

Signal Processing Seminar

Debunking Audio Myths

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How to think critically, 101

- Usually the folks with the wild claims are trying to sell you something
 - Hi-fi, dietary supplements, MLMs...
- Burden of proof is on those making claims
- Anecdotal evidence is not evidence at all
- Subjective tests not done double-blind are probably worthless
- Physics, electronics, materials science well understood
- Quantitative data is important
 - 0.001Ω output Z is no better than 0.01Ω when driving a 10Ω load

Digital Disinformation

In which it is claimed that digital systems are inherently inferior to analog systems...

Myth 1: Analog is better than digital

- Probable origin (PO) : Ignorance
- Reason for perpetuating (RP): Huge installed base of analog gear, warm sound (euphonic distortion), comprehensibility
- Supposed theory (ST): Two forms:
 - Analog gear has unlimited bandwidth and/or unlimited resolution
 - Digital is unnatural and sounds 'digital'
- Typical manifestations (TM): Expensive turntables that look fabulous
- Real truth (RT): Digital has better flatness, noise, distortion, robustness...

Myth 2: Sampling is bad

- **PO:** Poor performance of early CD players (see also Myth 1), which cast digital in a bad light
- **RP:** Ignorance
- **ST:** The signal changes in an unknown way between sampling points
- **TM:** Vinyl freaks
- **RT:** The signal is band-limited before sampling so changes predictably between sampling points; reconstruction produces images which are filtered out

Myth 3: Quantization is bad

- **PO:** Poor performance of early CD players (see also Myth 1), which cast digital in a bad light
- **RP:** Ignorance
- **ST:** Signal ‘between the steps’ is properly captured only by analog
- **TM:** ‘Vinyl has a resolution limited by atoms, so it’s like 40-bit digital’
- **RT:** When properly dithered, quantizer only adds noise; digital systems >14 bit have better signal-to-noise ratio than any analog recording system

Myth 4: We need 96 kHz, no, 192 kHz

- **PO:** Fairly reasonable observation that CD players have between 20 kHz and 24.10 kHz to roll off
- **RP:** Poorly conducted trials where sampling rate is not the only variable
- **ST:** More is better
- **TM:** 192 kHz DVD-Audio proposal
- **RT:** 96 kHz sampling rate makes design of reconstruction filter easier, but is much more than necessary; 192 kHz is just a waste of bandwidth; performance is traded off to get these sampling rates

Myth 5: 16 bits are not enough

- **PO:** ‘Quantization is bad’ nonsense
- **RP:** Converters are available with more than 16 bits, so why not?
- **ST:** The dynamic range of the human ear is greater than 16 bits
- **TM:** 24-bit DVD-Audio
- **RT:** 16 bits gives 98 dB dynamic range; typical home system can achieve 60 dB; CD noise floor can be as low as 19 bits perceptually; 20 bits is great for studio mastering but not needed in a delivery medium

Amplifier Design Dogma

In which it is claimed that amplifier design is a mystical art known only to a privileged few...

Myth 6: Negative feedback is bad

- **PO:** Badly designed early transistor amps that were not very stable
- **RP:** Poor design, lack of understanding
- **ST:** Audio fed back is delayed relative to the input, high NFB leads to low slew rate
- **TM:** Costly power amps with terrible distortion specs
- **RT:** NFB is indispensable, unavoidable; lowers distortion, lowers output Z , increases input Z

Myth 7: Fewer stages are good

- **PO:** Simple amps of the past (which were not very good)
- **RP:** Less is more, or something
- **ST:** Each stage of active devices degrades the sound, so the fewer, the better
- **TM:** In the extreme case, giant costly power amps with huge heatsinks because output stage is single-ended Class A
- **RT:** Typical recording will have passed through 100 op-amps and hundreds of metres of ordinary cable; distortion degrades sound, not gain stages

