

TV For Computers

Franklin Bell CBTE CBNT PMP
Certification Preparation for SBE CEV (Certified Engineer Video)
Infocomm Certified Technology Specialist (www.infocomm.org)

Polycom's Certified Videoconferencing Engineer (PCVE)
Cisco TelePresence Installations Specialist ([642-188 ITI](tel:642-188-ITI))
Avaya Certified Specialist Implementation (www.avaya.com)

Wire, Cable, connectors

- ▶ Conductor; OHFC Copper “Oxygen Free”, Cu plated steel, Aluminum, other e.g. ETP copper.
- ▶ Insulator; Air, foam, spacers, plastics, mineral, ceramic.
- ▶ Type; UTP (unshielded twisted pair), STP (shielded twisted pair, CAT varieties, SP (shielded pair), coax(ial), waveguide (normally closed), fiberglass, plastic fiber.
- ▶ Cables are multiple wires, which may be different types, in an overall jacket, e.g. rubber for mic cable. Water blocking may be included. Star quad for quality mic cable.
- ▶ Connectors CAT modular, Bayonet Neill-Concelman, fiber types, USB, D, many others. Not all are field connectable. D(series)E(size)15(pins)F(gender) “HD15”
- ▶ Power capacity, impedance, capacitance and attenuation
- ▶ are factors as well as noise immunity and flex life.

First Audio, then Radio

► Acoustics; The science of sound we hear

- Absorption, reduces decay time (polyfill & fiberglass)
- Reflection, contributes to decay time (flat or spherical inside)
- Diffusion, scatters the sound (complex surface shapes)
- Isolation (e.g. spring suspended ceilings)
- Resonance of structures (e.g. sheetrock walls)
- Standing waves in spaces contribute to frequency response, and hence feedback.
- Background or noise floor
- Absolute phase matters, an explosion is felt as pressure so don't reverse the wires. XLR pin 2 and tip is + phase.
- The response of the ear, see chart following page.
- The sense of where the sound is from matters, so a flat response including the environment is important.

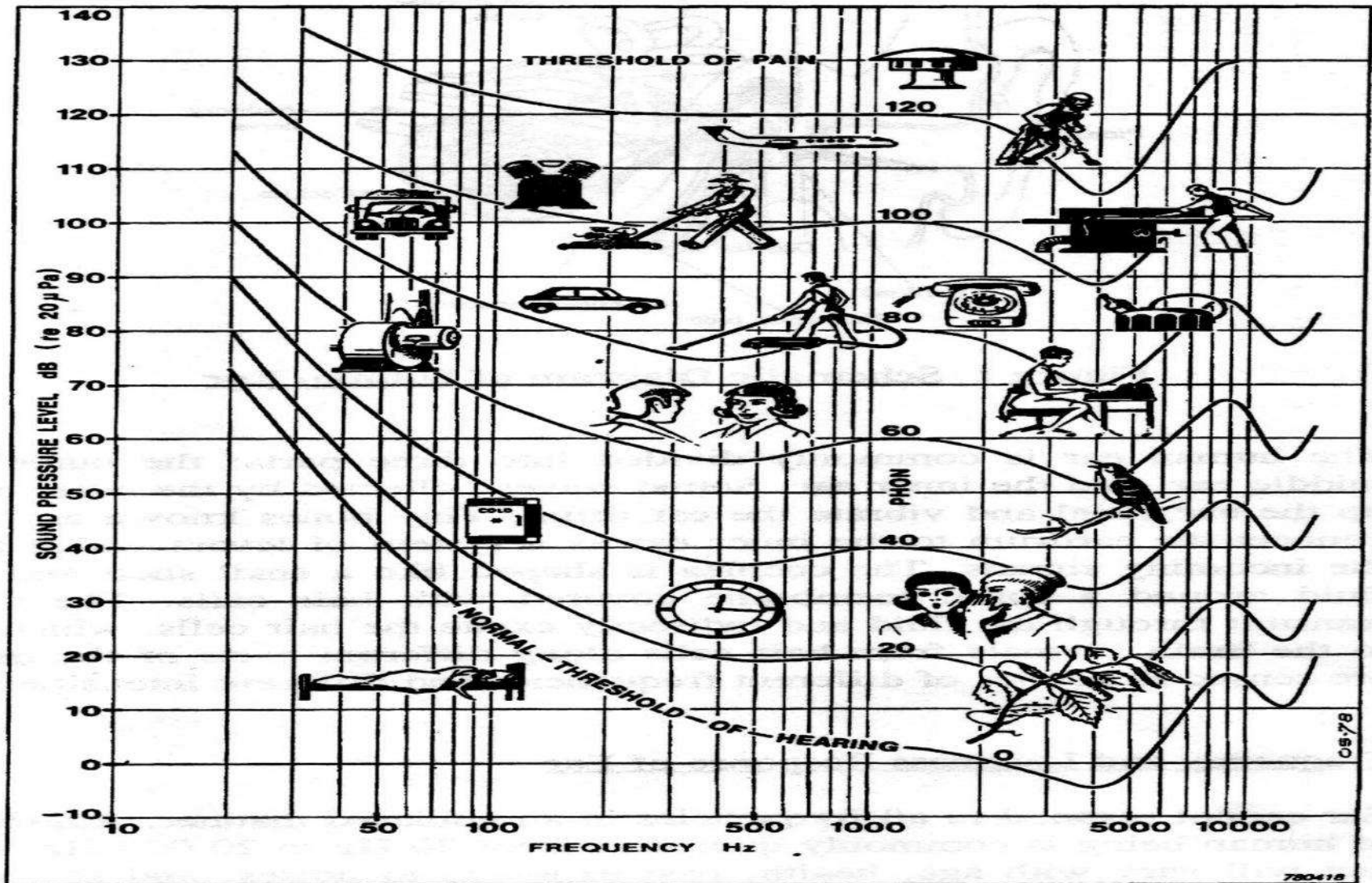
Acoustics

- ▶ The shape of the space matters, parallel walls cause standing waves for example.
- ▶ The surface material matters. E.g. heavy carpet with fiber back (absorbency 0.74), $\frac{3}{4}$ " (19 mm) sound absorbent tiles (absorbency 0.64) and absorbent drop ceilings (Owens Corning Frescor $\frac{5}{8}$ " 15mm absorbency 0.81) are best for high frequency absorption (4 kHz) absorbency . For low frequencies 4" (100mm) fiberglass with 0.79% perforation and a layer of 19mm polyester fill and thin, flame resistant cloth cover is best (125 Hz) absorbency 0.98.
- ▶ 1/3 octave equalizers can reduce feedback, but they smear the spatial localization of the sound image, good acoustics is a better sounding solution.

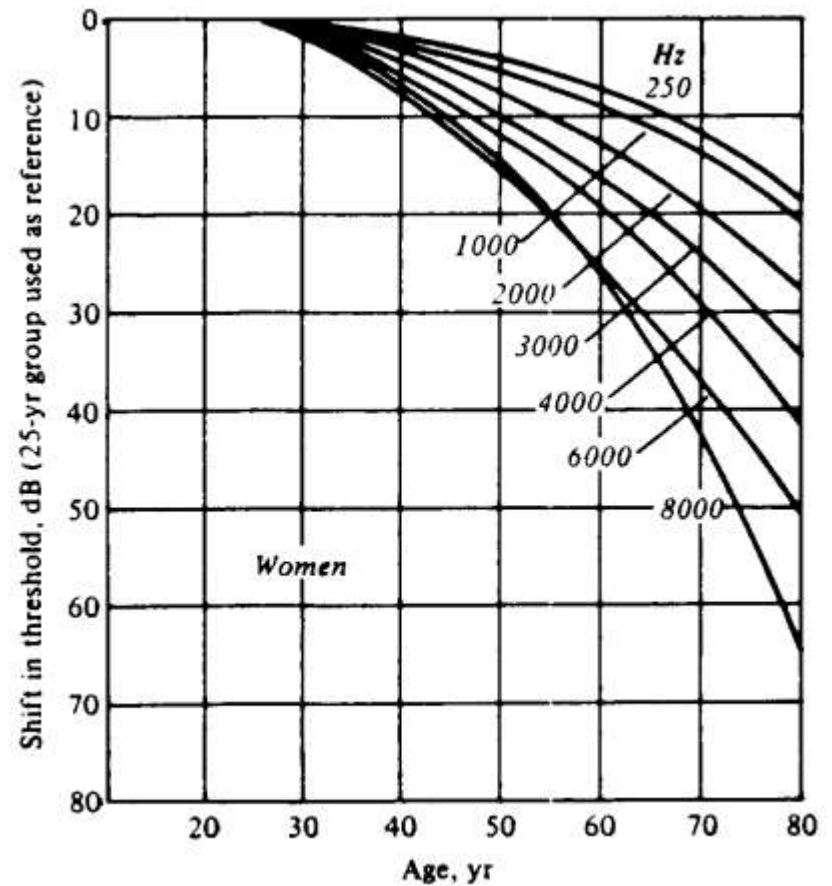
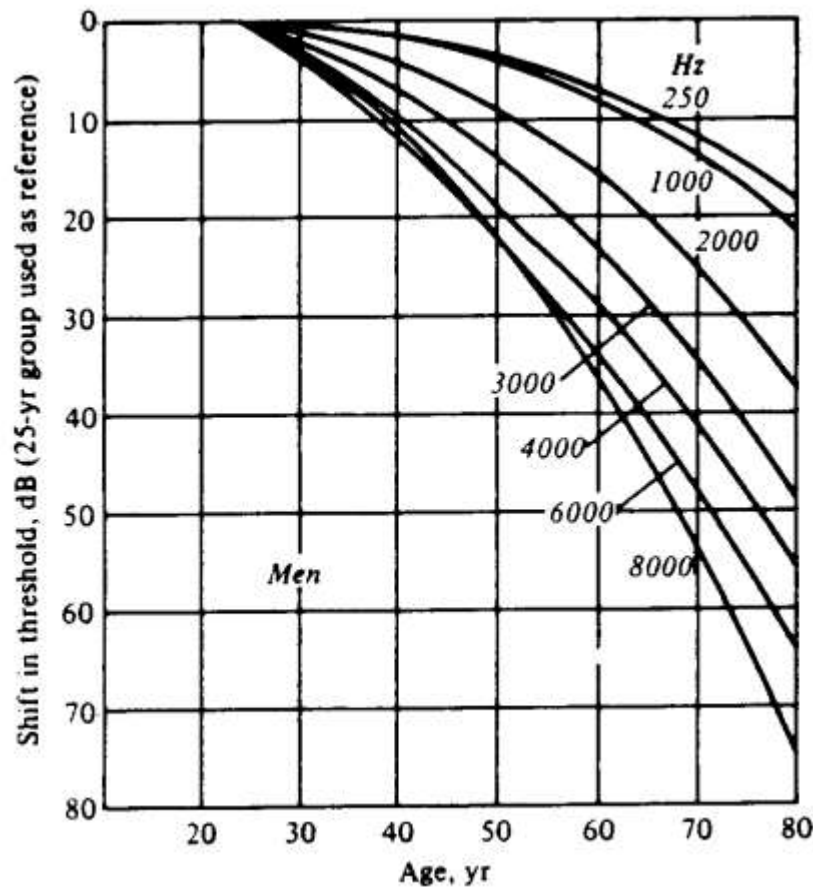
What are dBs? They are decibels, A.G. Bell

- ▶ $\text{dB} = 10 \log (P_2/P_1)$ where P_2 is second power, P_1 first, dBr.
- ▶ $\text{dBm} = 10 \log (P/1 \text{ mW})$. dBu is the same voltage (0.7746 V RMS), but may be into an open circuit or high impedance.
- ▶ $\text{dBW} = 10 \log (P/1 \text{ W}) = \text{dBm} - 30$
- ▶ But $P = V^2/R$ so where R is 600 audio, 75 TV and 50 RF ohms
- ▶ $\text{dB} = 20 \log (V_2/V_1)$
- ▶ So instead of multiplying the gain, or dividing by the attenuation, we can add or subtract dBs, and just shift frequency plots up and down that are plotted in dBs.
- ▶ dB(A) are sound loudness SPL based on the A human response.
- ▶ dB(C) are sound loudness based on a flat response.
- ▶ Loudness is also used in program content and it is based on the Dialnorm or normal voice dialog sound level electrically. Typical dialnorm is -24 dB, measured with a loudness meter relative to maximum analog or digital peak. Leq(A) Dolby

Frequency Response of the Ear



Variation with age on average



Audio signal connections

- ▶ Analog professional, XLR balanced pair or TRS phone plug
- ▶ May be microphone, or line level (+4 dBm reference level)
- ▶ Microphones may be capacitor/condenser which require 48v or battery power. Others do not. Not all inputs provide such power. If using a different source, the 48v may damage the source so check first.
- ▶ Pro digital may be BNC, fiber or XLR as AES3, clock/sync needed, 48 kb/s or more, 16 bit or more, 2 or more or USB
- ▶ Consumer may be RCA, mini phone or DIN or digital fiber as S/PDIF similar to AES3. Adaptors to professional are available. Toslink has square, miniplug or round connectors and 10m maximum length using the S/PDIF data format.
- ▶ The analog line level is -10 dBm and is unbalanced and more susceptible to hum and RF interference
- ▶ The mic jack may provide power for electret mics
- ▶ Digital audio may be in the video, DVI, HDMI or BNC

Audio speaker connections

- ▶ Do not use a speaker connection for an audio signal connection except for MP3 players or computer earphone connectors as damage may result.
- ▶ These may be banana plug/jack, screw terminal, phone plug/jack or speakon (an insert and twist type).
- ▶ Self powered speakers need a power cord, have an XLR or phone jack for balanced professional cable, and usually have a volume control. (consumer battery ones don't)
- ▶ Turn the self powered speaker or amplifier volume to about $\frac{1}{4}$ up and set the level on the mixer faders to 0 dB. Set the channel input level to where the green LEDS and yellow LEDs on the output level meet, then set the speaker for satisfactory listening volume.

