

## Acoustics: Listening Environments

reflection, absorption, dispersion, diffraction, transmission

### Isolation from external noise

- sound barrier - massiveness, change in density, air leaks
- air leaks
- double walls
- heat insulation vs acoustic insulation
- paths of sound transmission
  - windows, doors, leaks, duct work, gaps around pipes etc

### Open air sound

- inverse square law
- noise sources - distance from noise source - inverse square law
- sound absorption in audience
- reflecting surface (band shell)
- electronic reinforcement

### Sound in enclosures

- design - sound is reflected, little is lost
- diffusion is generally desirable
- attenuate external noise
- noise criterion
- reverberation: direct sound, early sound, reverberant sound
- speech -- little reverberation; orchestral music -- more reverberation
- trade-off between reverberation and sound absorption
- Sabine equation:  $RT=0.16*V/TA$ ; TA is total absorption,  
(surface area \* absorption coefficient)
- reflective surface in front, close to the sound source
- combination of reflective and absorbing surfaces on other walls
- irregular shaped surfaces to diffuse sound
- “raking”
- elevated stage
- avoid: echoes, focusing of sound by concave surfaces, sound shadows