

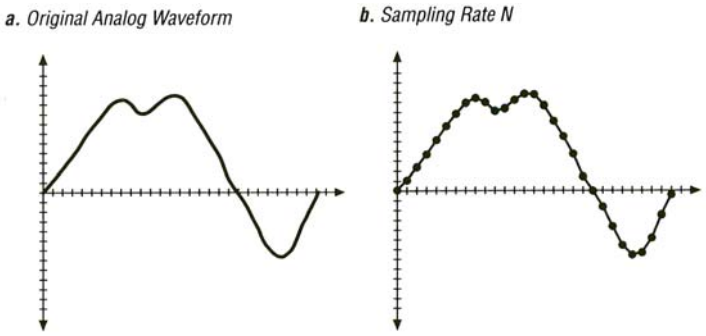


- Computers work with *digital*
  - Must convert analog to digital
  - Use *sampling* to get discrete values

Based on Chapter 4, *Internetworking Multimedia*, by Crowcroft, Handley, and Wakeman

Digital Sampling

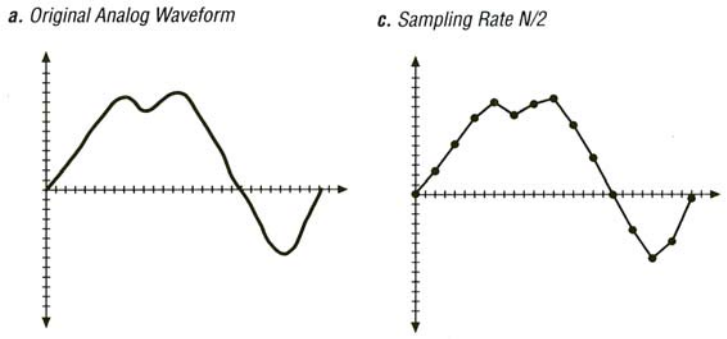
- *Sample rate* determines number of discrete values



Based on Chapter 4, *Internetworking Multimedia*, by Crowcroft, Handley, and Wakeman

Digital Sampling

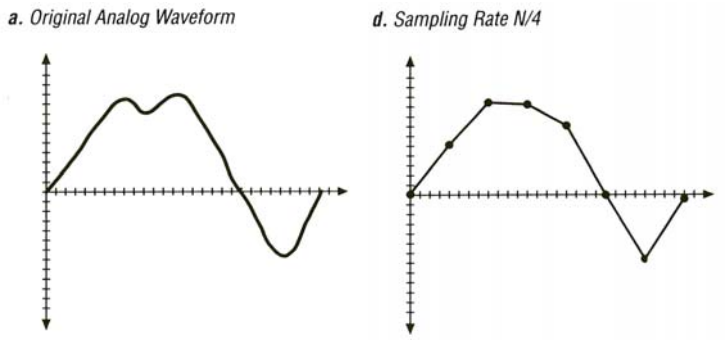
- Half the sample rate



Based on Chapter 4, *Internetworking Multimedia*, by Crowcroft, Handley, and Wakeman

Digital Sampling

- Quarter the sample rate



(Ask: why not always sample at the highest rate?)

Based on Chapter 4, *Internetworking Multimedia*, by Crowcroft, Handley, and Wakeman

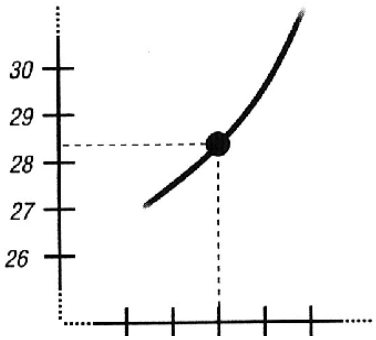
Sample Rate

- Shannon's Theorem: to accurately reproduce signal, must sample at twice the highest frequency
- Why not always use high sampling rate?
  - Requires more storage
  - Complexity and cost of analog to digital hardware
  - Human's can't always perceive
    - Ex: dog whistle
  - Typically want an *adequate* sampling rate
    - What is "adequate" depends upon use …