Audio Lab

- ▶ Examine and critique various audio connectors
- ▶ Silver tarnishes, gold is expensive and only thin plating (though preferred for BNC pins), nickel is recommended.
- ▶ Professional XLR, Bantam, 1/4" Patch, BNC and 1/4" TRS
- ▶ Consumer RCA, DIN 5 pin, Mini plug, Toslink
- ▶ Consider surface material, strain and fatigue protection for cable, ruggedness, waterproofing, dirt resistance.
- ▶ Learn loop-in, loop-out method.
- ▶ Advantages of gaffers tape, unsuitability of duct tape.
- ▶ See http://education.lenardaudio.com/en/09_mix.html for an online course

Feedback (that screech from the PA)

- ▶ Feedback is caused by the microphone picking up the sound from the speaker sufficiently loud to cause the same or greater level of sound to come out of the speaker. Keep them apart and facing away from each other. Avoid reflective surfaces in their region.
- ▶ Flat response microphones and speakers can help reduce the feedback, these cost more.
- ▶ Using an EQ or other device can reduce the feedback. This is more work and may cost more.
- ▶ Having a space with a low decay time can reduce the feedback, however not everyone is prepared to modify their building, so the sound guy/gal has to make do as best as possible. Listen for near feedback ringing sound.

Audio level -18 reading, Peak & Average

- ▶ There is the simple solution to directly feed the audio into the streaming. However the mixer is most likely set up for the house sound system. The level is so as to avoid feedback which means that the mic level is low as shown here. A workaround for this is to send the content to AUX1 and AUX2 as stereo, monitor the level sent to the streaming to get good level as shown on the next slide.

Audio level 0 VU peak and average

- ▶ You can see the level reaching or peaking just over 0 VU. This is good for streaming. Higher level may result in the streaming software applying some audio compression which may last for too long. Broadcasters have their audio pass through a compressor-limiter, and so are able to send a higher level peak e.g. +6 which may have a yellow color and then +9 is an indication to reduce the level showing a red color.
- ▶ 0 VU on an analog mixer normally means a +4 dBm (decibels relative to 1 mW in 600 ohms, normally unterminated.) The signal clips at +18 or +20 dBm as the mixer is designed. Digital mixers clip at +24 dBm, which sounds quite harsh. PBS sets 0 VU as -27 dB relative to the digital peak. Some places use more than 27.
- ▶ The screen on the left is showing the left compared with the right level. At present left only is shown. Mono would be tilted anticlockwise. Stereo would be a wider blur. Out of phase on one channel would be tilted clockwise. Usually that is from a cable somewhere with the polarity reversed between the ends. Please find and fix that as it sounds worse.

Hum and ground loops

- ▶ Sometimes hum is a problem. This can be from faulty equipment, non-electronic fluorescent ballasts and ground loops. Lifting the ground can be a safety issue.
- ▶ Ground loops can occur when different sources for the power are used e.g. video projector and sound system
- ▶ If analog video is fed into a mixer, it sounds like a noisy buzz, not a hum
- ▶ Using balanced audio helps. Sometimes lifting the ground wire on the line level balanced audio, at the source end, helps. Sometimes using an isolation transformer on the audio helps. However cheap isolation transformers can pick up hum themselves by magnetic coupling. Isolating the power with separate ground is an option. Understand the Kaufman experiment with fault currents and Emerald Book IEEE.
- ▶ Cheap dynamic microphones and guitar pickups also can pick up hum from a fluorescent or a transformer

Microphones

- ▶ Dynamic mics work well and don't require power, the better ones are worth paying something for.
- ▶ Electret or capacitor/condenser mics can perform well, but need power and may not like high humidity.
- ▶ Wireless mics are usually dynamic. They have to use an unused radio frequency (usually a TV channel). The professional grade ones have the ability to scan for a free frequency and set that for the mic to use. Also they have diversity so the signal is much less likely to fade out. The best ones have digital transmission, but cost more.
- ▶ Specialized mics include lapel, head-mount and shotgun directional ones. Check their sensitivity and self noise level.
- ▶ Windscreens and popper stoppers help the sound, but they may not look as attractive. Vibration isolation may also be appropriate e.g. on a lectern.

Microphone Techniques

- ▶ Microphones should have flat responses, and speakers likewise, to minimize feedback. This is worth some expense.
- ▶ For PA use, hold the mic just under the mouth but pointing at it, and a constant but reasonably close distance. This avoids plosive sounds affecting speakers and excessive sibilance.
- ▶ For TV interviews, the mic can be further away, e.g. lapel mics, positioned so clothing movement noise is minimal.
- ▶ Musical instruments have special requirements, complex. The musician may require special positioning and stand.
- ▶ Wireless headset mics can be good for active singers, and professional ones are worth the expense. Ensure that the mic is not heard outside of the performance time.
- ▶ Mics should be in phase with each other and the speakers. A pulse tester can check this. Reversed connectors may be a problem.
- ▶ A 1/3 octave analyzer and pink noise can check frequency response, but adding an audience changes that. Waterfall (Time, Energy, Frequency) analyzers are best, but take time and money.

Analog and Digital Audio

- ▶ Actual sound is analog, a continuously varying pressure.
- ▶ Microphones and instrument transducers convert this to an analog audio electrical signal.
- ▶ Analog to digital converters translate this into a binary code, with a limit on the range. This may 16 or more bits. If the camcorder is set for less, make it 16 bit.
- ▶ The processing and recording may be analog or digital, but digital is much cheaper for the same quality.
- ▶ The digital signal may be data compressed e.g. MP3, which usually sounds acceptably good. Distortion of less than 0.7% is not usually noticeable. Avoid cascading compression systems as artifacts can be introduced.
- ▶ In the end, a speaker or earphone is needed, analog again

Digital Audio Synchronization

- ▶ Because digital audio is streaming data of samples, the sources and destination clocks need to be synchronized, otherwise samples will be dropped or missing and this will result in clicks in the output audio.
- ▶ There may be different sample rates, e.g. 44.1 kHz on CDs and 48kHz (or multiples thereof) in professional digital audio. Sometimes some other sample rates are used e.g. 8kHz on phone calls. There are sample rate converter chips which can accommodate this, but it is best to avoid this as artifacts may occur.
- ▶ The word clock needs synchronization with the video reference distribution, e.g. a common sync generator.

Other audio

- ▶ Sometimes audio may be from another source, musical instrument, phone hybrid, cellphone, DJ etc. These can require suitable adaptors, e.g. an electric guitar rackmount processor instead of their usual amplifier.
- ▶ Musicians may require suitable separate monitor speakers which feeds their instruments, use an AUX send on a mixer, with those inputs only up.
- ▶ Other processors may be used, these may be Insert devices on a mixer channel or overall PA mix processing. Any recording should be of the audio before the mix PA processing.
- ▶ Cellphones might have HD Voice, use that if possible. Otherwise phone audio is for basic voice quality only. See the Dapafone and teleconference by Skype, Polycom & others.

Amplifiers and speakers

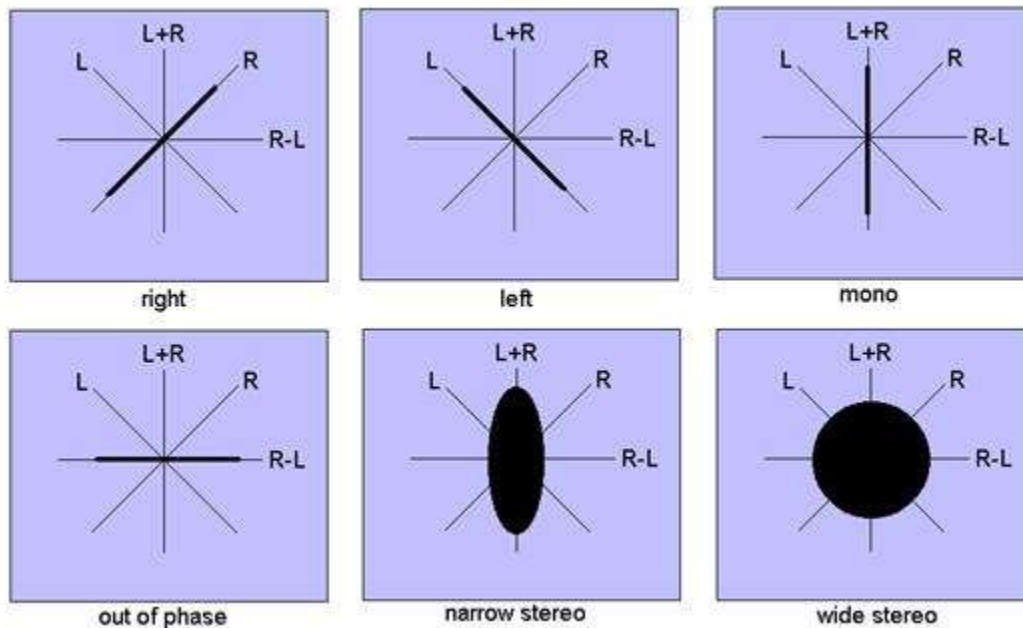
- ▶ Large spaces require power. This does cost something.
Check that the power rating is in RMS, if it is IHF or peak, the RMS is half that amount.
- ▶ The speaker should really be RMS rated for the power of the amplifier. If it is less, the speakers are likely to be damaged, and at the most embarrassing time. While lower power speakers are lighter and easier to transport, there is no free lunch.
- ▶ Different speaker types have different efficiencies and frequency responses, check the specifications.
Independent evaluations are better. Horn speakers are efficient, but have poor bass response. Non vented speakers may be higher power, but quieter.

Surround & Immersive Sound

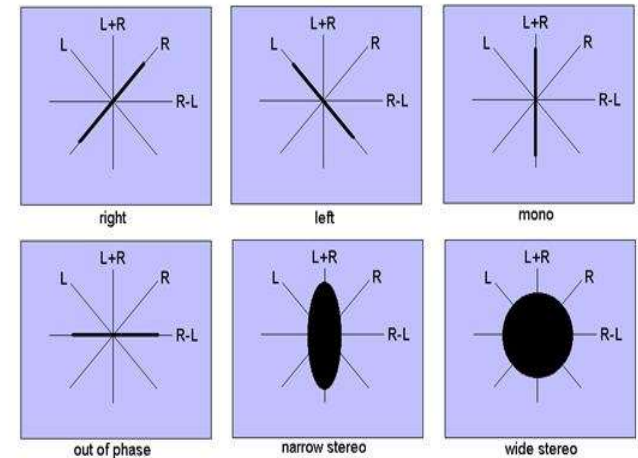
- ▶ With one person speaking, is surround needed?
- ▶ For music, stereo is important to give the spread of the band. Subwoofers help to give the bass punch.
- ▶ With wide screen video, HDTV has moved to 5.1 sound, usually Dolby encoded. L, C, R, LS, RS, with 0.1 being the subwoofer. The L and R speakers can carry bass information. In a small space one subwoofer is OK, but a large space should have left and right bass. Sales staff are not often aware of this point. The Dolby decoding configuration should match the amplifier-speaker system.
- ▶ Movies have more channels, but this is FYI.
- ▶ The multiple channels have mixer and video recorder issues, especially if multilingual translation dialog is added. Use 5 for surround music and effects plus 1 or more per language including original from the talent.

Sound monitoring

Stereo interpretation



Surround sound monitoring



Don't use a camera mic and a handheld mic for stereo, it sounds odd and should be rejected.

The Mixer, analog and digital

- ▶ Analog mixers can perform very well, unlike analog video.
- ▶ Inputs for channels may be mic, line, line stereo and insert
- ▶ Channels have a preset gain. Maybe a +48v and phase.
- ▶ Then EQs, start with them set flat. LF cut in for mics.
- ▶ Dynamics may be available, for compression, try without first and use as needed.
- ▶ Aux sends are for monitoring, reverb and other outputs.
- ▶ Pan is for Left-Right on main. Surround pan is uncommon.
- ▶ Mute and PFL/AFL for pre-fader/after fader listen
- ▶ Then the main fader. These may be motorized. A type that withstands coffee spills is preferable, but they cost more.
- ▶ Metering may be channel level or just a signal presence LED with orange/red for overload.

The Mixer, output section

- ▶ Output sections can vary. Some have USB to connect to editing software. Some are digital, if so, there should be a word clock or sync reference input to use with video which is digital.
- ▶ The main is usually stereo, but additional groups may be 2 or more channels e.g. for surround sound. These may have dynamics, multiband EQs (e.g. 1/3 octave). However recorded audio should be before the EQ. A 2 track tape in and out on RCA is common.
- ▶ Monitoring sections vary, maybe just a headphone volume
- ▶ AUX sends can have level per send.
- ▶ Some mixers have effects such as reverb and oscillator.
- ▶ Some mixers can have a musician monitoring unit also.

