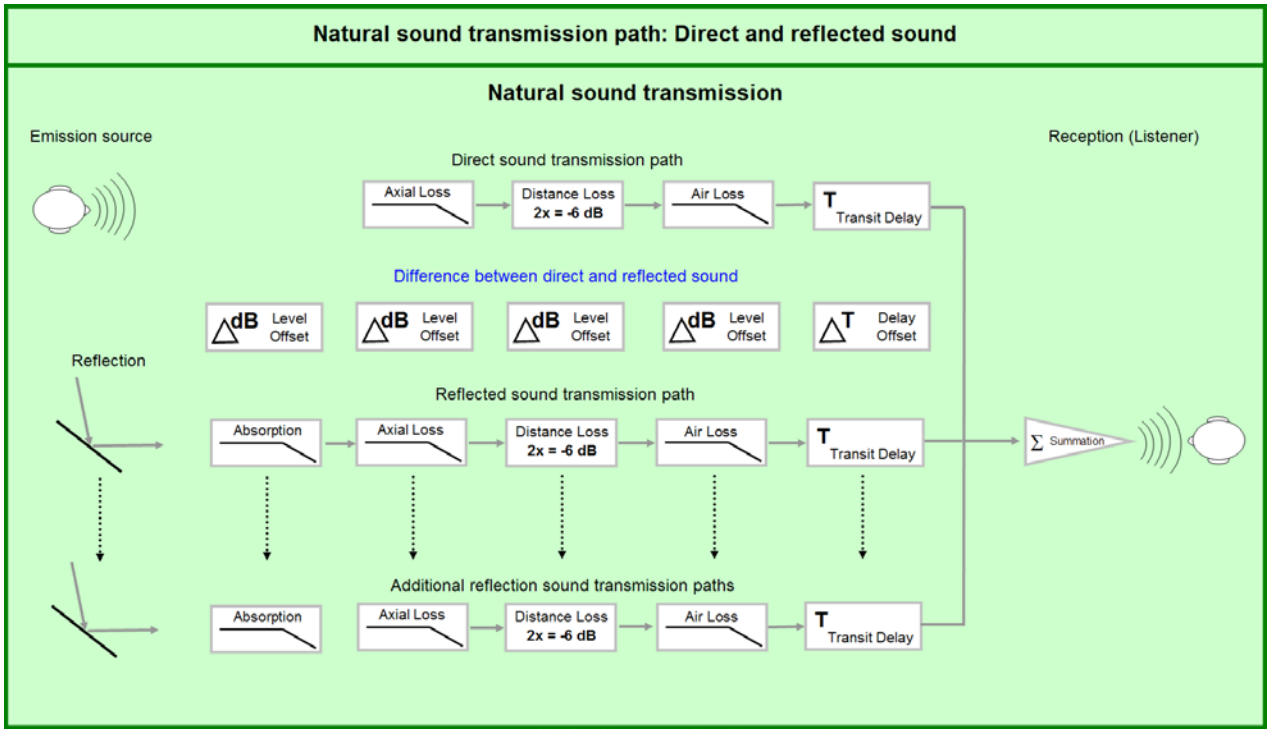