Based on Chapter 4, *Internetworking Multimedia*, by Crowcroft, Handley, and Wakeman

Sample Size

- Samples have discrete values



- How many possible values?
  - *Sample Size*
  - Common is 256 values from 8 bits

Based on Chapter 4, *Internetworking Multimedia*, by Crowcroft, Handley, and Wakeman

Sample Size

- *Quantization error* from rounding
  - Ex: 28.3 rounded to 28
- Why not always have large sample size?
  - Storage increases per sample
  - Analog to digital hardware becomes more expensive

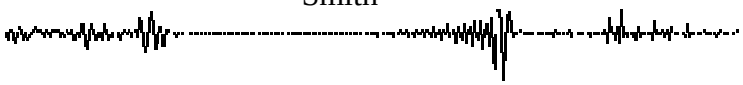
Groupwork

- Think of as many uses of computer audio as you can
- Which require a high sample rate and large sample size? Which do not? Why?

Audio

- Encode/decode devices are called *codecs*
  - Compression is the complicated part
- Ex: for voice compression, can take advantage of speech:

"Smith"



- Many similarities between adjacent samples
  - Send differences (ADPCM)
- Use understanding of speech
  - Can 'predict' (CELP)

Based on Chapter 4, *Internetworking Multimedia*, by Crowcroft, Handley, and Wakeman

Audio by People

- Sound by breathing air past vocal cords
  - Use mouth and tongue to shape vocal tract
- Speech made up of phonemes
  - Smallest unit of distinguishable sound
  - Language specific
- Most speech sound from 60-8000 Hz
  - Music up to 20,000 Hz
- Hearing sensitive to about 20,000 Hz
  - Stereo important, especially at high frequency
  - Lose frequency sensitivity as age

Typical Encoding of Voice

- Today, telephones carry digitized voice
- Capture to 4 KHz (8000 samples per second)
  - Adequate for most voice communication
- 8-bit sample size
- For 10 seconds of speech:
  - 10 sec x 8000 samp/sec x 8 bits/samp = 640,000 bits or 80 Kbytes
  - Fit 3 minutes of speech on a floppy disk
  - Fit 8 weeks of sound on typical hard disk
- Fine for voice, but what about music?

Typical Encoding of Music

- Human ear can perceive 10-20 KHz
  - Full range used in music
- CD quality audio:
  - sample rate of 44,100 samples/sec
  - sample size of 16-bits
  - 60 min x 60 secs/min x 44,100 samp/sec x 2 bytes/samples x 2 channels (stereo) = 635,040,000, about 600 Mbytes (typical CD)
- Can use *compression* to reduce
  - mp3, RealAudio

Sound File Formats

- Raw data has samples (interleaved w/stereo)
- Need way to 'parse' raw audio file
- Typically a header
  - Sample rate, sample size, number of channels, coding format…
- Uncompressed examples:
  - .wav for IBM/Microsoft
  - .aiff for MAC
- Compressed examples:
  - .mp3 for MPEG-3
  - .ra for Real Audio
  - .au for Sun μ-law
  - .midi has instrument commands

MP3 - Intro

- 'MP3' abbreviation of MPEG 1 audio layer 3
- 'MPEG' abbrev of 'Moving Picture Experts Group'
  - 1990, Video at about 1.5 Mbits/sec (1x CD-ROM)
  - Audio at about 64-192 kbits/channel
- Committee of the International Standards Organization (ISO) and International Electrotechnical Commission (IEC)
  - [Whew! That's a lot of acronyms (TALOA)]
- MP3 differs in that it does not try to accurately reproduce PCM (waveform)
- Instead, uses theory of 'perceptual coding'
  - PCM attempts to capture a waveform 'as it is'
  - MP3 attempts to capture it 'as it sounds'.