Channel controls



Overview



More detailed



Mixer Block Diagram



Mixer Lab

- ▶ Explore the different sections of various mixers.
- ▶ Using an oscillator, set a gain structure in a mixer and speaker.
- ▶ Use pink noise and 1/3 octave spectrum analyzer to examine EQs and room behavior.
- ▶ The uses of various buses and using aux for effects and mix-minus sends.
- ▶ Understand noise floor and THD (Total Harmonic Distortion) of clipping limit.
- ▶ Use a compressor limiter and average/peak level metering for higher level without distortion when transmitted for streaming or broadcast.

Sound Processors

- ▶ Many external audio processors are available.
Limiters/compressors, EQs, Delays to match lipsync and large PA delayed speakers, voice processors to add even harmonics (e.g. tube devices), surround processors, guitar and other music processors, reverbs.
- ▶ A low reverberation time space can have reverb and audience mics added to make it more live, but making it less live is very expensive on electronics, Lexicon did but not now available.
- ▶ Sound effects libraries may have the clip you need, or make your own sound of a better mousetrap, I did.
- ▶ Music for ambiance is available from many sources, but take care of copyright appropriately.

ESD (Electrostatic Discharge)

- ▶ The zaps you feel on a dry winters day can be damaging to electronics. These are examples of ESD, but weaker ones that you don't notice can still cause damage that may not be noticed until years later.
- ▶ All connectors should be ESD resistant, but the equipment inside ALWAYS needs ESD safe procedures.
- ▶ When passing a board or memory stick, touch the person first.
- ▶ Use grounded wrist straps, soldering irons, ESD safe bags and packing materials like pink peanuts, furniture, shoes and flooring.
- ▶ Grounding yourself before using a keyboard or mouse is helpful.

Lighting

- ▶ May be natural, local artificial or production lighting or combination. Demonstrate filter swatch. leather gloves.
- ▶ Color temperature varies, 6500 day, 3500 tungsten. This needs the white balance to be set in the camera.
- ▶ Fluorescent lights can make people look green in the camera but not in the eye, white balance does not correct this. It is a spectrum issue that filters can correct.
- ▶ The illumination angles and colors make for mood effects
- ▶ LED production lighting is becoming practical for camera
- ▶ Stage spotlights are mostly tungsten (incandescent), which requires kW and cooling. A dimmer system is needed.
- ▶ Lighting for TV includes monitoring the video waveform
- ▶ Use of lights and filters is art and science to study.
- ▶ Power connectors may be stage plugs which are flat.

Auditorium Design for Audio/Video

- ▶ The acoustics has been noted, but real auditoriums normally have basically parallel walls. Side zigzag or sawtooth wall additions help diffuse, but the lower frequencies are not affected because of their long wavelength. So absorption is needed also. Carpet is desirable, and absorbent ceiling tiles that are dark if visible from the stage.
- ▶ The front screen need not have a black border, and can have white surrounding which directed lighting can set the scene. House lighting may be on, but should be electronic ballast warm white installed so it does not illuminate the stage. The hall color should be dark. This lowers the ambient light on the screen for real black.
- ▶ A dimmer system needs power and adequate HVAC.
- ▶ Ambient noise should be minimized, e.g. HVAC & kitchen

Video Processes

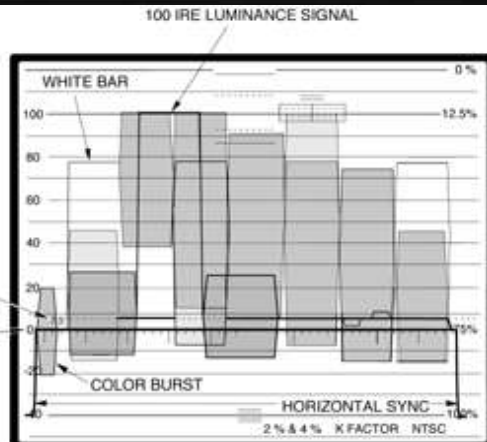
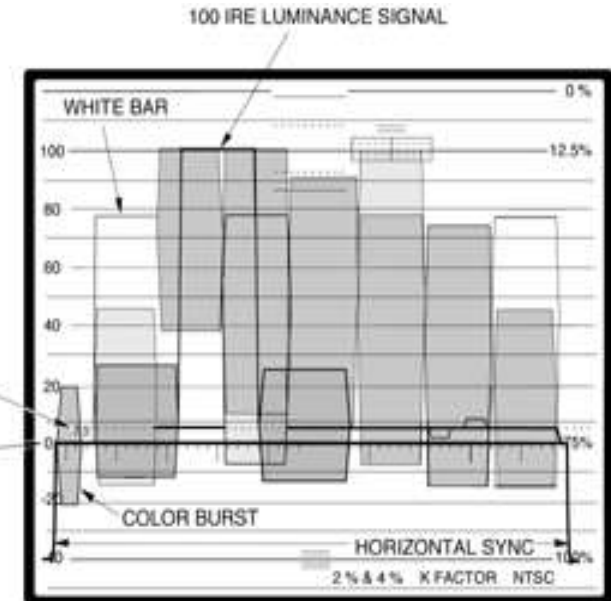
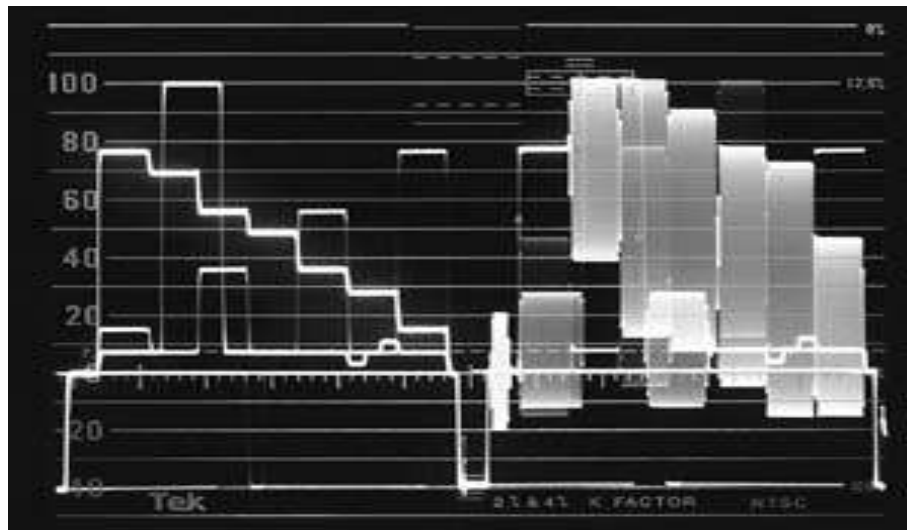
- ▶ Pre-production. Book, script, storyboard, talent budget and equipment planning, timing plan, sponsors & credits, costumes and set prep, copyright, promotion
- ▶ Production. Get equipment set up on location, one or multiple takes. Logistics. Making a movie is like writing a book, but you are using a 5 ton pencil. Continuity
- ▶ Post-production. Editing/mixing audio and video, computer graphics and SFX. Foley sound or narration
- ▶ Master Control 24/7 or other origination of various contents, DVD or BD, tape release
- ▶ Transmission Over The Air, cable, fiber, satellite, internet
- ▶ Consumer electronics radio, TV, computer, smartphone

The Video Signal, analog composite

Luminance,

Luminance & chroma

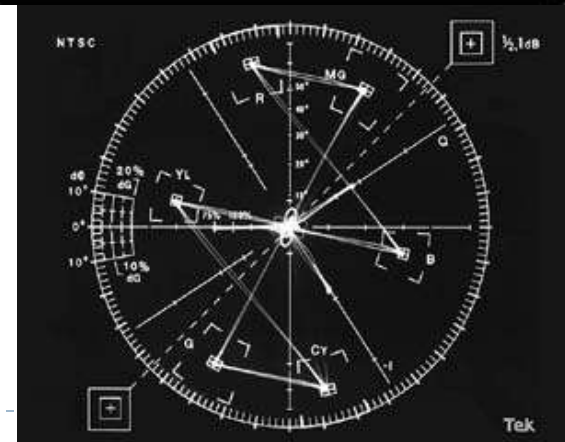
explanation



Note 7.5 setup
on NTSC

SMPTE Color
Bars

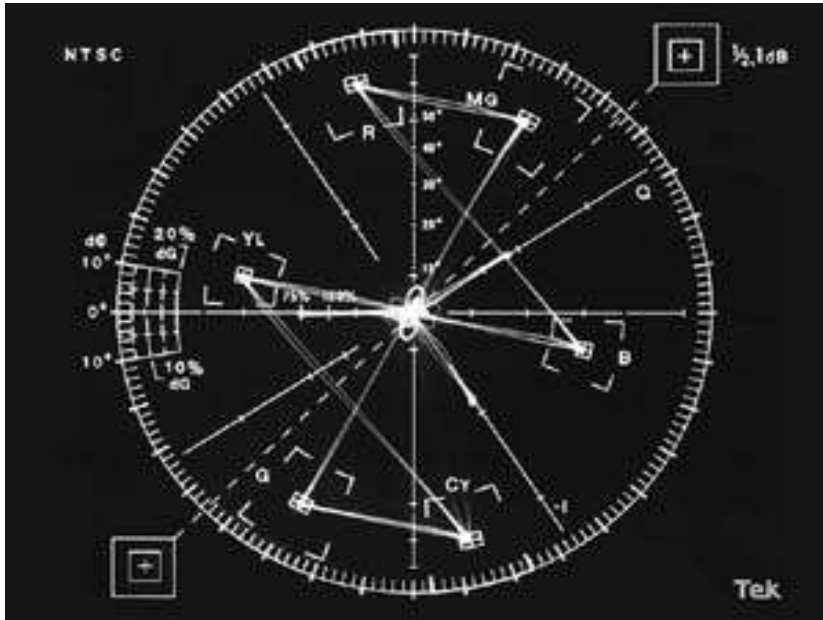
Vectorscope
display



Observe on previous slide

- ▶ The 100 IRE white at the bottom & zero value
- ▶ The 7.5 IRE setup for NTSC composite
- ▶ The -40 sync, and 40p-p chroma burst
- ▶ Front porch and back porch
- ▶ Gain and EQ adjustments
- ▶ The bottom dark (invisible) and light (visible) bumps
- ▶ The chroma burst on the vectorscope
- ▶ The chroma magnitude & phase rotation on vectorscope
- ▶ How to adjust timing for SC/H precision using magnify
- ▶ The I and Q at 90 degrees
- ▶ Why chroma is on 75% bars, to limit level to transmitter
- ▶ Use of blue button or filter for bright, contrast, color and chroma adjustments on a monitor. R, G or B saturation effect.

Video, Digital, this is component YPbPr



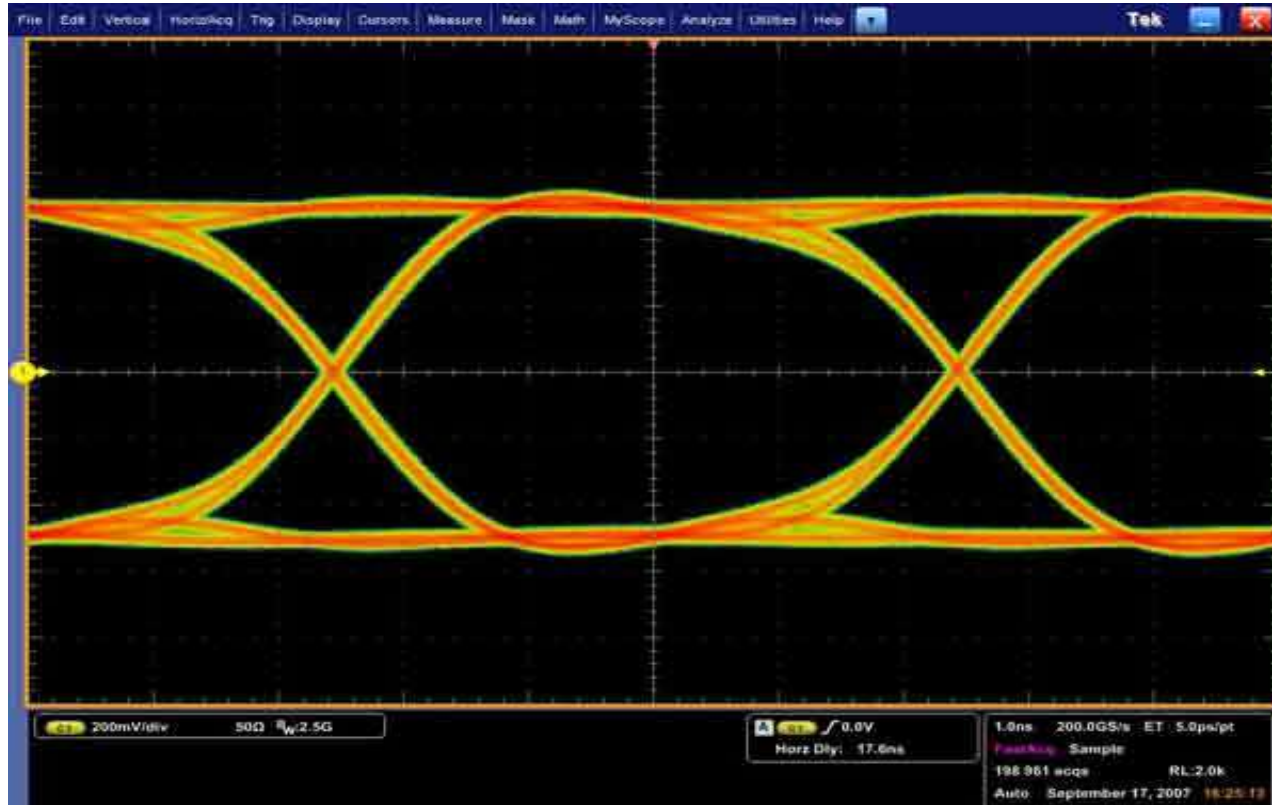
0s and 1s, difficult to use. Data may be 270, 1480 or 2940 Mb/s for video on BNC and coax cable. The data is Y (luminance), Pb (blue-luminance) Pr (red-luminance). RGB (red green blue) is also used in graphics and displays like VGA analog, DVI digital

How wide and how high is the eye? This one is good. A jitter value and spectrum is also useful. Jitter may be caused by hum, lightning, EMI, crosstalk and other noise including thermal. Too small an eye results in the “digital cliff” effect.