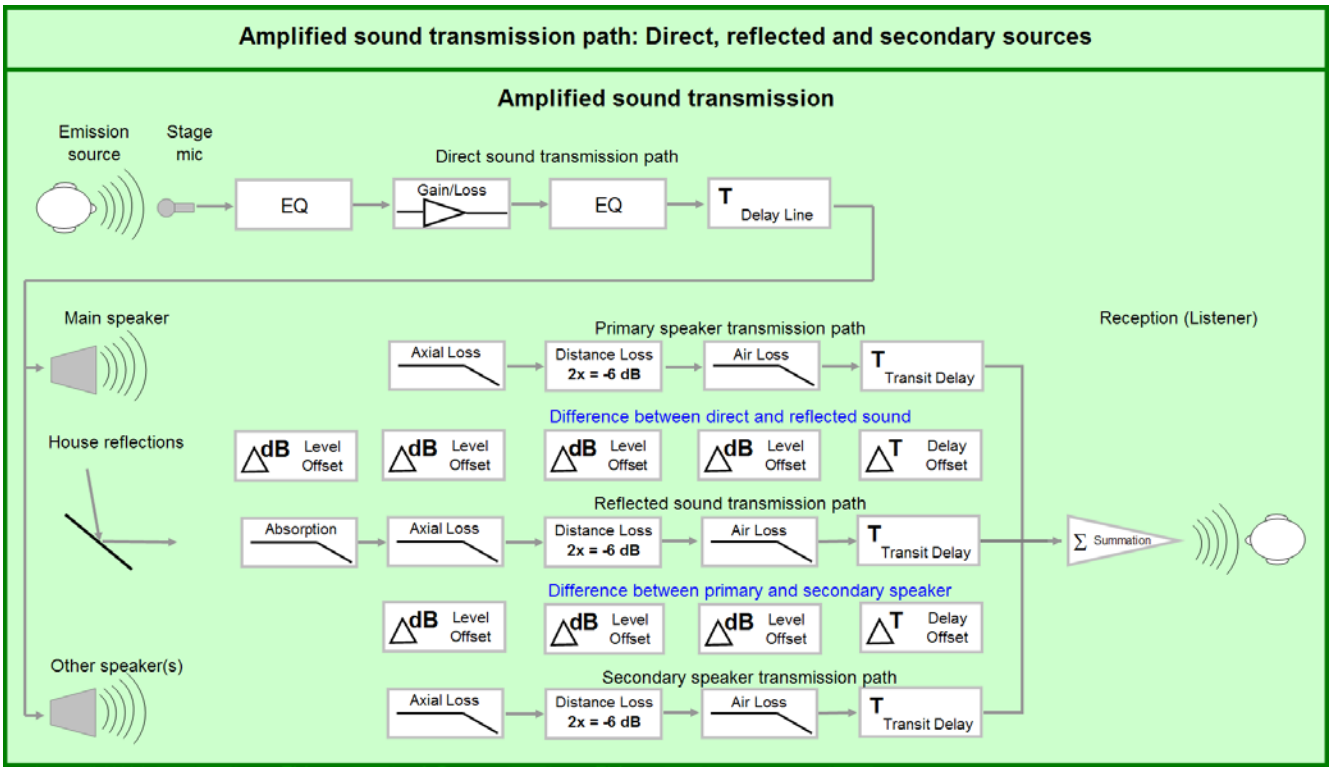
Lecture Summary – Evaluation