Myth 8: Glass is better than silicon

- **PO:** All old things are perceived as better than new ones (e.g. acupuncture)
- **RP:** Musicians, the beauty of glowing scalding-hot glass bottles
- **ST:** Tube amplifiers have higher even harmonic distortion than transistor amps
- **TM:** Big heavy McIntosh amps with more chrome than a '67 Mustang
- **RT:** High output Z (transformer), high distortion (low feedback), high cost (transformer), low reliability; transistor amps have much lower even harmonics

Myth 9: Integrated circuits are bad

- **PO:** ICs used to be bad
- **RP:** ICs are cheap, so must be bad; IC power amps are not as good as discrete
- **ST:** Trade-offs made by IC designer may not be the ideal trade-offs for the intended application
- **TM:** Expensive pre-amplifiers that would be better and cheaper with good ICs
- **RT:** Talented IC designers and full control over device properties produce incredible results (e.g. AD797, distortion < -120 dB at 6 V_{rms}, voltage noise < 1 nV/ $\sqrt{\text{Hz}}$)

Myth 10: Switches degrade the sound

- **PO:** High-end audio mania
- **RP:** Feeling of superiority over owners of Japanese consumer equipment that lights up like a Christmas tree
- **ST:** All switches, cables, tone controls, and LEDs in the power supply degrade the sound
- **TM:** Pre-amplifiers which offer no control other than volume and source switching
- **RT:** No effect from switches; some tone controls have too much range, needing make-up gain with possible added noise

Myth 11: Power supply is critical

- **PO:** Single-ended power amplifiers that have terrible PSRR
- **RP:** See above; delusion
- **ST:** Supply's ability to 'deliver energy' smoothly affects the sound
- **TM:** Gigantic (and expensive) supplies; 'reference' power cords
- **RT:** Properly designed amps have high PSRR; PSRR design determined simply by current draw of amp and frequency of mains power; power cords have effectively zero resistance

Cable Crazyiness

In which it is claimed that cables have distortions that are immeasurable...

Myth 12: Cables are directional

- **PO:** Unscrupulous or deluded stereo store owners
- **RP:** A nice simple tweak, pricey cables look cool
- **ST:** Cables are made by drawing them in one direction, so they are directional; copper crystals act as rectifiers
- **TM:** Big fat cables with arrows on them
- **RT:** No known physical theory could explain suggested rectification; measurements show no effect; audio signals are AC anyway

Myth 13: Audio transmission lines

- **PO:** Probably a case of not examining the actual numbers involved
- **RP:** Selling expensive speaker cables
- **ST:** Audio is going from one place to another, so the cable must be a transmission line
- **TM:** Black boxes hanging off cables
- **RT:** Audio cables are *not* transmission lines (even 20 kHz has a wavelength of around 5 km in cable); audio cable can be modelled perfectly by lumped elements

Myth 14: Gold is better

- **PO:** Tutankhamen
- **RP:** Gold is fabulously attractive; gold is expensive so must be good
- **ST:** Gold's conductivity is qualitatively different from anything else (apart from silver used in tube output transformers)
- **TM:** Gold-plated everything
- **RT:** Gold is great for connectors because it's soft, it's quite conductive, and it doesn't tarnish; but it's expensive and doesn't conduct as well as copper; no pro gear uses gold connectors

Myth 15: Black boxes improve things

- **PO:** Desire to tweak in an increasingly untweakable world
- **RP:** Outrageously positive reviews by subjectivists
- **ST:** A smorgasbord, including ‘Harmonics are lost in the recording process’, ‘Digital is too harsh’, etc
- **TM:** Line-level patented black boxes
- **RT:** Unless pre-amp has no drive ability (unlikely), box can only add noise and distortion (and sometimes is designed to do exactly that); this is not hi-fi

Conclusions

- Buy CD players, amplifiers, and other electronics based on their feature set
- Speakers improve markedly up to around \$1500/pair
- Spend time setting up your listening environment for best results
- Use 12-gauge to hook up your speakers
- Use good co-ax for interconnect
- Avoid tweak items such as rubber feet, cones, black boxes, esoteric cables, power cords, and line filters