Video Waveform Lab

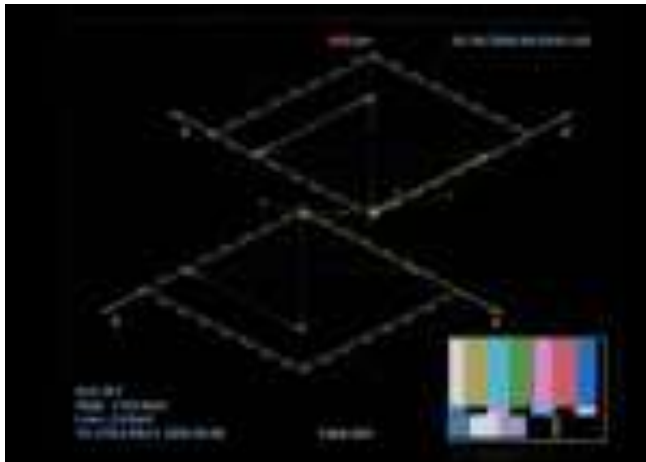
- ▶ Measure composite analog and digital component waveforms using test and live video.
- ▶ Set chroma phase on vectorscope and a monitor

Jitter Spectrum



Video component, analog not used now.

- ▶ The legality of colors is important. The split diamond is one method.
- ▶ CG can create illegal colors.



With cinema or 4K video, HDR (High Dynamic Range) and WCG (Wide Color Gamut) are also possible.

Color Sampling methods

- ▶ 8 bit or 10 bit (sometimes more) per sample. HDR and WCG
- ▶ Samples as per Y (luminance), Pr (Red-Y), Pb (Blue-Y)
- ▶ Fewer chroma samples as the eye has less resolution for chrominance.
- ▶ 4:1:1 color difference sampled on all lines at quarter luminance rate
- ▶ 4:2:0 color difference sampled on alternate lines at half luminance rate
- ▶ 4:2:2 color difference sampled on all lines at half luminance
- ▶ 4:4:4:4 color difference sampled on all lines at luminance rate plus alpha or key sample

Color Sampling Diagram

4:2:2		4:2:0		4:1:1	
Y, Pr	Y, Pb	Y, Pr	Y, Pb	Y, Pr	Y
Y, Pr	Y, Pb	Y	Y	Y	Y, Pb

4:4:4		RGB	
Y, Pr, Pb	Y, Pr, Pb	R, G, B	R, G, B
Y, Pr, Pb	Y, Pr, Pb	R, G, B	R, G, B

4:4:4:4	
Y, Pr, Pb, α	Y, Pr, Pb, α
Y, Pr, Pb, α	Y, Pr, Pb, α

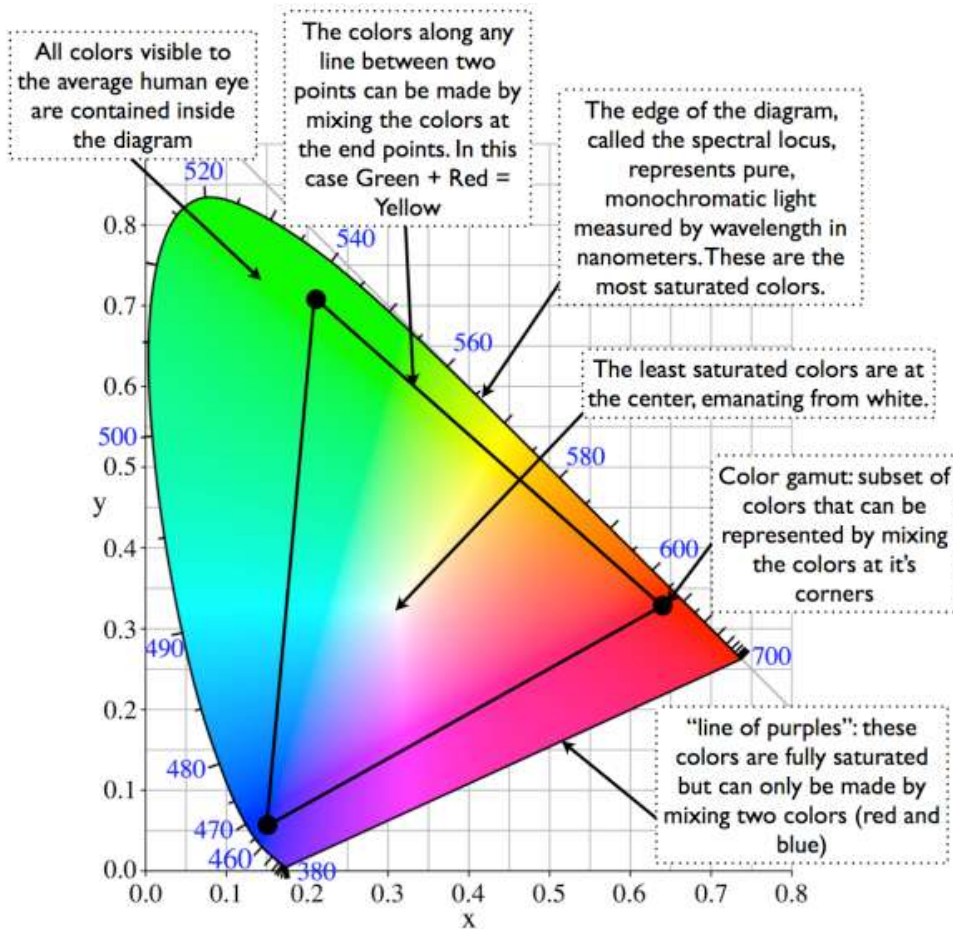
Digital Video Eye and Jitter Lab

- ▶ Examine the eye pattern of digital video
- ▶ Examine the jitter of digital video with different bandwidths.
- ▶ Examine the jitter spectrum of digital video
- ▶ Note SMPTE RP 184 for SD 270 Mb/s ITU-R 601 and HD 1.465 Gb/s ITU-R 709, and if possible, double that “3Gb/s”

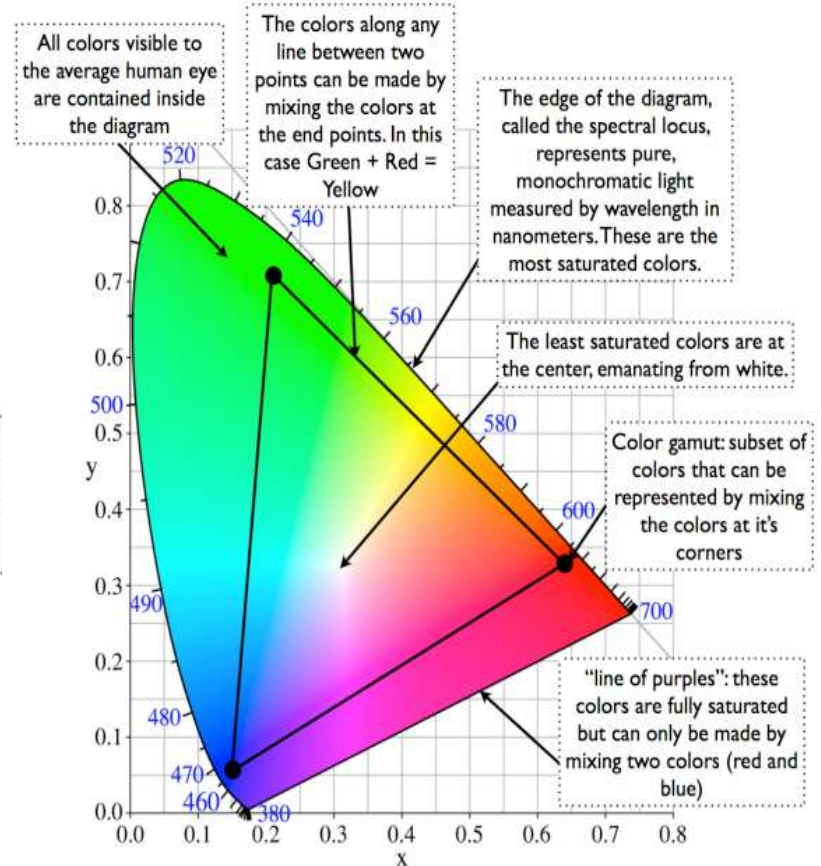
Video formats, limited selection.

- ▶ 480i29.97, NTSC based SD
- ▶ 576i25, PAL and SECAM based SD, 78% of world
- ▶ 720p60 based on computer display of PCs HDTV
- ▶ 1080i29.97 ATSC based HDTV
- ▶ 1080i25 EBU HDTV
- ▶ 2k4k UHD TV not commonly broadcast, a film format
- ▶ i means interlaced with 2 fields, p means progressive
- ▶ Timecode is 24 film, 25 PAL/SECAM, 29.97 ATSC (30 not really used) and 48 for some movies, and 60 (really 59.94) ATSC
- ▶ 29.97 and 59.94 timecode usually DF (drop frame) to get 1000/1001 division but may be ND (non-drop)
- ▶ Timecode is essential to good editing. Audio and video edit control uses this in EDLs (Edit Decision Lists).
- ▶ Based on this data, there are various compression systems, MPEG-2, MPEG-4-AVC+H.264, MPEG-4+H.265 now, cinema and proprietary
- ▶ Aspect ratio 4:3 for SD, 16:9 for HD, 2:1 or other for movies

Video color gamut, CIE 1931

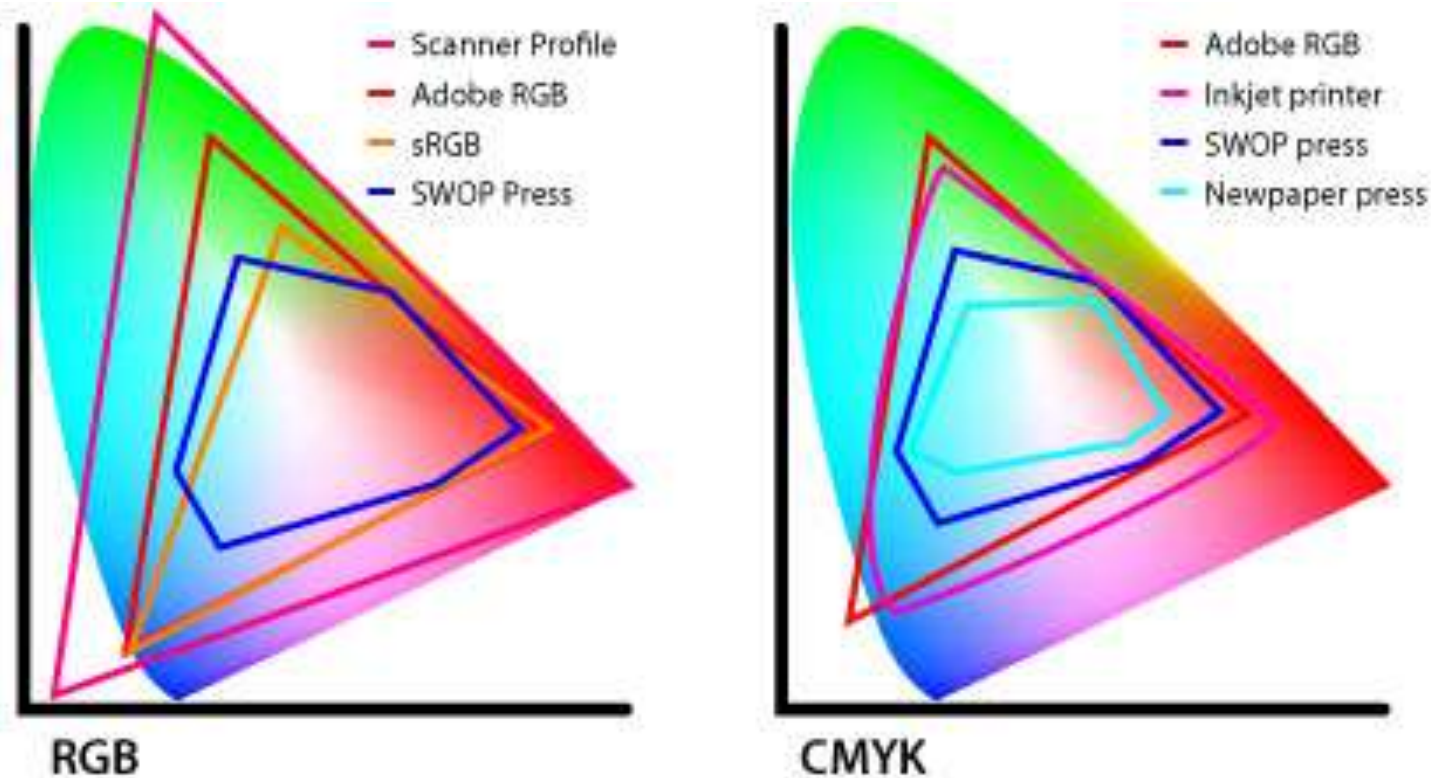


Anatomy of a CIE Chromaticity Diagram



Anatomy of a CIE Chromaticity Diagram

Gamut comparisons, scanner and printer



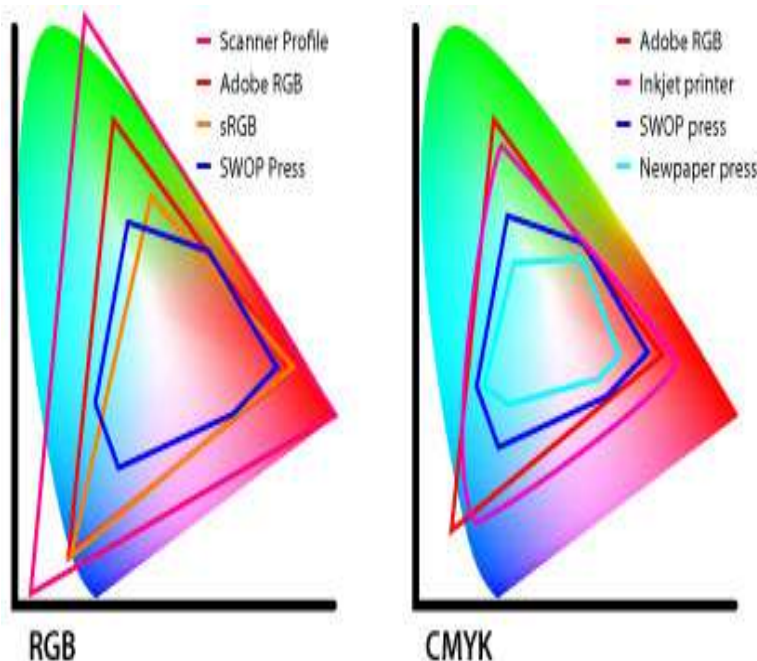
The ITU-R 601 is for PAL and NTSC component, and ITU-R 709 HD