Based on *BEHIND THE MASK - Perceptual Coding: How Mp3 Compression Works*, by Paul Sellers
http://www.soundonsound.com/sos/may00/articles/mp3.htm

MP3 - Intro

- Ears and brains imperfect and biased measuring devices, *interpret* external phenomena
  - Ex: doubling amplitude does not always mean double perceived loudness. Factors (frequency content, presence of any background noise…) affect
- Set of judgments as to what is/not meaningful
  - *Psychoacoustic model*
- Relies upon 'redundancy' and 'irrelevancy'
  - Ex: frequencies beyond 22 KHz redundant (some audiophiles think it *does* matter, gives "color"!)
  - *Irrelevancy*, discarding part of signal because will not be noticed, was/is new

Based on *BEHIND THE MASK - Perceptual Coding: How Mp3 Compression Works*, by Paul Sellers
http://www.soundonsound.com/sos/may00/articles/mp3.htm

MP3 - Masking

- Listener prioritizes sounds ahead of others according to context (hearing is adaptive)
  - Ex: a sudden hand-clap in a quiet room seems loud. Same hand-clap after a gunshot, less loud
  - Ex: guitar may dominate until cymbal, when guitar briefly drowned
- Above examples of 'time-domain' and 'frequency-domain' masking respectively
- Two sounds occur (near) simultaneously, one may be partially masked by the other
  - Depending relative volumes and frequency content
- MP3 doesn't just toss masked sound (would sound weird) but uses fewer bits for masked sounds

Based on *BEHIND THE MASK - Perceptual Coding: How Mp3 Compression Works*, by Paul Sellers
http://www.soundonsound.com/sos/may00/articles/mp3.htm

MP3 – Sub-Bands

- MP3 not method of digital recording
  - Removes irrelevant data from existing recording
- Encoding typically 16-bit at 32, 44.1 and 48 kHz
- First, short sections of waveform stream filtered
  - How, not specified by standard.
  - Typically *Fast Fourier Transformation* or *Discrete Cosine Transformation*
- Divide into 32 'sub-bands', represent different parts of frequency spectrum
- Why frequency bands? So MP3 can prioritize bits for each
  - Ex: Low-frequency bass drum, a high-frequency ride cymbal, and a vocal in-between, all at once. If bass drum irrelevant, use fewer bits and more for cymbal or vocals

Based on *BEHIND THE MASK - Perceptual Coding: How Mp3 Compression Works*, by Paul Sellers
http://www.soundonsound.com/sos/may00/articles/mp3.htm

MP3 – Frames

- Sub-band sections are grouped into 'frames'
- Determine where there is masking in frequency and time domains will occur
  - Which frames can safely be allowed to distort
- Calculate *Mask-to-Noise* ratio for each frame
  - Use in the final stage of the process: bit allocation.

Based on *BEHIND THE MASK - Perceptual Coding: How Mp3 Compression Works*, by Paul Sellers
http://www.soundonsound.com/sos/may00/articles/mp3.htm

MP3 – Bit Allocation

- Decides how many bits to use for each frame
  - More bits where little masking (low ratio)
  - Fewer bits where more masking (high ratio)
- Total number of bits depends upon desired bit rate
  - Chosen before encoding by user
- Quality a high priority (music) 128 kbps common
  - Note, CD was about 1400 kbps, so 10x less

Based on *BEHIND THE MASK - Perceptual Coding: How Mp3 Compression Works*, by Paul Sellers
http://www.soundonsound.com/sos/may00/articles/mp3.htm

MP3 – Playout and Beyond

- Save frames (header data for each frame). Can then play with MP3 decoder.
- MP3 decoder performs reverse, but simpler since bit-allocation decisions given not decided
  - MP3 decoders cheap, fast
- What does the future hold?
  - Lossy compression not needed since bits irrelevant (storage + net)
  - Lossy compression so good that all irrelevant bits are banished

Based on *BEHIND THE MASK - Perceptual Coding: How Mp3 Compression Works*, by Paul Sellers
http://www.soundonsound.com/sos/may00/articles/mp3.htm