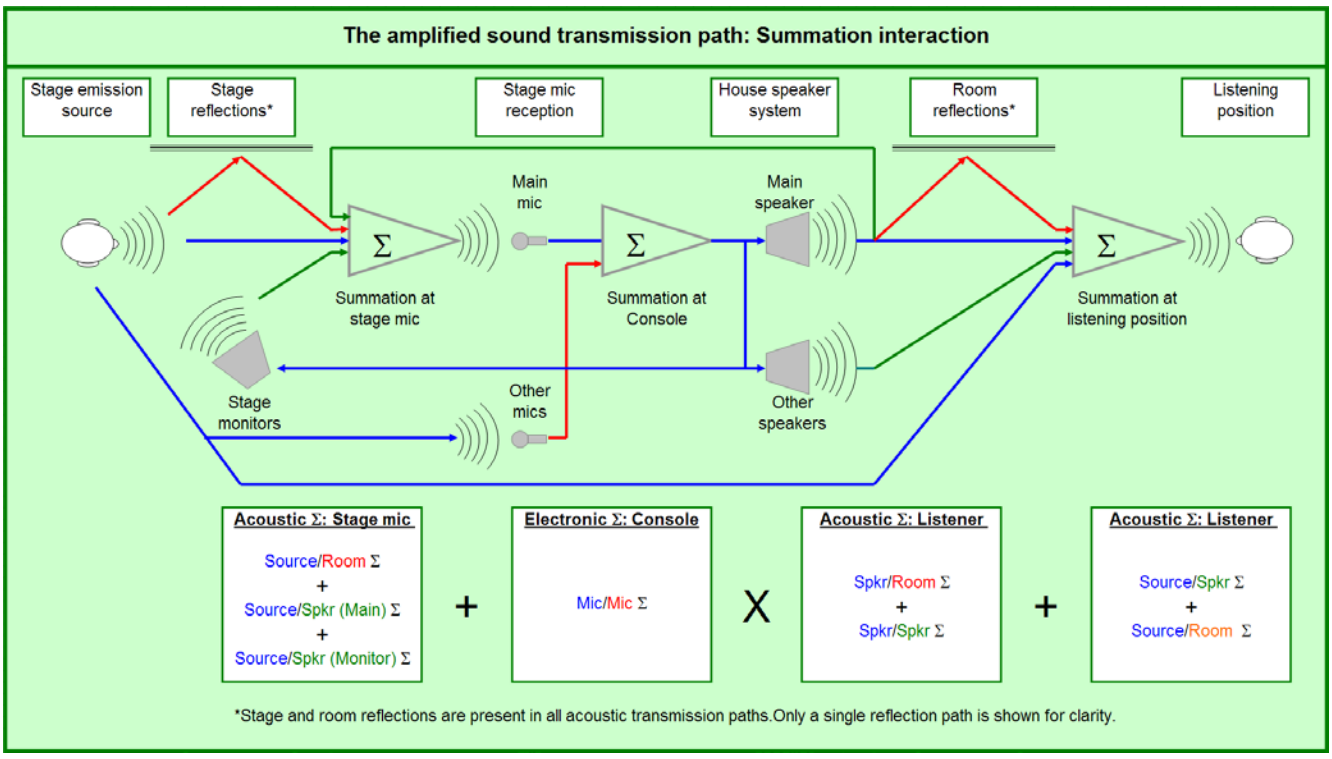
Chapter 6

- **features of natural emission/transmission/reception**
  - **individual sources are mixed on stage**
  - **emission originates from multiple sources in one general location (the stage)**
  - **transmission support by the room is required**
  - **separation between the emission sources and the transmission medium is prohibited (musician, stage, and house are all one)**
  - **reception becomes uniform in level and tone by lack of separation**



- **features of amplified emission/transmission/reception**
  - **individual emission sources are isolated on stage, and the stage is isolated from the main transmission system**
  - **transmission originates from multiple locations (stage, stage monitors, house main speakers, house auxiliary speakers)**
  - **transmission support by the room is an optional enhancement, not a requirement**
  - **separation between the emission and transmission sources is required (musician, stage, and house are all separate)**
  - **reception becomes uniform in level and tone by virtue of separation**


Amplified sound transmission path: Direct, reflected and secondary sources
Amplified sound transmission
Emission source
Stage mic
Direct sound transmission path
EQ
Gain/Loss
EQ
T Delay Line
Main speaker
Primary speaker transmission path
Axial Loss
Distance Loss 2x = -6 dB
Air Loss
T Transit Delay
Reception (Listener)
Difference between direct and reflected sound
House reflections
dB Level Offset
T Delay Offset
Reflected sound transmission path
Absorption
Axial Loss
Distance Loss 2x = -6 dB
Air Loss
T Transit Delay
Σ Summation
Difference between primary and secondary speaker
Other speaker(s)
Secondary speaker transmission path
Axial Loss
Distance Loss 2x = -6 dB
Air Loss
T Transit Delay


The amplified sound transmission path: Summation interaction
Stage emission source
Stage reflections*
Stage mic reception
House speaker system
Room reflections*
Listening position
Main mic
Main speaker
Σ
Summation at stage mic
Summation at Console
Summation at listening position
Stage monitors
Other mics
Other speakers
Acoustic Σ: Stage mic
Source/Room Σ
+
Source/Spkr (Main) Σ
+
Source/Spkr (Monitor) Σ
+
Electronic Σ: Console
Mic/Mic Σ
X
Acoustic Σ: Listener
Spkr/Room Σ
+
Spkr/Spkr Σ
+
Acoustic Σ: Listener
Source/Spkr Σ
+
Source/Room Σ
*Stage and room reflections are present in all acoustic transmission paths.Only a single reflection path is shown for clarity.