http://www.sony.net/SonyInfo/technology/technology/theme/xvcc_01.html

Charles Poynton, Mark Schubin and color meters from vendors available.

The Eye

The eye has a logarithmic iris characteristic, but the rod and cone sensors have a 100:1 luminance range, hence 0 to 100 IRE luminance works well. So 8 bit video works to the eye. However 10 bit video camera, recorder and processing is better as some sorts of processing result in striations or banding in shade changes.



Cameras

- ▶ Some photo cameras also do HDTV, however the shot duration, audio input and others limit the capability
- ▶ HDTV zoom lenses cost money for a decent zoom ratio and image stabilization. Do not consider electronic zoom. 10:1 is too limited
- ▶ If a microphone jack is available, an adaptor for XLR is available from Beachtek. Don't consider camera mic only. Multilingual recording?
- ▶ The video out is important. Firewire (iLink), HDMI and BNC SD/HD are important. Analog out is only for SD monitoring.
- ▶ Flash drives for HDTV are now realistic, and more reliable than transport mechanism. However the recording duration is important.
- ▶ Professional cameras also have timecode, monitor in, intercom, remote CCU (camera control), sync for multicamera shoot and better zoom. Monitoring of waveform to control the aperture. Zoom & focus use. Sports use 100-1 zoom with stabilization.
- ▶ Cinema 2k4k cameras are now becoming used for TV.
- ▶ The tripod/jib/steadycam needs consideration for the smoothness, steadiness, and ease of cameraman use. A short tripod doesn't get over the heads.

Camera Lab

- ▶ Become acquainted with setting the focus, zoom, iris and white balance of a camera.
- ▶ See how the depth of field varies with the iris. Understand that a larger depth of field therefore requires a considerable amount of light. While increasing the gain compensates for lower light, it adds noise in the dark areas.
- ▶ Become acquainted with the video, audio, reference, timecode, remote control, monitor in and intercom connections of a camera.
- ▶ Cheaper cameras have poorer color accuracy, but 3 sensor ones are better. Some single sensor ones have high quality filtering, but that is more expensive than normal ones.
- ▶ CCDs were normal but now MOSFET sensors are getting better. Larger sensors are better for higher resolution, but that also means larger and more expensive lenses.
- ▶ Keep it clean and dry.

Editing system, nonlinear only now

- ▶ Audio needs consideration. Dialog multilingual? Music & effects
- ▶ There are many vendors listed in Wikipedia. However Avid sells quite a range of professional systems. Quantel is the high end, and not even mentioned. Many are from camera vendors, but may have limitations with other vendors equipment.
- ▶ For HDTV, an adequate quad core PC with large RAID and dual display graphics is important. This costs perhaps \$4000 and the software may cost \$1000. So cheaper software is not much of a saving. Adobe Premier Pro CS6 is current, and has good graphics integration.
- ▶ The library might have a book, but then it may be for analog A/B roll tape editing using linear edit control. The technology develops quickly and needs to be worked for a return on investment.
- ▶ What is the EDL format, MXF, BXF or proprietary?
- ▶ What control of external devices? I/O formats HDSDI, HDMI?

Editing Lab (if available)

- ▶ Become acquainted with the timecode, timeline and other editing functions to produce video to a specified duration.
- ▶ Become acquainted with the video graphics capabilities.
- ▶ Become acquainted with the audio editing capabilities, mixing, whether noise reduction is available, other audio processing.

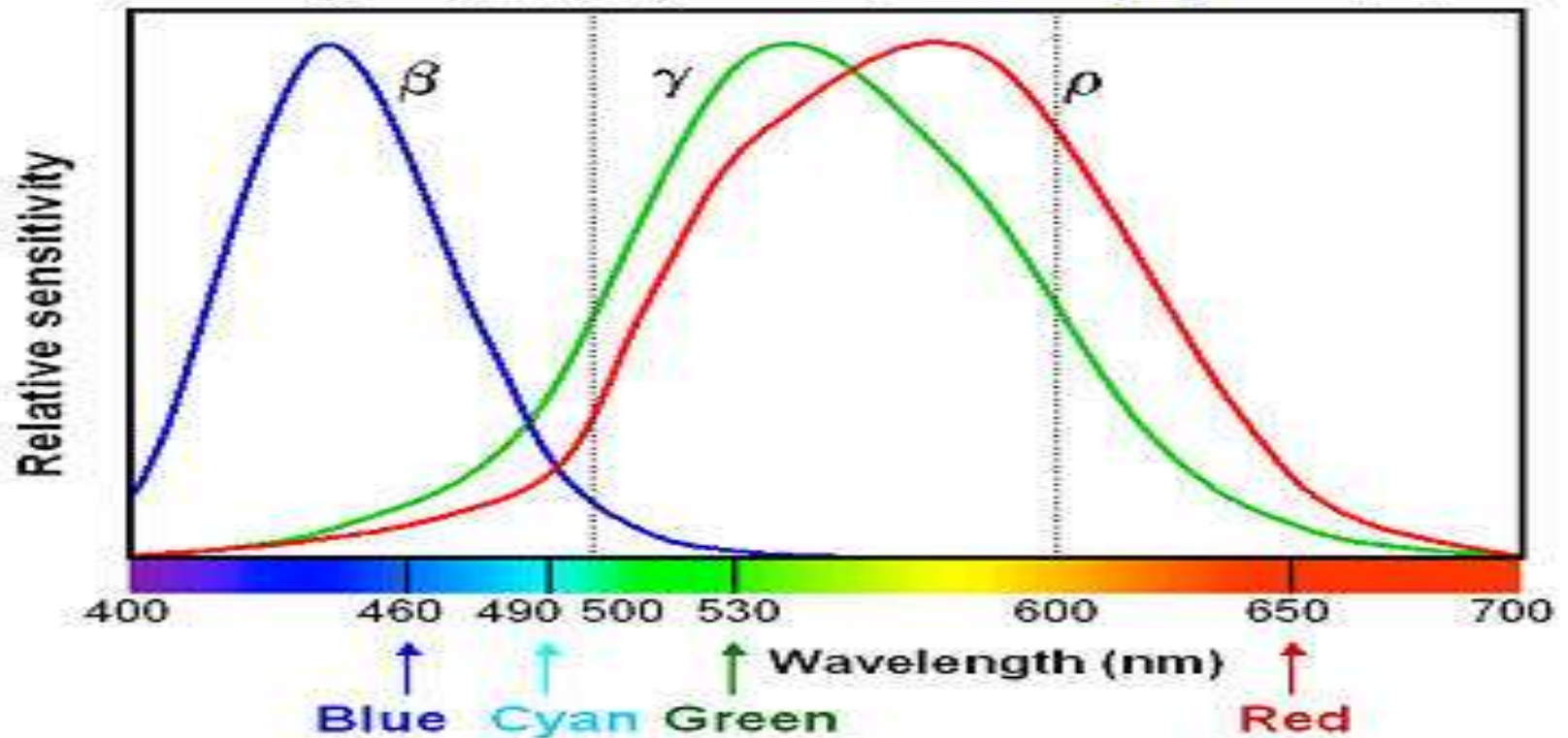
Video Switcher

- ▶ These are now all digital. Studio and broadcast ones are using synchronized sources. Industrial/Prosumer ones have a frame sync on the input for non-synchronized sources. This adds to the processing delay which can make the audio ahead of the video, which is a lipsync problem and causes tension in people.
- ▶ Some include the ability to upconvert an SD input to HD.
- ▶ Two buses with a transition lever is normal. There may be additional buses for source selection for other uses e.g. DVE and videowalls.
- ▶ DVE to resize a picture, keying e.g. for green/bluescreen and additional graphics, stillstore of photos or graphics are other features.
- ▶ SD is for small budgets, and HD is becoming affordable and what the public expects for quality. The old equipment is not a good investment. However 1080 or 720 is not an obvious choice, so flexibility is desirable.

Video Switcher, software

Human spectral sensitivity to color

Three cone types (ρ , γ , β) correspond *roughly* to R, G, B.



Video switcher, hardware



Video Switcher and DVE Lab

- ▶ Become acquainted with the switching and wipes abilities.
- ▶ The uses of the various buses.
- ▶ The DVE function
- ▶ Keying on luma and chroma.

Video synchronization

- ▶ Actual video signals are serial with pixels then lines in sequence. So video equipment needs to be synchronized.
- ▶ This is done by a sync generator, which is video black in the selected standard and may also generate timecode and word clock for digital audio synchronization. HD may use a tri-level sync signal.
- ▶ Any unsynched video source to the switcher has to pass through a frame sync if it is the same standard or a standards converter if it is not. If SD is converted to HD at the same frame rate, the standards converter is called an upconverter and the aspect ratio decisions have to be made as to letterbox, sidebars or stretching. Notice how there have been a lot of fat people on TV the past years? They were stretched sideways in upconverters.

Closed Captioning

- ▶ For the benefit of deaf people and those in bars and laundromats, closed captioning is used (a legal requirement also).
- ▶ In the U.S. There is EIA 608 for SD and EIA 708 for HD.
- ▶ In Europe there is the Teletext system which has “subtitling”. However it is a pixel system not a data system.
- ▶ Japan and some other countries have the OP47 system which is more complex than 708 for Asian alphabets, but China is using 708 as it supports Unicode.
- ▶ Adding the captioning is employment for disabled people at home.

Playout

- ▶ There are many playout systems. The original ones had Master Control operators changing tapes in VCRs.
- ▶ Now there are disk based systems called video servers, into which the content has to be ingested first. While this may seem an added complication, usually video is played a number of times on a 24/7 basis.
- ▶ After the video is played, it passes through keyers which add the station bugs, logos, sports stats, EAS (Emergency Alert System) and other screen action.
- ▶ These keyers can have their sources changed. An alpha is the key signal.
- ▶ The disk based playouts may be attached to an archive system, which may be a data store or an LMS (tape jukebox).
- ▶ Sometimes videotape jukeboxes are used, but these are more expensive than technology developed for the IT market.
- ▶ The ability to handle live feeds is important to consider.

Automation and traffic

- ▶ Broadcasters and cable channels have the playout controlled by an automation system. There are quite a variety of these ranging from single channel playout, adding redundancy for reliability, to systems that may be controlling over a dozen with triple redundancy, i.e. maybe 40 playlists.
- ▶ The basic playlist is controlled from the traffic department which selects the air time of every item that is not manually initiated. Segments, spots, bug changes, etc.
- ▶ Manual control is provided for sports as the game may start late (though filler is normally used), end late with overtime, or late breaking or live news items.
- ▶ The automation system is controlling all the other devices.

Workflow

- ▶ Originally, tapes were played by operators or TV was live.
- ▶ Then automation systems controlled the tape machines and operators supervised and perhaps changed tapes.
- ▶ Video servers controlled by automation followed. The material had to be ingested and deleted.
- ▶ However Video, Audio and metadata became separate objects, so MXF then BXF standards were developed.
- ▶ Data tape archives may be used. So the workflow may be Ingest, Edit, Transfer to Archive, Automation transfer to server, Playout (perhaps advance and redundant), Deletion. What gets done defines the architecture.

Transmission

- ▶ Having produced the video, it needs to be delivered. Normally this is broadcast by redundant means, even over the air may have a backup transmitter and tower available. This was a problem for some broadcasters after 9-11.
- ▶ Fiber, satellite, microwave and coaxial cable is used.
- ▶ Internet streaming is also used, but the delivery reliability is best effort as bursts of data can cause congestion which causes the video + audio packets to be lost. Some vendors provide higher delivery reliability by guaranteeing an available bandwidth, but they charge for this.
- ▶ Cisco have a bandwidth manager if you control the network, so teleconferencing video quality can be provided.
- ▶ It is possible to bypass internet audio with a phone call as a backup if this is prepared for beforehand.
- ▶ Video transmission is now normally compressed using MPEG (latest is H.265 a.k.a. HEVC) or other systems. Netflix/Google uses VP9. Multichannel systems may be fixed bandwidth mux or statistical mux. This is a whole subject itself.