Topics

- Computer Audio Technology
- Music Guidelines (next)
- Audio Process Guidelines

Music in Games

- (Scott Morton audio director at Dragonfly Game Design)
- Despite technology improvements, emotional intensity in computer games not that of films
- Many reasons, but one facet that *could* contribute has been consistently under-utilized… *music*

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Games are not Film

- Game designers "filmize" games
  - Set up cut scenes with orchestral cues
  - Add drama to in-game fights with battle music
  - Add music to areas and levels to give identity and emotional backdrop
- It would seem this approach makes sense, but *games are not film*
- Film linear, so composer knows exactly what's coming, sets up the perfect emotional "hook"
- Games relativity can't be foreseen, calculated, or controlled
- However… some concepts you can take away from film soundtracks apply to games

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Mini-Outline

- First, dispel some myths
  - Music Mistakes (4)
- Second, briefly describe some techniques
  - Good Music Rules (4)

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Music Mistake #1 (1 of 2)

"Watering down my music and making it 'subtle' will help it to fit in and work in multiple situations."

- Ambient in nature, play straight through and repeat
- Ex: common in an RPG
  - Enter a dark dungeon? Music doesn't foreshadow
  - Finished a battle and am inches from death? Music doesn't reflect the critical nature of the situation at all
  - Why is the music even playing!? Doesn't make immersive. Just white noise. *Detracts* from immersive
  - Better to have soundscape (wildlife or city bustling noise) since draw into reality

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Music Mistake #1 (2 of 2)

- So why do game makers make this mistake?

1) It's the norm. There has always been level music.
   - Ex: something to hum to while jumping from pipe to pipe, squashing mushroom people
   - Not comfortable with musical silences in games
   - But irony is that film doesn't always have music!
   - Need to understand "less is more" factor in music for games…

2) Don't trust player to form own emotional picture
   - Ex: entering dark forest just as immersive and spooky with only audio backdrop, as it is with music
     - Try turning off the music next time you play!
   - Once trust player, use music to *augment* emotions
     - Don't have that opportunity when ambient music always on

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Music Mistake #2

"Adaptive music will solve emotional detachment issues and tie players into my game because it will follow what is actually happening"

- Opposite problem … adaptive music can be *too* reactive (each at one end of spectrum, both watered)
- A great power of film, can choose different types in single scene to change emotion
  - Ex: humorous music to a physically violent scene, versus agitated music (or no music)
- Let music keep emotional independence, not solely dependent upon literal events in game
  - If adaptive music follows gameplay and triggers "appropriate" music, can't speak independently
  - Slave to game input (player input)

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Music Mistake #3 (1 of 3)

"Cut scenes with live orchestral music will get players more emotionally involved in my game."

- Consider *Prince of Persia: The Sands of Time* (Ubisoft)
  - Cut-scenes before and after game are brilliant
  - Ones in middle don't have "full movie splendor"
    - Fragments of gameplay or are sequences rendered with the same "real-time level" of graphics detail
  - Wouldn't Ubisoft have been smarter to make all "movie-style" (including music)?
    - No! Might have dropped immersive factor

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Music Mistake #3 (2 of 3)

- Why do game designers put cut scenes in a game?
  - Expose storyline and introduce new material into the game … but could do that with dialogue box!
  - Cut scenes are created because the designer thinks; "I want to make an emotional, dramatic impact on the player with the way I present this information."
- So, makes sense for a full orchestra to accompany these cut scenes
  - Orchestra is legendary, for 100s of years
  - "So we should use it for games!" Yes, but …

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Music Mistake #3 (3 of 3)

- Watching film is a passive
  - Watching Matrix. "Cool when Neo kung-fu'd Mr. Smith"
- Games are active. Don't say "cool when *Joe* lobbed the grenade" but "cool when *I* lobbed the grenade"
  - Player "is" the avatar
- During cut-scenes, lose that. Lose emotional involvement.
  - Making it more grandiose, takes away even more
- Orchestra can color game if used at right point

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Music Mistake #4 (1 of 2)

"Let's just loop the music once it reaches the end."