- **subjective room parameters**
  - **intimacy – feeling of proximity to the music (as if listening in a small room)**
  - **liveness – fullness of tone in mid/high range**
  - **warmth – fullness of tone in low frequencies**
  - **loudness of direct sound – appropriately scaled to musical content**
  - **loudness of reverberant sound – appropriate mix of level and duration**
  - **definition, clarity – clear and distinct sound**
  - **brilliance – bright, clear, rich in harmonics**
  - **diffusion – spatial aspect of reverberation (sound arriving from all directions)**
  - **balance – relative level of instruments and voice (instruments heard in proper level perspective, e.g., lute and bagpipes – *PDQ Bach*)**
  - **blend – harmonious mix of instruments**
  - **ensemble – how well musicians can hear themselves**
  - **immediacy of response – measure of how well the musicians feel about the responsiveness of the sound**
  - **texture – the fine grain of the listening experience (fine texture = richness and complexity in its "outer surface")**
  - **freedom from echo – discrete echoes are not heard**
  - **freedom from noise – the noise floor of room/system is low**
  - **dynamic range – difference between maximum level and noise floor**
  - **tonal quality – flat system response**
  - **uniformity – the extent to which all listeners have the same experience**

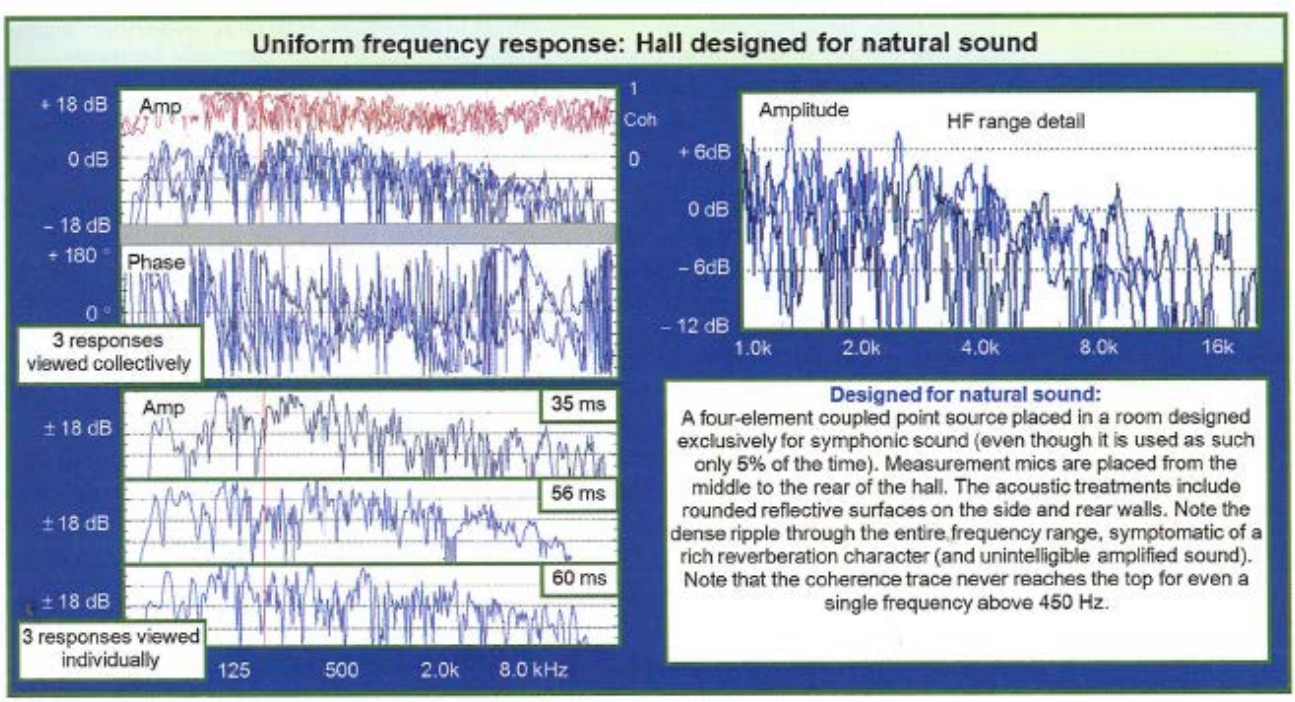
- **room design to support natural acoustics vs. amplified sound**
  - **agreed**
    - **diffusion**
      - **reflections provide a richer reverberation character if the surfaces are diffuse; scattering provides a more gradual and dense reverberation tail**
      - **natural: summation arrivals become more randomized, leading to more texture, a steady decay character, and less risk of echo perception**
      - **amplified: summation arrivals become more randomized, leading to more texture, a steady decay character, and less risk of echo perception**
    - **freedom from echo**
      - **achieved by preventing single reflections to stand out above the decay pattern or focus points to occur from the confluence of multiple reflections**
      - **natural: reflections must transition steadily toward isolation**
      - **amplified: greater risk because of lower reflection density and higher sound levels; concentrated beams of directional speakers increase possibility of focused reflections ("slap back" from rear wall or balcony surface**
    - **freedom from noise**
      - **natural: achieved by isolating the transmission from noise source**
      - **amplified: same as natural, with addition of electronic noise and feedback/"ringing" (also, excessive sibilance – also called *de-essing*) reference: https://www.youtube.com/watch?v=k9exwW0fpw8**