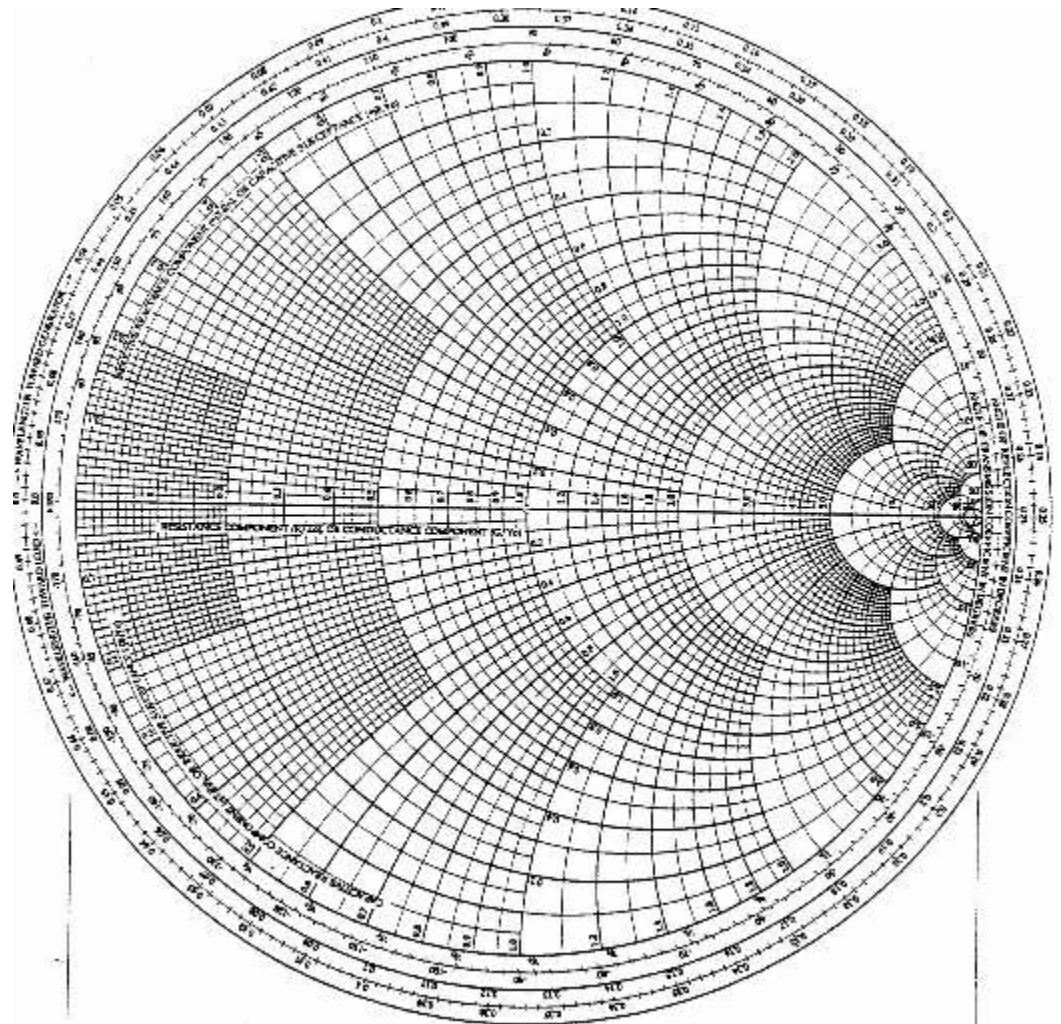
Transmission Lines (are only analog!)

- ▶ Wires may be pairs, coaxial, waveguide or fiber, plus shield
- ▶ Have characteristic impedance in Ohms Ω , may be reactive (i.e. have imaginary number component) Z_0
- ▶ Where $Z_0 = \sqrt{(R + j2\pi fL)/(G + j2\pi fC)}$ or $\sqrt{L/C}$
- ▶ R resistance, G conductance, L inductance, C capacitance per unit length.
- ▶ An impedance transition causes a reflection and less energy to the far end.
- ▶ Attenuation is dB/length (e.g. 100m) and usually increases with frequency.
- ▶ Cables are wires with shield and perhaps other wires.
- ▶ E.g. single coaxial cable undersea with bidirectional communication plus power for amplifiers (tube or transistor).

Smith Chart and imaginary operator

$i^2 = j^2 = k^2 = ijk = -1$ imaginary operators i, j, k

- ▶ Center is no reflection
- ▶ Outer is 100%
- ▶ Top inductance
- ▶ Bottom capacitance
- ▶ Left short
- ▶ Right open.
- ▶ This is an introduction only.
- ▶ Google “Smith Chart”
- ▶ Vector Network Analyzer measurements
- ▶ $V_r/V_i = (Z_L - Z_0)/(Z_L + Z_0)$



Teleconferencing

- ▶ This can range from two or multiparty Skype.biz (10 max with Premium) to full productions at multiple locations.
- ▶ Video type equipment may be on internet e.g. (Tandberg/Ericsson), this has full voice bandwidth. Skype or Polycom soon will interoperate with HD Voice. Polycom works well but may involve custom installing by vendors.
- ▶ Smart whiteboards are sometimes used. File sharing.
- ▶ Echo cancellation is important, but with PA may result in the source audio being muted. Use a mix-minus on AUX to feed the remote(s) and minimize feedback. Mute non-speakers.
- ▶ Recording for subsequent playback may be needed.
- ▶ Cisco TelePresence Bandwidth Management
- ▶ MPEG-4 +H.265 (HEVC) coming.
- ▶ KITD.com, Vidyocast.com, Streambox.com, but interoperable?
- ▶ Check bandwidth wireshark, wildpackets, or winpcap or other

Lipsync

- ▶ When the audio and video are not in a timing relationship which is not natural, this is a loss of lipsync.
- ▶ Humans are used to the delay of audio when the action is distant.
- ▶ However the complex processing of video usually delays that and the audio needs to be delayed to be in time with the video. Keeping this organized is an engineering task as operators are not expected to be tweaking this moment to moment.
- ▶ There are various technologies to assist in this.

Live Video

- ▶ For viewer satisfaction, this is normally a multicamera shoot, or news with cutting back to the anchor.
- ▶ The delay through satellite transmission is a minimum of 0.7 seconds, but as this is compressed video nowadays, it may be several seconds.
- ▶ To reduce this, it is bypassed with fiber or microwave with low latency compression or uncompressed video.
- ▶ The intercom may also bypass the delay.
- ▶ This delay adds to production operational complexity as automation systems are to be considered also.
- ▶ Action replay and slomo require special equipment

Projectors & Videowalls

- ▶ Projectors require low ambient light for black. Contrast 1000:1 is 10 bit video, but 256:1 is 8 bit and normally OK
- ▶ LED Videowalls are good for daylight as the surface is black. 4:3 aspect ratio, but 3 high, 4 wide is 16:9 (5 high 6 wide OK?)
- ▶ The black border is not needed any more, was for film.
- ▶ Electronic keystone correction may cause artifacts on fine text and graphics, try tilting the screen or raising/lowering the projector if not obstructing much view. Rear projection?
- ▶ Screens can have directional reflectivity, use appropriate.
- ▶ Bigger means more lumens needed 2x size, 4x lumens.
- ▶ High lumen projectors may not have video motion performance or good color gamut. Aim for 4k+ lumens large.
- ▶ Check input switching DVI, VGA, HDMI, HDSDI, audio
- ▶ Purchase with spare bulb, or pre-approve purchase. Warranty?
- ▶ Check size for space, and ability to shut off screen lights.
- ▶ Is the bottom of the screen at or above standing eye height?
- ▶ Redundant projectors in case of failure during event

Intercom

- ▶ The producer, TD (technical director), talent, cameramen (who may be female), audio ops, gaffers and others need to be working together and this is with an intercom system.
- ▶ It is not a big party line, though simple systems may be.
- ▶ IFB is to the talent, as they reply on mic or by nodding or shaking the head. They do not get their own voice back in their ear. This may be done using a mix-minus as a source.
- ▶ Other terminals are usually bidirectional. May use CAT5.
- ▶ Phone lines may be used, wired or wireless intercom., cellphones. Wireless on 2.5 GHz may have limitations
- ▶ The intercom may be part of a public phone-in system, or that may be a separate system, e.g. Gentner
- ▶ The intercom may be part of an AES router, Riedel.

Talent

- ▶ They are not just acting a script. For example, at a school bus crash in Brooklyn, the reporter was giving a report and the next break was coming up. The producer told the reporter this and asked if they could wrap it up in two minutes or if they would need more time. The reporter gave a nod. The producer said “we will count you in”. 1:00, 45, 30, 25, 20, 15, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1. The video for the spot rolled and the reporter composed and delivered the narrative concluding a second before being cut off. Do you think that you could do that? I couldn't, but they are paid to deliver not just the interesting news but also the advertising income. Everything said is logged as evidence as sometimes court cases arise from news reports.
- ▶ Overall appearance/action needs eye candy appeal.

Gaffers, CG and Grips, what do they do?

- ▶ Grips hold and move things as required (movie camera)
- ▶ Gaffers set up and strike. They use gaffers tape which can be removed without leaving a mess (no duct tape!)
- ▶ Cables are spooled on a reel or in loops with loop out, loop in alternating so the cable is not all twisted.
- ▶ They may also do off-camera people management, so need to be courteous.
- ▶ The talent may need refreshments in the green room while waiting
- ▶ The CG or Chyron has an experienced operator who knows about TV line sizes and transition timing.

Safe Areas, Gamma and 3D

- ▶ A video may be shot in 16:9 but later broadcast in 4:3, or shot in 2:1 and later broadcast in 16:9 (or 4:3).
- ▶ The screen area for the action is less than full screen, and the smaller areas are also marked. Otherwise the on-screen action may be interacting with off-screen to the puzzlement of the viewer,
- ▶ The screen area for the graphics is less than the smallest action safe area, so it is never off-screen.
- ▶ Displays, cameras and film do not have a linear voltage/brightness relationship. This is called gamma and the management of this is important to match that needed.
- ▶ 3D is not easy to do properly, so call a professional who has studied that. Getting the graphics correct for the video is an example. Poor 3D causes headaches.

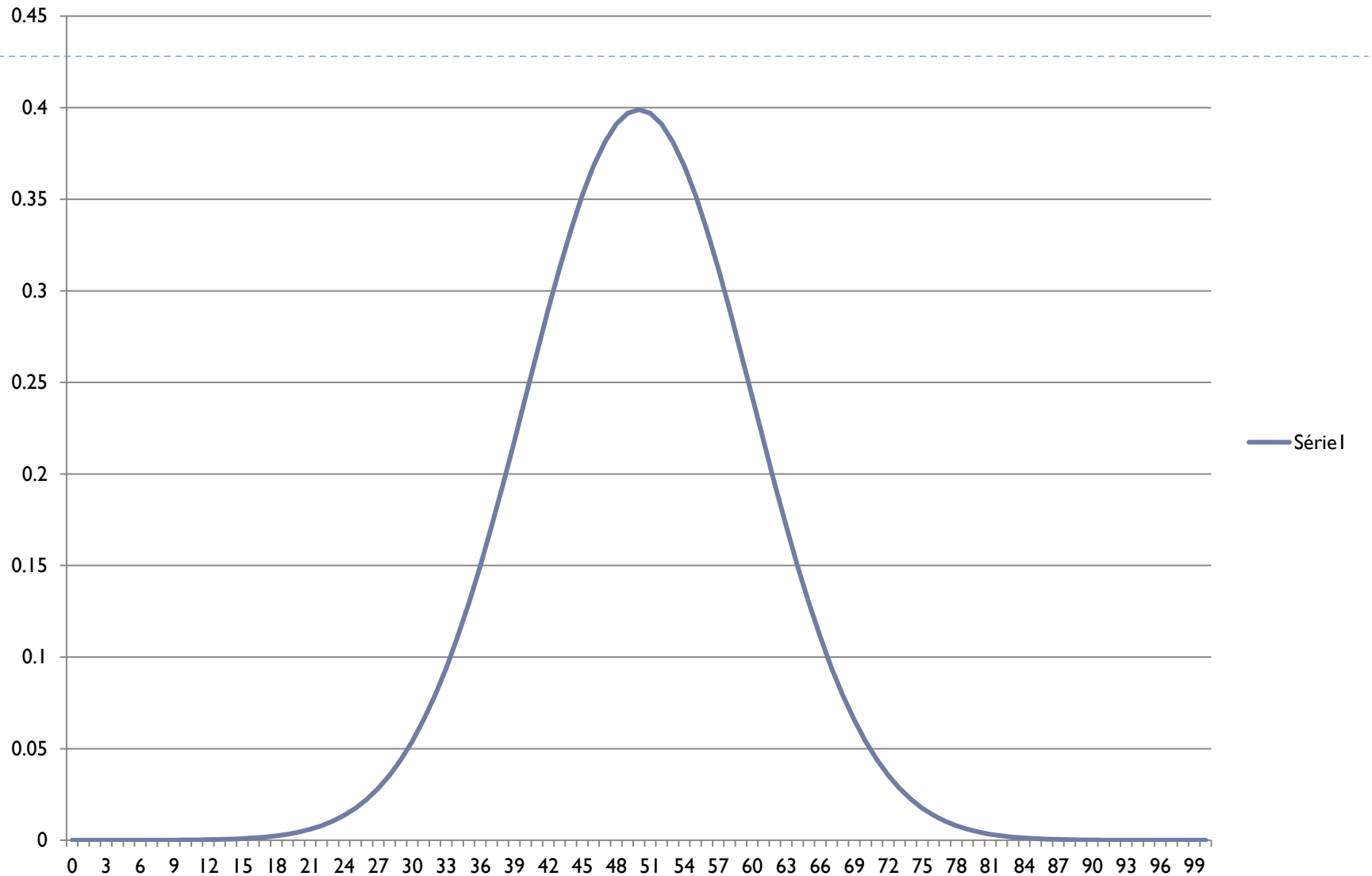
Power and reliability. Broadcast 99.999%

- ▶ This is another whole area and lesson but in brief;
- ▶ Power and security and reliability problems need to be addressed and the producer or manager needs to decide what is an appropriate expense.
- ▶ On the other hand, are you going to be the person who did not bring a spare bulb for the projector?
- ▶ Having additional equipment as spares is more expense and schlepping, but when the mixer fails, a smaller spare is really important for the show to go on.
- ▶ Quality production facilities include generator, transfer switch, UPS and other security & reliability measures. Electronics loads on 3 phase can have double the neutral current and problems. Generators stability is important for UPS loads. Are Cam-Lok plugs appropriate? They are usually 400A 600V.
- ▶ Broadcast quality means 105°C electrolytics and maybe even being able to replace the fan or power supply without having to stop using the unit. RAID arrays can fail, not just drives.

