Why tubes?

At VTL we feel that tubes are the best technology for audio, for the following primary reasons:

1. Tubes use simple circuits
2. Tubes overload gracefully
3. Tubes are more linear, and therefore,
4. Tubes require less overall negative feedback

Tubes are a more viable technology now than in yesteryear, as better components are now available for modern tube amplifiers.

At VTL we have found that in general, passing the signal through a lesser number of components yields a purer, more immediate sound. Simple circuits with fewer components have been found to sound cleaner than complex circuits with many components in the signal path. This is because there are fewer components to change, or distort, the sound (add to or degrade the signal).

Simple circuits also have inherently higher reliability, since there are less parts to fail.

Tubes are more tolerant of circuit drift and parts deviations, and thus can be used in the simplest circuits.

Music has great dynamic swings, and in tube amplifiers the onset of clip/overload as maximum power is reached is gradual, with a low even-order harmonic.

Even-order harmonic distortion is somewhat benign, and less offensive to the ear than the harsh, odd-order harmonic distortion characteristic displayed by solid-state circuits, even though the distortion figures for tubes are somewhat higher.

Transistor amplifiers generally reach their power limit and clip in a mostly odd-order harmonic, which is more fatiguing to listen to. In such a transistor amplifier the distortion rises very quickly as the maximum power level is reached, with an almost square wave characteristic, and a high DC component, (which can destroy loudspeaker drivers).

As an example of the difference in the distortion characteristics between the two technologies, tube guitar amplifier manufacturers

have traditionally designed their equipment to drive the output stages into overload distortion, using the resultant distortion to get the sound they like, also known as “tone”. In a tube amplifier this tone contributes to the amplifier’s sound, but in a solid-state amplifier this distortion would be intolerable and would destroy speakers.

Tubes are voltage amplifiers (as opposed to solid-state current amplifiers), with the result that tubes are a more linear amplification technology, requiring less overall negative feedback to make the circuit linear.

Overall negative feedback is a sample of the output of the amplifier re-injected into the input 180 degrees out of phase, and is used to correct non-linearities and distortions.

Too much negative feedback in general tends to slow the amplifier down and suck the emotion and life out of the music. High feedback designs usually give a sterile and boring, lifeless sound, while low feedback designs give a more immediate sound to the music.

Negative feedback has other benefits, as the use of feedback helps to lower output impedance of the amplifier. Lower output impedances can control loudspeaker loads better. Zero feedback designs tend to have very high output impedances, and therefore tend to be very reactive to the loudspeaker load, while high feedback designs can help to provide the flattest response into a given loudspeaker load.

Zero to 20dB of negative feedback is generally considered acceptable, and is usually the maximum amount of feedback needed to make a tube amplifier circuit linear and to keep the output impedance down to an acceptable level. Transistors (depending on technology and type of output device used) generally need over 50dB of negative feedback overall (either globally or within local loops).

The benefits of feedback are lower output impedance, (and therefore higher damping factor), and generally less reactance to the loudspeaker load and therefore better control of the loudspeaker.

Single ended amplifiers with zero negative feedback, while being the most simple amplifiers lowest in parts count, are very high output impedance. Because of the high DC current in the output transformer, the output transformer is easily saturated, with the result that such

amplifiers are generally extremely low powered and have very narrow frequency response capabilities.

The higher working voltages present in tube amplifiers generally allows better voltage swing capability and better headroom. This higher working voltage yields higher audible energy storage with a lower value capacitor (audible energy storage is voltage squared divided by 2 multiplied by capacitance) Compare 600 working volts of tube amplifiers vs. 80 working volts of transistor amplifiers. This is most likely why many listeners feel that tubes sound more powerful.

By using transistors in the area where they are better: Solid state rectifier diodes offer faster rectification, and have the ability to address a much higher capacitance than the older tube rectifiers. (Tube rectifiers are designed to handle only 50 microfarads (mf) at maximum, while solid state rectifiers can handle capacitances greater than 4000 mf). Solid state rectifiers also offer far better reliability and don't age as quickly as tube rectifiers. (Tube rectifiers age and eventually short out the power supply cap, which is an expensive repair).

Newer electrolytic capacitors available today have much higher energy storage in a smaller package – 4000 mf and greater – than older paper in oil caps, which offer just 50mf maximum. In any amplifier a better power supply translates to wider high frequency response and better bass control capability.

Better quality insulation materials available today, as used in VTL Signature output transformers: The tighter coupling between each layer, and the better interleaving of the output transformers both help to keep capacitance (and resultant high frequency roll off ) down, and offers more efficient current transfer with lower insertion loss, to improve current supply capability to the loudspeaker, thereby offering much improved bass and top frequency performance capability.

PC boards available today offer a better method to keep components apart, which is superior to point to point assembly. PC boards offer easier manufacturability and serviceability.

Teflon insulated wire is more suited to the higher working voltages, which is a more stable insulation than the old system of cloth wrapped

wire. High voltages run on separate wires avoids copper crystallization (whiskers, due to high voltage) between layers of fiberglass when high voltage is run on PC board traces. Teflon wire also has better thermic stability and can withstand higher current for a short time than PC board traces.

These multiple newer technologies allow us to make tubes perform closer to the limit of their designed capabilities, which couldn't previously be done, and allows tubes to offer better sonic performance than before.