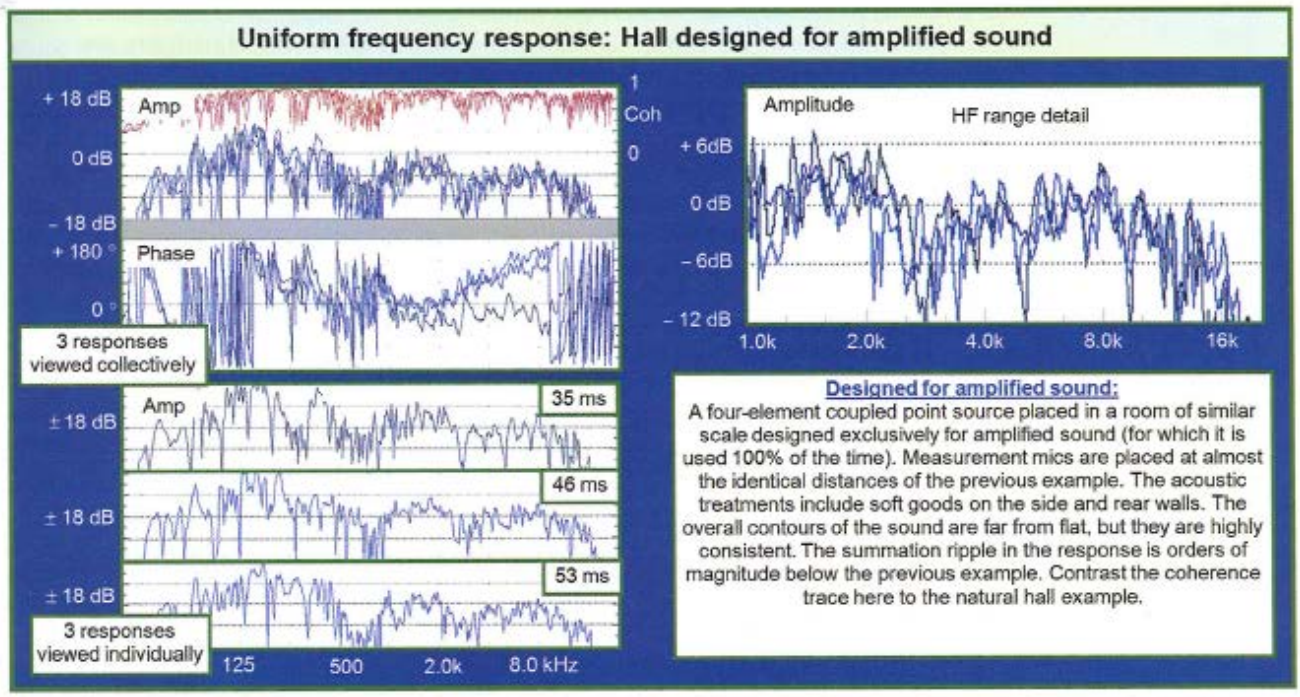
- **room design to support natural acoustics vs. amplified sound, continued…**
  - **opposed**
    - **intimacy**
      - **initial time delay gap: early arrivals should be within 5 dB and 20 ms offset of direct sound**
      - **natural: strong reflective summations are needed for acoustic power addition; multiple arrivals required to provide sufficient comb filter density *(so that dips/peaks are beyond tonal resolution of ear)***
      - **amplified: strong reflective summations are NOT needed for acoustic power addition; since speaker is single directional source the reflection pattern lacks complexity, and the combing summation will be perceived as a tonal distraction!**
    - **liveness**
      - **optimum reverb time is program-material dependent**
      - **natural: reverberation is highly dense combining zone and isolation zone summation; the density neutralizes the tonal signature and provides a desirable sense of spaciousness**
      - **amplified: separation of room into distinct speaker coverage areas breaks the unifying element of room reverberation, rendering it less uniform; best when meets minimum needs and principally provides spatial enhancement (bulk supplied electronically)**
    - **warmth**
      - **achieved by ensuring reverberation time in low frequencies about 25% longer than that of midrange/highs**
      - **natural: reflective surfaces should be of sufficient density and hardness to reflect low frequencies and ensure sufficient LF reverb time (plaster, thick wood)**
      - **amplified: coupled speaker/subwoofer arrays and nearby surfaces provide conditions for uniform LF summation; sufficient LF power capability obviates need for longer LF reverb time**
    - **loudness of reverberant sound**
      - **natural: must scale with venue size; achieved with strong, extremely dense combing zone, combining zone, and isolation zone summation**
      - **amplified: ratio of direct to reverberant sound should be kept as high as possible; achieved by minimal combing and combining zone summation (isolation zone summation accepted within limits for its ability to provide sense of spaciousness)**
    - **ensemble**
      - **natural: strong/dense combing, combining, and isolation zone summation – sound of each instrument must spread across stage to other musicians; instruments not isolated from one another**
      - **amplified: ensemble on stage achieved by isolating the individual sound sources, combining electronically in the mixer, and returning the signal via individually adjustable stage monitors (problems: stage monitors near microphones can reenter transmission path, causing combing/feedback; also, disturb acoustic partitioning of house speakers)**