Quality of Workmanship

- ▶ To deliver 99.999% uptime requires not only reliable and redundant equipment, but also workmanship quality.
- ▶ Connectors are usually crimped instead of soldered, but different manufacturers, tools and operators have different quality. A complex installation has lots of connectors and defects may take years to become apparent. Data cables should be 100% tested with full bandwidth testers, cheap cables may be copper plated and unreliable. MIL-SPEC cable staff are high quality, but rare.
- ▶ Your personal life should be a six sigma lifestyle, high quality for everyone.
- ▶ Broadcast – you come on time, perform well, get paid well, and are not a problem for management. Talent understand this despite appearances also. E.g. John Denver doing Arbor Day recording. Working with Woody Allen.

Six Sigma, The Normal Curve



Six Sigma explanation

- ▶ Measure the σ or SD (Standard Deviation) for samples.
- ▶ See how 6σ compares with the control values, allowing for variation in the average if appropriate.
- ▶ If the result is inside the control values and management is accepting the performance, then the process can be considered under control. 6σ should result in about 3.4 defects per million samples.
- ▶ If the process is not under control, then consider the Pareto Principle, which may be considered in one form as that 80% of the problems are caused by 20% of the root causes. Eliminate the root causes and if the result is acceptable, OK. If not, repeat the process.
- ▶ Also look for the nature of a histogram plot of the values for normal shape.

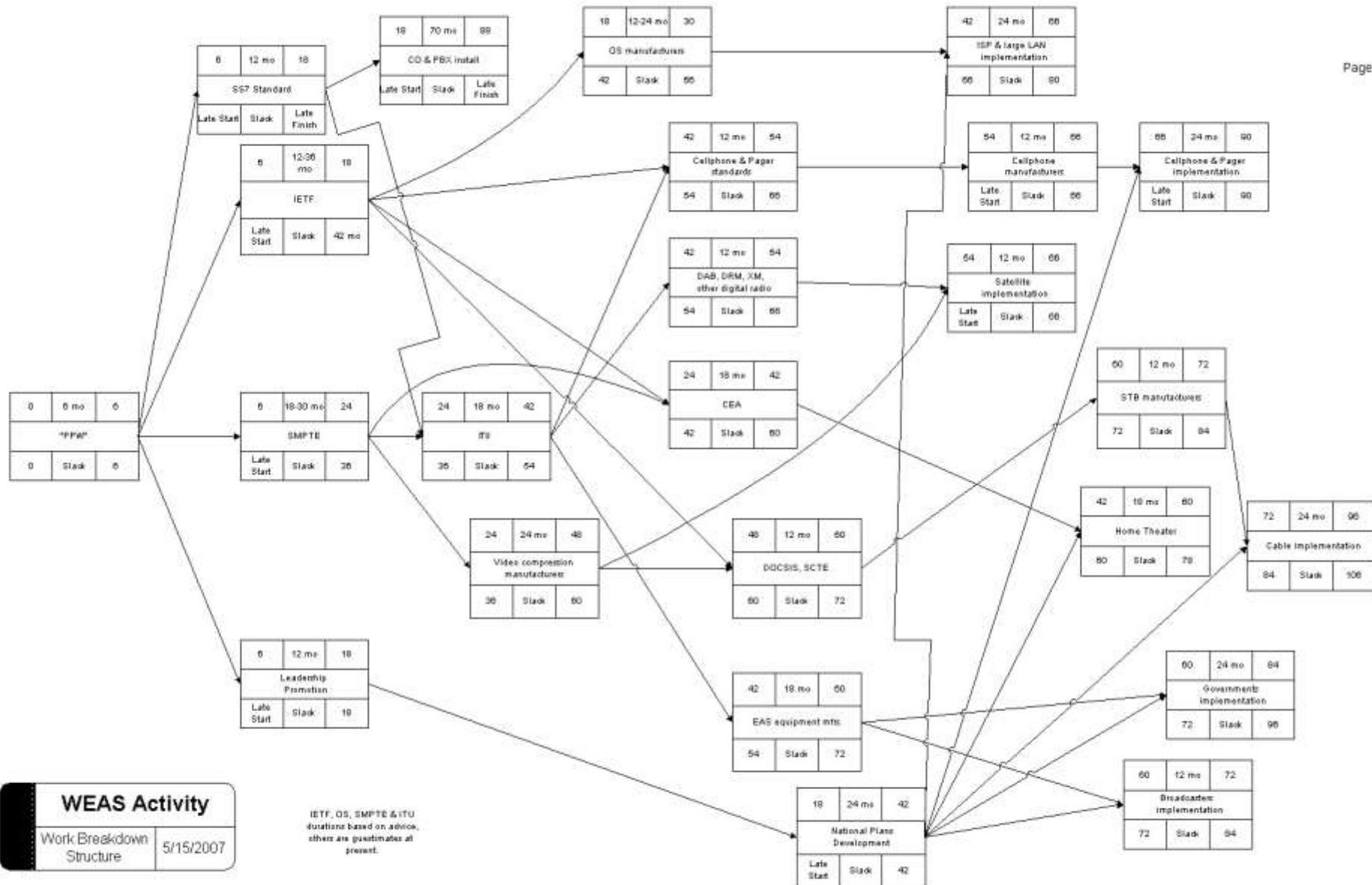
Six Sigma

- ▶ $S = \frac{\sum_{i=1}^N (Xi - M)^2}{(N-1)}$ where i is the sample, N number of i , M mean value
- ▶ A histogram is a bar chart with the number of samples in equal size ranges added making perhaps 20 bars on the x axis base.
- ▶ Beware of a) 2 or 3 points near the control limit, b) runs of 7 or more consecutive points increasing or decreasing, c) periodic cycles that are not explained by time of year, temperature during day, etc. d) trends from start to finish like a set point is drifting.
- ▶ Use of a chart of Z value and the probability of the tail illustrates this. Excel has such statistical functions, see example spreadsheet.

Project Management

- ▶ This is a specialty of the Project Management Institute (www.pmi.org), though Infocomm.org also relates to this.
- ▶ With the stakeholders, define the requirements. Develop the budget based on the required equipment, consumables, time and resources. Check that technical compatibility is assured. Check that the budget and requirements are satisfactory to the stakeholders, and adjust as needed. A deposit or prepayment may be appropriate. Address critical path items in a timely way.
- ▶ Complete the service in time, which may be limited in available time at the venue, allowing for backup for equipment problems. Allow for last minute program and material changes. Strike inconspicuously before conclusion, securing valuable but small items (mics, laptops, etc.). Seek feedback and adjust as appropriate throughout the process, organizers do not always anticipate every complication in the planning stages.

