Pasmore

PASS

Background

In the 1950's most audiophiles only had maybe 10 watts of tube amplifier available, but they achieved realistic concert performances with loudspeakers whose design emphasized powerful and efficient motor assemblies and diaphragm materials chosen for musicality, low mass, and large radiating surfaces. Enclosures were designed with the same thought that goes into musical instruments, with a live harmonic characteristic and an appreciation for fine wood craftsmanship. Many of these products endure as classics, and are still highly prized by audiophiles as treasures from a golden age. They were as much a result of refined taste and trial and error as they were science and engineering.

For years we have asked ourselves why these old designs are so good, and why modern high-end audio does not show all the audible improvements to be expected of 50 years of technological advances.

In the 60's and 70's, high power amplifiers became available, and loudspeaker design took a left turn onto the road it follows today. With mighty solid state amplifiers at the designer's disposal, efficiency was no longer an issue, and the design goals revolved around raising the power handling ratings and sacrificing efficiency in order to deliver low bass frequencies in small enclosures. Never mind that the bass was boomy and that the music sounded like it was pushed through a sock; it fit on a shelf, and it used up the higher power of the amplifier the industry was eager to sell.

Many of the differences between then and now are obvious. With efficiency as a priority, classic high-end loudspeakers had sensitivities in the range of 100 dB/watt. The old designs used expensive magnetic circuits and tightly toleranced motor assemblies to achieve high force from a small amount of electrical current, and they coupled these to lightweight paper cones whose sonic signature was the result of much trial and error – more art than science and engineering.

Today, most speakers are about 87 to 92 dB/watt, which is about 1/10 the acoustic output of the old classics. This is the difference between 10 and 100 watts of amplifier for the same level. The cones are heavy and the magnets are working into wide voice coil gaps. Why is this? It costs a lot less to do it this way, and also loudspeaker enclosures can be made less

conspicuous while retaining some low frequency response. Much of loudspeaker science operates on the presumption of the cone material as a rigid piston, which plays well into the use of heavy, thick materials in order to achieve the character of a piston. The high mass of the cone results in slow attack and decay response to impulses from the amplifier, but this has been considered an acceptable trade off. Of course, there really is no such thing as a loudspeaker that acts as a true piston.

The old designers knew they were never going to get a really rigid neutral piston, so they researched cone materials that were light, well damped, and whose deviations from the ideal were at least musical. This philosophy was in keeping with the approach to the old tube amps as well; they didn't measure that great, but their faults were at least musical and fairly inoffensive. The old designers measured and listened carefully, and were persistent. Most of them had taste, and they knew what they wanted when they heard it.

These light diaphragms and efficient motors have a very dynamic quality. From silence they spring to life in response to musical transients. Well done, they articulate infinitesimal details and have a warm, spacious, easy character. The paradox is, of course, that modern designs in many ways are not as sonically pleasing as the old classics. For all the power available, they have traded off dynamic range, transient attack and decay, and articulation. They have sold their musical souls, and they sound uneasy about it.

The old speakers came in big enclosures, made of spruce, maple and other acoustically live woods designed to get the last bit of bottom end performance from a big lightweight paper cone. Large bass-reflex boxes and horns filled audiophile listening rooms. The wood in the enclosures was flexible and had a sonic signature of its own. Like the material used in the paper cones, it was chosen for sonic harmony with the drivers, and was the object of craftsmanship in construction and finish.

Today? Monkey caskets: Medium density fiberboard, or worse, particle board rules the marketplace. It's cheap, easy to machine, and is supposed to be acoustically dead. Actually, it pretty much is…… dead, lifeless and uninteresting.

As speakers have gotten less efficient, amplifiers have gotten bigger and more powerful. In an evolution similar to speakers, amplifiers achieved better specifications through the use of more complex circuitry and greater amounts of feedback. The old simple ways of building good amplifiers gave way to a specifications race, and similar to the loudspeaker paradox, we find ourselves with complex circuits achieving lots of feedback in order to correct for the poorer linearity of more complex circuits.

The big difference between then and now is that much of the industry relies more on science and engineering than persistence and good taste in the development of products. Even the most ardent subjectivist designer has a rack of test equipment, and he keeps at least one eye on it all the time.

The Pass Rushmore loudspeaker design originated with speculation as to how loudspeakers would have evolved if in the 60's designers had stayed with high efficiency drivers,

relatively low amplifier power and live sounding enclosures.

So what are we doing here that's different? Some parts of this design are similar to other commercial offerings, but no product embodies such a comprehensive integration of design and technique with this level of taste and performance.

Very Sensitive Drivers

When we began this project over three years ago, we decided high efficiency drivers at least 96 dB efficient were the only ones likely to meet our criteria for dynamic range, inner detail, and transient response. This observation comes through strictly personal experience with a large number of successful classic designs. We purchased or borrowed pairs of every component that met this specification that we could find, which included cones, horns, domes, and ribbons. This was a lot of drivers, drawn from both the consumer and pro audio industries. We used the prototype XVR1 crossover network to mate these to each other in test systems in order to evaluate each driver objectively and subjectively, separating the wheat from the chaff. Over the course of two years of testing, we isolated a few candidate components from hundreds. No horn driver made the cut, nor did any dome. The bass to upper midrange drivers that met our requirements ended up all paper cone type drivers, and only ribbon tweeters satisfied us at the top two octaves.