- **room design to support natural acoustics vs. amplified sound, continued…**
  - **opposed, continued…**
    - **definition/clarity**
      - **achieved by optimal mix of intimacy, liveness, and loudness**
      - **natural: mix of direct sound, dense combining zone, and isolation zone summation is required**
      - **amplified: clarity is result of a high ratio of coupling and isolation zone summation, and a low ratio of combing zone; achieved by directional speakers with distinct coverage zones and carefully managed patterns**
    - **response/attack**
      - **natural: stage is directly coupled to house; how transmission character of house returns to stage is decisive factor (reverb time)**
      - **amplified: monitors are principal reference on stage, yet sound in house will have an appreciable effect on experience (loudspeaker sidelobes and rear-wall or balcony face reflections)…may need to compromise on isolation from main transmission system trying to achieve through use of monitors**
    - **tonal distortion**
      - **prevented by not allowing absorption to occur at selected frequency ranges**
      - **natural: prevented by dense complex multiple summations of different relative time and level (if a single reflection is too dominant it will cause cancellations and excessive additions)**
      - **amplified: minimized by focusing on coupling zone and isolation zone summations (combing zone is avoided to maximum extent possible); tonal distortions unique to amplified systems include harmonic distortion, compression, and sonic image distortion**
    - **uniformity**
      - **hall is free of "dead spots" and/or response anomalies (maximum similarity of sonic experience)**
      - **natural: achieved by coupling all seating areas to transmission system, and saturating the frequency response with super dense combing, combining, and isolation zone summations**
      - **amplified: achieved by isolating the speakers from each other and the room; frequency response is maintained by coupling and isolation zone summations (combing zone avoided to the extent possible)**