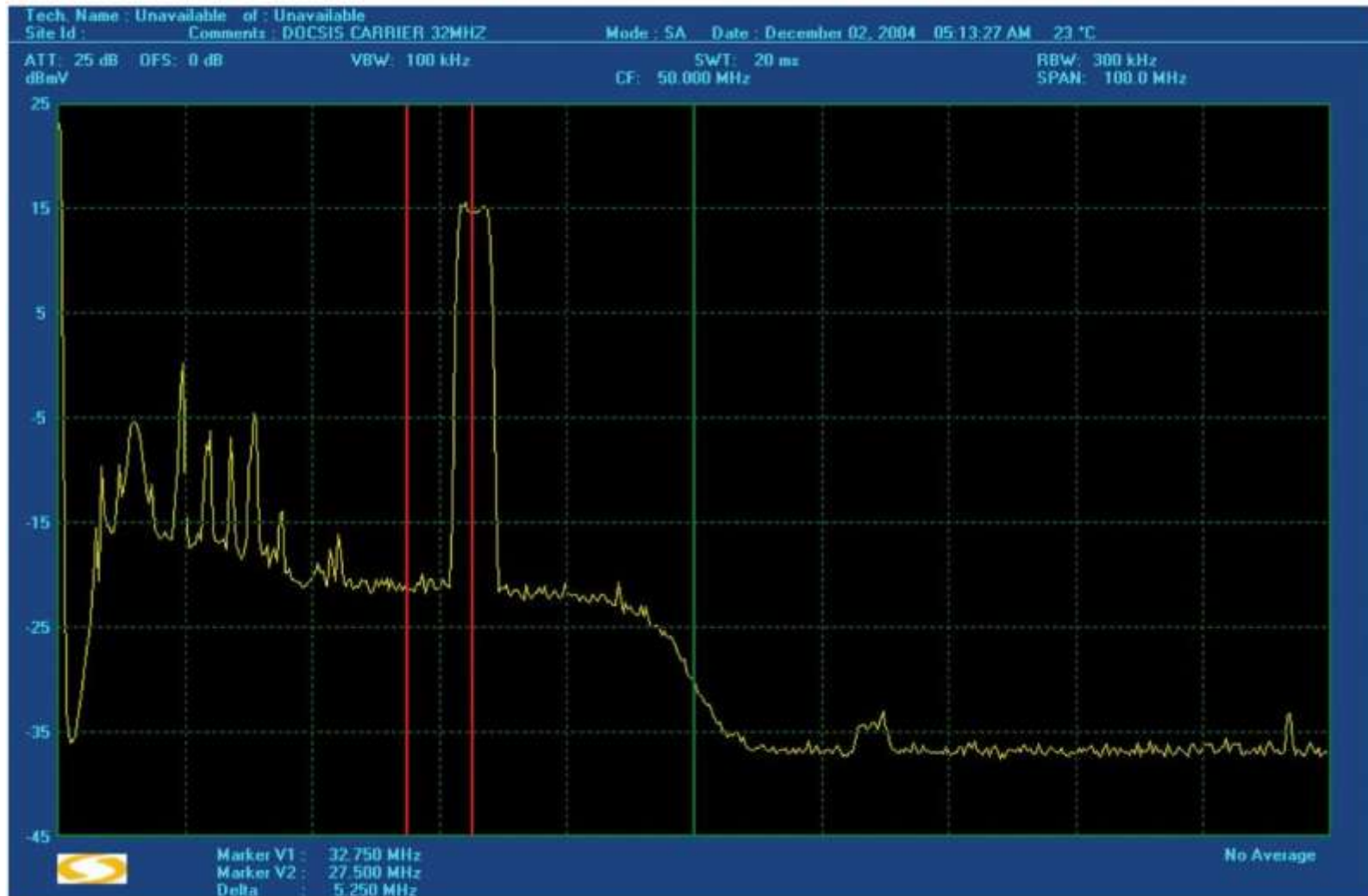
Project Management, Activity On Node



Project Management Terminology

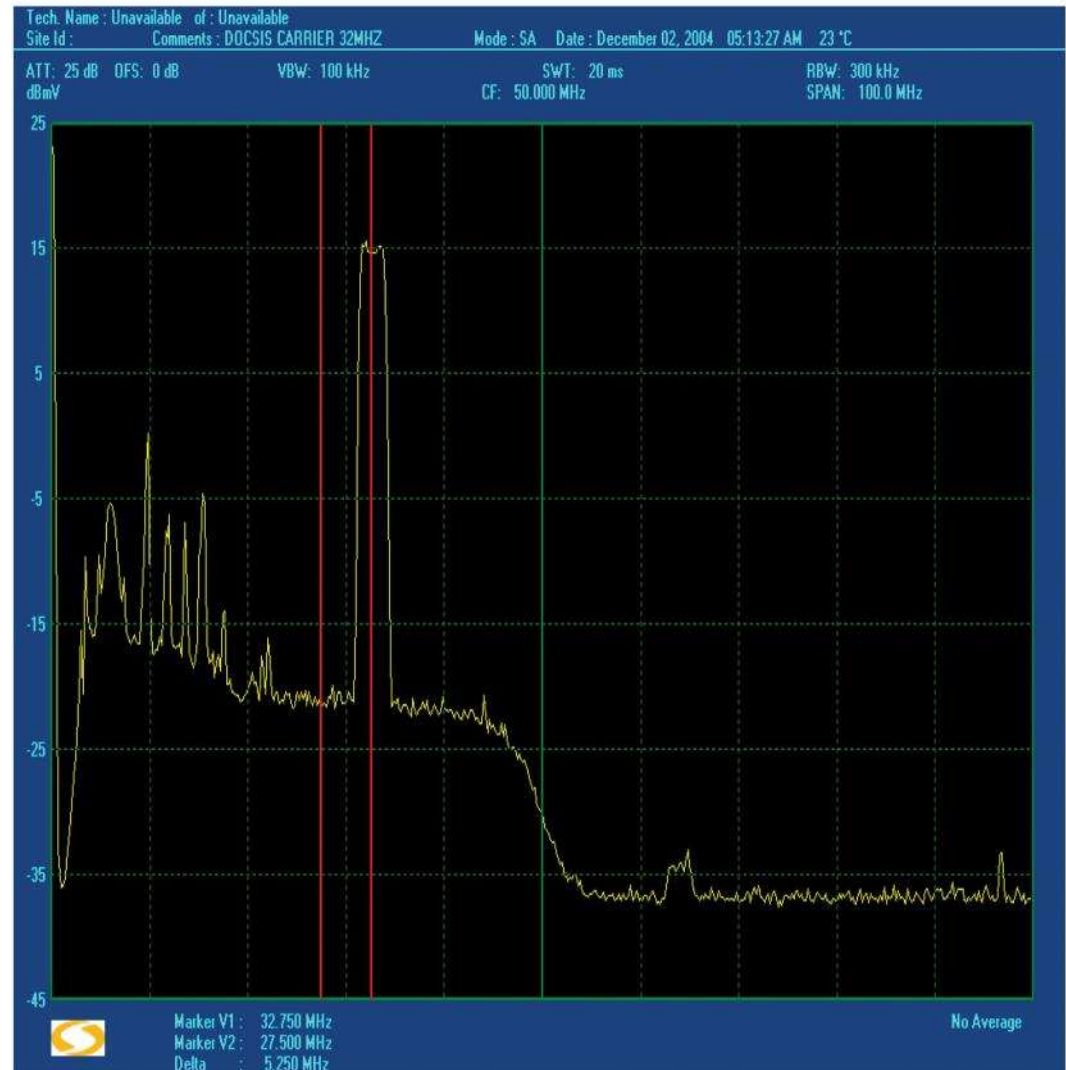
- ▶ Sponsor – the person supporting the project in a responsible position.
- ▶ Stakeholder – any person or organization who has an interest in the activity or outcome of the project
- ▶ Critical Path – the sequence of activities that limits the time to completion of the project
- ▶ WBS – the Work Breakdown Structure of the components in the project management diagram whether a Gantt Chart, Activity On Node or PERT chart.

Spectrum Monitoring



Modulation of a carrier as a galaxy

- ▶ The phase angle is shown in samples.
- ▶ Noise and jitter cause fuzziness.
- ▶ MER is modulation to error ratio in dB transmitted
- ▶ EbNo is energy per bit/noise per 1 Hz bandwidth received in dB



Satellite Uplink and Downlink

- ▶ Because RF transmitters are involved, an FCC or SBE certified engineer is required, preferably who has also taken an RF Safety course. Also because it is possible for errors to cause problems for other satellite users. E.g. my link received interference from a NASA conference.
- ▶ There are various tools to aid in pointing, e.g. Satcal.
- ▶ TVRO dishes, usually about 8 ft, may be polar mount, otherwise az-el (azimuth-elevation) is used. The elevation can be measured with a level/angle tool, but a compass for azimuth is likely to be in error. Rotate until a bird is found. DBS satellites are circularly polarized. Others are “Horizontal” and “Vertical” polarized. RV DBS satellite dishes can have an automatic pointing system.
- ▶ C band is unlikely to fade, Ku and Ka (DBS) can be lost with rain, snow, paint or leaves. L band (950 to 1800 MHz is on cable)
- ▶ Familiarity with a spectrum analyzer is important, though simpler downlinks may only need a signal strength meter.

Shielding and lightning protection

- ▶ Shielding may be electrostatic, magnetic or electromagnetic.
- ▶ Shielding characteristics change with frequency
- ▶ Cables should be shielded, though when RF energy is small, data cable may be unshielded as errors are usually corrected by TCP/IP. Susceptibility to EMP and solar EMI is wide range
- ▶ Power and proximity and frequency of transmitters or hum sources make a difference.
- ▶ Plenum rated cables should be used in plenum, fire hazard
- ▶ Shield should connect to the metal case, not circuit board
- ▶ Fiber needs physical protection, gentle radius, not shielding.
- ▶ Braid and foil shielding is best for cables.
- ▶ Star quad is best for microphone cables for hum immunity.
- ▶ Separate cables (power, phone, data, antenna, A/V should be grounded together or have lightning surge protection between them and ground.

Authorization and EAS

- ▶ There are various authorization and associated encryption schemes for cable , fiber, satellite and also broadcast is possible.This is FYI.
- ▶ EAS (Emergency Alert System) is required for cable, fiber and broadcast radio (including Low Power FM) & TV.This is for public safety messages, e.g. maps of flood areas and earthquake alerts are now to be included.
Complementary to this is WEA (aka CMAS) and ETN (Reverse-911).Also MEAS is becoming available for smartphone TV reception and Broadband EAS for computers. Consideration of your audience or employees is appropriate.This is a life and injury saving matter, not just FYI. It may be added to fire alarm PA systems.
Earthquake alerting is being incorporated.

SCADA (Supervisory, Control and Data Acquisition)

- ▶ SNMP for video can be from equipment vendors e.g.
- ▶ Evertz (Vistalink and Magnum)
- ▶ Harris Broadcast (Pilot and Navigator)
- ▶ Grass Valley (Newton, Netconfig, Netcentral & browser)
- ▶ Or vendors that only provide for their own devices.
- ▶ Extron, Crestron, or AMX control system programming, implementation, and testing.



Safety & Environment

- ▶ Broadcast transmitters are high power. Proximity causes heat in tissue and can be lethal. RF Safety required. This is non-ionizing radiation and does not cause cancer. $E=hf$
- ▶ Electronics has used toxic materials e.g. lead, cadmium. The EU has ROHS and WEEE requirements for CE certification to eliminate these in municipal waste. However some connectors and cables have low temperature plastic that does not withstand the higher temperatures of lead-free solder. Check what is appropriate. Buy CE equipment.
- ▶ Some equipment has high voltages or lasers, caution.
- ▶ AC mains is lethal. 70 mA through heart can kill.
- ▶ Use non-lead solder where practical.

Grounding

- ▶ Some people have been removing the ground pin to eliminate hum. This is not a correct method as it removes that safety also.
- ▶ All grounding must be bonded for electrical code.
- ▶ Balanced shielded pair audio may have the shield disconnected at the source end for line level signals. This stops ground currents running through circuit boards.
- ▶ With an XLR, the pin 1 shield can have a 100pF 100v disk capacitor to the shell. This provides a path for RF energy to go to the metal case and avoid the circuit board. This is not in cables sold, but they are unlikely to be star quad mic cable anyway which is best. Make your own.

Mains Isolation

- ▶ Isolation transformers are available to isolate mains power. However they most likely have the ground connected through so do not isolate ground loops. A low voltage (18v) MOV of decent size provides a safety path and isolation for that isolated power.
- ▶ Shielding of all mains wiring and components, and separating the mains safety ground and signal ground is a ground loop protection method. However those signal grounds must be connected and at a common point connected back to the mains ground. Include raised floors
- ▶ Mains needs ground cable, but also all conduit should be connected to that at both ends as this is best for noise reduction and lightning protection.
- ▶ Understand the Kaufman Experiment and orange sockets.
- ▶ Neutral currents may double with zero sequence currents.
- ▶ The THD of mains voltage may exceed 5% (U.S. limit)

3 Phase Neutral & Power Quality

- ▶ Three phase currents with harmonics can be summarized as 1 +, 2 -, 3 0, 4 +, 5 -, 6 0, 7 +, 8 -, 9 0, 10 +, 11 -, 12 0, 13 +, 14 -, 15 0, etc. Where + is positive rotation, - is reverse rotation and 0 is zero sequence which all 3 phases add in the neutral (NOT cancel). Significant even harmonics normally indicate a problem with the load.
- ▶ All harmonics, particularly zero sequence, cause transformers to overheat. Zero sequence currents may double the neutral current and cause failure. 3, 9 & 15 can be bypassed.
- ▶ Dranetz and other Power Quality Analyzers, and thermal cameras, can detect these and other power problems

Diagnostics or Troubleshooting

- ▶ Equipment will have problems. There are 3 methods to diagnose these problems.
- ▶ Analysis. This means measuring the signal at various points and observing quality tally indicators to determine where the problem occurs, and what is contributing to it. It is possible that the signal may seem satisfactory but may contain some incorrect data that leads to processing failure by equipment that is behaving normally. Eye pattern
- ▶ Elimination. This involves taking large segments of the signal path and determining whether the problem is before or after or within one segment. E.g. the left and right analog audio could be reversed in and out and see if the problem moves to the other channel, or redundant paths could have the signal swopped at a particular stage.

Diagnostics 2

- ▶ Experience. This is recognizing that a certain type of problem usually has a certain type of cause. Bypass analysis and diagnosis and proceed to eliminate the cause first. Understanding of differences of hardware, software and register soft errors e.g. on FPGAs.
- ▶ The availability of QC or test equipment, patchpoints to provide monitoring or injection of signal, SNMP monitoring of equipment, SMPTE video QC tally e.g. 269M & 273M, level metering, accurate description of the signal path in documentation, known good equipment for substitution.

Lesson Plan Summary

1/1	1/2	2/1	2/2	3/1
1-7	8-10	11-14	15-17	18-22
	Audio Lab			
3/2	4/1	4/2	5/1	5/2
23-26	27-30	31-34	35-39	40-43
Mixer Lab		Video Lab	Digital Lab	
6/1	6/2	7/1	7/2	8/1
44-46	47-48	49-51	52	53-55
Camera Lab	Editing Lab		Switcher Lab	
8/2	9/1	9/2	10/1	10/2
56-59	60-63	64-67	68-71	72-76
11/1	11-2	12-1	12-2	13-1
77-79	80-83	84-86	87-89	
		Test	Review results	
All	11-12	0-25		

Developments of Broadcasting

- ▶ NDI is a technology where the camera uses video compression before sending it on a CAT5 (for HD), CAT6 or CAT7 computer network cable. Audio/Video rated switches are used. Because of the delay by the compression/decompression, this is not suitable where a live audience is fed the delayed audio and video. It is however more economical and also the cameras may be security type units when NDI is used in the security network.
- ▶ Blackmagic Design is selling UHD and cinema resolution cameras and related audio and video equipment. 12 Gb/s cabling is used and this equipment is price competitive. However, because of the limited lengths of cables, such equipment is for smaller installations. Technical support is somewhat limited to videos for users and service information is difficult to obtain unless the distributor has such capability.
- ▶ A question for any equipment vendor or manufacturer is;- What is the temperature rating of the electrolytic capacitors in your equipment. 85 or 95 C rated parts are liable to leak the water through the seal and the part fail after some years. Equipment with 105 Celsius rated electrolytics for 2000 hours are expected to live much longer.

Developments of Other Video Technology

- ▶ Audio is now being transmitted using IEEE 802.1avb, which is incorporated into AES67, which is a UDP transmission protocol, and can use CAT5 cable. It may be combined with the video and other data. On fiber there can be an Amber and Blue redundant outputs to corresponding redundant switches.
- ▶ Video can also be transmitted using IEEE 802.1avb as part of SMPTE ST-2110 and PTP 2059. These are combined and adding a MXP (Media eXchange Protocol) for live or facility use. The latest version is recommended. Cisco or other switch can handle the data rate replacing the traditional video router in 2 U rackspace instead of 3 racks. It requires an SFP+ connector for bit rates up to 25 Gb/s or more. Transmission on 9 microm singlemode fiber is normal for this. To reduce data rate, the JPEG-XS protocol which is only a few lines of delay. Files may be MXF.
- ▶ These are both being incorporated into ATSC 3.0 by the advanced Television Standards Committee. This also extends the resolution to UHD (3840x2160) and 4K (4096x2160) and beyond. HDR (high dynamic range of 12 or 14 bits), Immersive Sound (7.1 surround + 4 overhead + 116 objects = 128 separate “channels”). There are two candidates, Dolby Atmos and Fraunhofer MPEG-H.

Translation Considerations

- ▶ Often translations are to a part of the audience.
- ▶ It can be a problem to achieve delivery, using cellphones MAY be adequate, but large venues require additional measures.
- ▶ The management of audio level into the ear so the translation is clearly above the house sound system is likely to be a problem. The ability to make comparative measurements to get the loudest without distortion is quite important. An acoustic isolation box for measuring earphone output levels is available with 37 dB isolation.
- ▶ Delivery may be by conference call system, these may be limited to 1000 calls simultaneously, but not all at one location.
- ▶ The translator should use a headphone type microphone to be the loudest, and consistent level with noise cancelling. The connection may be by Bluetooth to a cellphone, adaptor to a cellphone, or direct connection (though there is no level measuring or control with this.) Alternatively, a landline telephone hybrid may be used, as is done for radio talk shows. The connection to avoid feedback or echo needs to be made for the mixer if bidirectional speech is provided. Compressor-limiters to increase the average level help.