- Very prevalent *Final Fantasy* to *Zelda*,
- Many reasons why bad idea
  - Looping hand-in-hand with "watered-down, ambient music" approach (no emotional connection)
  - Worse, detached the player from even registering it
  - Worser, becomes annoying
- Moved from "why should we even have music playing here" to "why shouldn't we turn off the music altogether and listen to MP3s?"

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Music Mistake #4 (2 of 2)

- Why do we fall into this trap?
  - It's familiar, done in most games
  - If small music budget might "want to make the best of what we have."
  - Maybe Mr. Programmer said "I don't know what else to do besides looping" and "Mr. Producer told me to stick Music A into Level B."
  - Above reasons not for AAA titles
- The bottom line:
  - *if we can't move beyond mediocre methods of implementation when it comes to music, we will never progress and mature in this area.*

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Good Music Rule #1 (1 of 2)

"Follow the dramatic arc with the game's soundtrack"

- In film, soundtrack has two purposes
  - Impose emotion on scene
    - Such as subtle underscore during dialogue
    - Such as full-blown cue with just visuals and music
  - Supplement dramatic arc over whole film by connecting everything together musically
    - Not yet done any sophisticated manner in games
- Composers think beyond "What does this level sound like" to
  - "What role does this level and its characters play in the grand scheme of the game and the plot?"
  - "How do I portray that with the music I write?"
  - "Where do I place the music within the level to bring this across in the most effective manner?"

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Good Music Rule #1 (2 of 2)

- Consider *Baldur's Gate: Dark Alliance*
  - Boss battles feel more intense than common battles because no music triggered during normal battles
  - When music kicks in for a boss battle feels more important
  - Each boss has its own identifying style and theme.
  - Final battle against Eldrith, plays main theme of game during title screen
- Create a *musical climax* in your game
  - Don't use most intense music until critical points in dramatic arc
  - Is final boss battle more important than miniboss battle? → Show it in the music.
  - Let player (subconsciously) interpret importance of events based on accompanying music

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Good Music Rule #2

"Never use music unless it is making a specific emotional statement to the player."

- Music playing should mean something
  - In a film, music never plays just to play.
- Good guideline to remember "The less you use something, the more effective it is when you do use it."
  - Don't be afraid of musical silences in games
  - Use the sounds of forests or dripping caves or crowded streets to immerse a player
  - Trigger music to bring to next level of emotion
- Keep music more sparse
  - Will retain its special element of influence
  - Will not simply be "tuned out"

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Good Music Rule #3 (1 of 2)

"Get the composer involved early in the process!"

- Film composers can be given fixed and final product. Watch to see how music inserted from a technical and artistic standpoint
- Games are more intricate. Composer needs:
  - designer's motivations from dramatic and story perspective
  - how story is presented
  - what kind of influence player has on story
- Bottom line: "hiring the composer when we're done with the game" is not a good idea

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Good Music Rule #3 (2 of 2)

- Also, important that composer do at least some (if not all) of the music implementation.
  - Needs the ability to experiment and find what works best to match vision
- Could be
  - Team-up with an audio programmer
  - Tools for inserting music
- Method for composer to have influence in all musical performance aspects of game

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Good Music Rule #4

"The more content, the better"

- A piece of music more impact if played in one place
  - Identifies single, critical moment or event
- The more musical content created, the more room for dedicating unique cues to certain places
- Reality of music budget and cost-per-minute of composer can get in way
  - Get composer involved early
  - Dedicate more budget to music and sound
- Awareness of how much influence a well-written and well-implemented musical score can have in a game, hopefully, will raise the priority of a game's soundtrack in the budget in the near future

Based on *Enhancing the Impact of Music in Drama Oriented-Games*, by Scott Morton
http://www.gamasutra.com/features/20050124/morton_01.shtml

Topics

- Computer Audio Technology
- Music Guidelines
- Audio Process Guidelines (next)