We spent a year with the permutations of systems which could be built with these drivers in combination with each other, tweaking, listening, and measuring, until we settled on the best combination of parts and the crossover and amplifier characteristics most ideal to each component.

The result is a four-way system, with a 15 inch deep bass driver, a 10 inch mid bass driver, and a 6 inch midrange, and a ribbon tweeter. The bass driver is 97 dB/watt efficient, and the remaining drivers are at least 98 dB/watt. The cone drivers are all high quality professional drivers rated at high wattage levels which by coincidence work very well together. As a group, they were the best we could find.

Single-Ended Class A power amplifier devoted to each driver

The bottom end is powered by an Aleph X balanced single-ended Class A amplifier, a cousin of the newly released Pass XA series. Using the two most important patented topologies available to Pass Labs, it combines the warmth and sweetness and detail of the Aleph series single-ended output stage with the dynamic range and control of the Supersymmetric topology of the Pass X amplifiers.

The three mid-bass, mid-range, and high-end amplifiers are conventional Aleph series circuits, best suited to elicit the best qualities of articulation and imaging, warmth and top end sweetness of these very dynamic loudspeaker drivers.

Having only two stages, these amplifiers embody the audiophile quest for the most realistic sound through minimalism and purity of signal path. Single-ended Class A amplifiers have what is known as a monotonic character; they continue to improve as the power level goes down.

Thus, the first watt is the best watt, and they give a great performance at ordinary volume levels. This character greatly complements very sensitive drivers, and Rushmore invites you to listen at normal loudness. You do not have to play music at abusive levels to achieve detail and drama with this loudspeaker.

Each amplifier is adjusted for the specific voltage, current and gain requirements of each driver. The cone drivers are direct coupled to the amplifiers with no intervening passive circuitry to make maximum use of the damping provided by the amplifier and to assure minimum distortion and signal loss.

The heat sink for the amplifiers is a 4 ft. long finned extrusion that embodies the rear of the loudspeaker from bottom to top. During operation, it reaches approximately 55 degrees C. in the area containing the 20 power Mosfets which populate the 4 channels of amplification.

The power supply to the amplifiers delivers a continuous constant 300 watts to the Class A output stage during operation. This draw is constant regardless of signal level, and drops only when the speaker is powered down. The capacitor filter bank contains 240,000 uF capacitance and uses dual CLC pi filters to reduce ripple and noise by a factor of 20 dB lower than a conventional unregulated supply.

The bass amplifier is rated at 80 watts into the woofer, the mid-bass amplifier is 20 watts, the mid-range amplifier is 20 watts, and the ribbon tweeter amplifier is rated at 20 watts, all single-ended Class A.

The absolute maximum output of the speaker at 1 meter is approximately 120 dB with musical material.

Quad Amp Crossover

The filter characteristics for each driver are determined in passive filter networks prior to each of the four amplifier inputs per speaker. Their specific characteristic has been trimmed and evaluated through trial and error over a long period of time in many rooms with many listeners and confirmed by measurement equipment. For best transient and phase response, the mid-bass and mid-range band-pass filters are single-pole types, while the bass driver sees a 2-pole low-pass filter at 22 Hz and the ribbon tweeter is crossed with 2 poles at 8 KHz. None of these filters uses feedback, positive or negative.

The result is a flat response that falls off at 20 Hz on the bottom and 40 KHz, above the top of the audio band.

The individual level of each driver is calibrated, but each has an adjustable level control allowing for +/- 3 dB adjustment for different environments and taste.

The input of the speaker can be made from a line level source into either a balanced input or single-ended input at the rear of the speaker. The input impedance is 20 Kohm balanced and 10 Kohm single-ended. The balanced input common mode rejection offers 40 dB of noise rejection.

The gain of the input through the output has been calibrated to 100 dB output at 1 meter for 1 volt input.

Granite and Piano Enclosure

We believe that this much achievement should be housed in the finest temple, so we went to woodworkers versed in the wood forming and finishing of pianos. The curved sides of the Rushmore are made of 9 individual layers of veneer material formed and cured in a vacuum press and mated to a 1.25 inch thick solid front baffle faced with 0.75 inch thick granite. The top and bottom are panels of 0.75 inch thick granite. The rear of the loudspeaker consists entirely of an extruded, machined and anodized heat sink which holds all the electronic components.

The front baffle of the speaker is made acoustically dead so that the drivers feel a firm unyielding mounting surface, but the rest of the enclosure has been allowed to remain relatively live, and contributes in its own subtle way to the overall sound of the speaker.

The Rushmore weighs approximately 300 lbs, is 50 inches high, 18 inches wide at its widest point, and 28 inches deep. It has been designed by Nelson Pass, Kent English, and Desmond Harrington.