- **room design to support natural acoustics vs. amplified sound, continued…**
  - **different…but not conflicting**
    - **loudness of direct sound**
      - **natural: maintained by arranging seating as close to conductor as possible (benchmark is 60 feet); function of transmission path length from stage to listener**
      - **amplified: function of transmission path length, drive level of speaker, and axial orientation; directional speakers in separate locations allow constant level to be maintained over space**
    - **brilliance**
      - **achieved when sound is intimate and reverb time in HF balanced with midrange**
      - **natural: mix of direct sound, dense combing zone, and isolation zone summation is required**
      - **amplified: distant speakers will have HF boost to compensate for HF air loss ("pink shift"); separated directional speakers allow for even amounts of HF distribution**
    - **balance**
      - **natural: the room must transmit all instruments in the proper mix; stage and house reflections must have sufficient strength and density for uniform level and frequency response to be achieved – balancing of instruments is in the acoustic space**
      - **amplified: role of speaker system is transmission of pre-mixed signals originating at mix console – stage sources are isolated and balanced in the mix electronically**
    - **blend**
      - **natural: harmonious blend achieved by positioning of instruments – spacing between instruments on stage is a key factor**
      - **amplified: role of speaker system is transmission of pre-mixed signals originating at mix console – instruments are blended by separation into multiple transmission channels (left, right, center) and appropriate use of panning; isolated electrical signals are blended in the acoustic space**
    - **texture**
      - **achieved by carefully spaced and sequenced reflection patterns**
      - **natural: achieved by a steady transition of the low level reflections through the isolation zone (enhanced by high reflection density)**
      - **amplified: acoustic texture can be augmented electronically with the isolation zone summation induced by outboard reverberation (and can be applied separately to different input channels)**
    - **dynamic range**
      - **maximized by having the strongest summation of the direct sound and early reflections while keeping background noise to a minimum**
      - **natural: maximum acoustic addition requires both coupling and combing zone summation**
      - **amplified: maximum acoustic addition requires both coupling and combing zone summation; limited by power handling capability of system and gain before feedback**

- **common goals**
  - **tonal balance**
  - **freedom from potentially disturbing reflections**
  - **uniformity of diffuse energy**
  - **appropriate levels of ambient noise**
  - **uniformity of sound field**
  - **clarity and intelligibility**





- **"amplified-speaker-centric" view**
  - **room shape – "line of sound" considerations**
  - **matching shape to purpose – "stereo everywhere" difficult (impossible) in wide spaces**
  - **under-balcony spaces – height must increase as depth increases**
  - **side seating areas – challenging!**
  - **low-frequency absorption/diffusion – "tight low end" (vs. "boomy" or "muddy")**
  - **mid-frequency diffusion – areas near speakers, or on-axis**
  - **high-frequency absorption/diffusion – especially needed on rear walls**
  - **ceilings – want to avoid them (preferably splay away from speaker locations)**
  - **sidewalls – benefit from outward splay angle**
  - **floor/seating/aisle areas – treat will carpeting as needed**
  - **hidden speaker locations – must be acoustically transparent**
  - **main speaker locations – try to keep image low/central**
  - **front fill speaker locations – keep as high as possible**
  - **mix position – needs to be in the house**
  - **stage – benefit from variable acoustics (shells and drapes)**
  - **surface complexity – aids diffusion**
  - **balcony fronts – usually benefit from absorption**

- **middle ground**
  - **variable acoustics (reverberation control)**
    - **curtains**
    - **rotating wall panels**
    - **acoustic filters**
  - **electronic reverberation enhancement**
    - **optimum is to have separate (distributed) "reverberation source" loudspeakers (vs. running through main system)**