Based on Ch 9 of *Audio for Games*, by Alexander Brandon

The Popularity of Game Audio

- (Chapter 9 Called "Looking Ahead" but really guidelines for making process methods better)
- Game-audio folks complain for not being recognized by peers and public
  - Justified? Yes, difficult skills to master
  - Skills of directing audio, composing music, directing voice, doing sound effects, programming audio
- Note, should be awards for really good (not everyone)
  - Compare plugging instruments in and jamming away to sound and music of Star Wars

Based on Ch 9 of *Audio for Games*, by Alexander Brandon

Game Audio Awards

- Academy of Interactive Arts and Sciences
  - Best licensed soundtrack, best original music composition, best sound design
- Game Audio Network Guild
  - Supposedly awards for all aspects
- Selection:
  - Allow nomination by anyone
  - Maybe allow voting by anyone
  - *National television broadcast*
    - May come naturally when games as popular as film (and when audio is as good)
- Misc:
  - Music4Games (www.music4games.net) - news on game music
  - GameMusic.com (www.gamemusic.com) - buy game soundtracks

Based on Ch 9 of *Audio for Games*, by Alexander Brandon

Popularity Challenges

- Need better production methods
  - (See previous topic on "mistakes")
  - Better voice acting
  - Less repetition
- (Much of which requires more budget, still)

Based on Ch 9 of *Audio for Games*, by Alexander Brandon

Guidelines for All Videogames (1 of 2)

- Address audio early, in pre-production
- Publisher or developer hire audio director to oversee audio production
  - Create budget and schedule
- Game audio tasks specialized
  - Ex: composers not do sound effects
  - Ex: producers not direct voice actors
- Ideal: Audio director, Composer, Sound designer, Sound engineer
  - Not necessarily all hired for full project

Based on Ch 9 of *Audio for Games*, by Alexander Brandon

Guidelines for All Videogames (2 of 2)

- Don't repeat audio unless musical theme re-instated
  - In that case, variation
- Pace conversations properly, with voice acting
- Game soundtracks adaptive to player actions (makes games different than film)
- Appropriate soundtracks (consider player choice for driving, fighting, puzzle games)
  - (Next)

Based on Ch 9 of *Audio for Games*, by Alexander Brandon

Guidelines for Fighting Games

- Non-repetition
- Dozens, hundreds of injury sounds
  - Ex: Soul Caliber 2 better than most
- It is ok to have lyrics for music here
- Music adaptive to players moves, fight situation

Based on Ch 9 of *Audio for Games*, by Alexander Brandon

Guidelines for Driving Games

- Adaptive sound tracks already used for some
  - Ex: *Need for Speed 3: Hot Pursuit* when cop approaches, tension filled
  - Trick: can activate a music track (bass, guitar drums) at checkpoint, say
- Player could choose sound like radio in car
  - Ex: Sega's *Out Run* and *Out Run 2*
- Real sounds merged with synthesized sounds

Based on Ch 9 of *Audio for Games*, by Alexander Brandon

Guidelines for Puzzle Games

- Adaptive soundtracks based on difficulty
  - Ex: *Russian Squares* for XP Puzzle Pack
- Avoid repetition, even for sound effects that designate puzzle moves
  - Vary slightly

Based on Ch 9 of *Audio for Games*, by Alexander Brandon

Guidelines for Sports Games

- Music transitions based on game conditions (penalty, score)
- Music from PA of system (like at real game)
  - Ex: *Madden NFL*
- Crowd sound effects, reactions to action
- Audio commentary if depicted as broadcast

Based on Ch 9 of *Audio for Games*, by Alexander Brandon

Guidelines for Action/Adventure Games

- Use ambient (background) sounds
- Sounds should paint "sonic landscape"
- Sound "textures" like visual textures
  - Ex: *Half-life 2*, used when objects collide
- Surround sound to aid immersiveness

Based on Ch 9 of *Audio for Games*, by Alexander Brandon