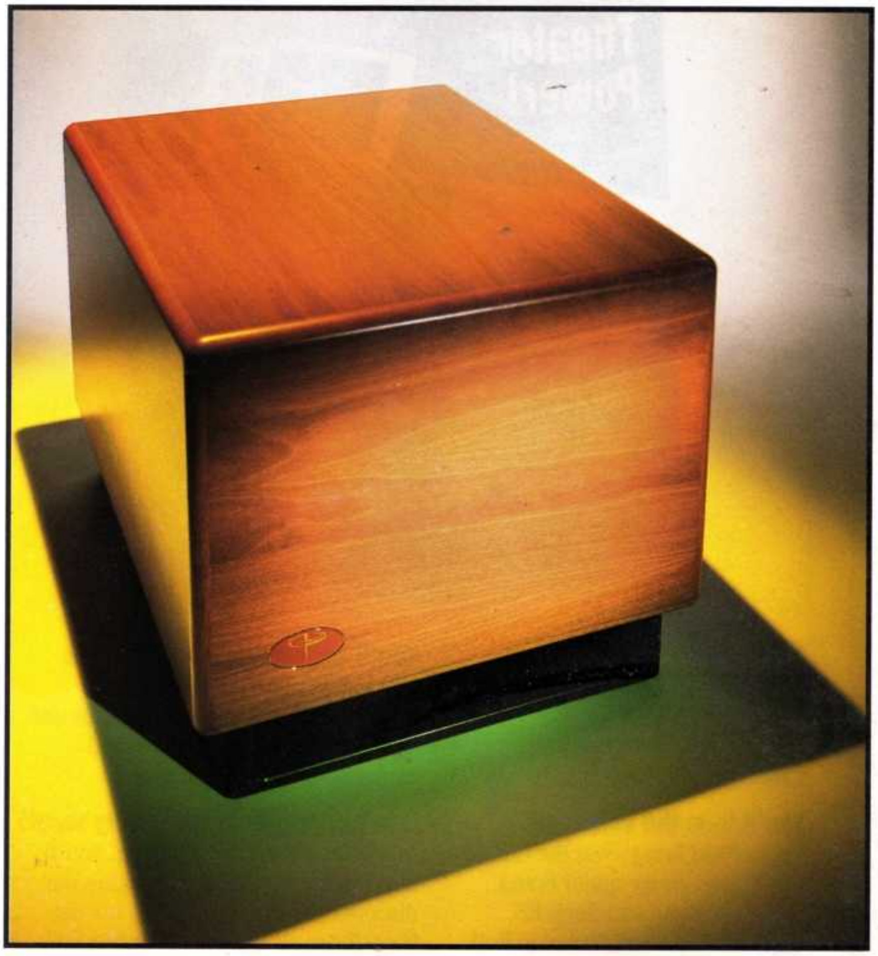
D. B. KEELE, JR.

Whise Profunder 320 Subwoofer



Ever get really ticked off after reading something? I did over Michael Riggs's "Fast Fore-Word" column in the March issue. He was passing on information gleaned from a demonstration at the January Consumer Electronics Show (CES) of a new subwoofer using technology developed in Australia that purported to best the tried-and-true Thiele-Small loudspeaker enclosure design techniques. That subwoofer turned out to be the Whise Profunder 320, the subject of this review, which is now being marketed in the United States by TMH (for Tomlinson M. Holman) Corporation.

The description of the new technique, dubbed Parametric Acoustic Modeling (PAM), left me very skeptical. PAM's developers, Graeme Huon and Greg Cambrell, claim a number of extraordinary benefits, including: 4 to 5 dB higher efficiency, lower distortion, precise control of frequency response, control of group delay independent of frequency response, and the ability to make group delay very low. Is this just marketing hype and pseudoscience, or is it solid stuff? Read on to find out.

The Whise Profunder 320 subwoofer is based on a double-tuned vented bandpass enclosure. This enclosure has separate cavities attached to the front and rear of the driver cone, each of which is vented to the outside air through a tube, forming dual Helmholtz acoustic resonators. These resonators, which are typically tuned to high and low frequencies in the bass range, define the subwoofer's passband. Each acoustically loads the speaker at its resonance frequency, where it dramatically reduces cone excursion and distortion, and simultaneously increases the system's output with sound radiated from the vent. The Profunder 320 builds on the double-tuned bandpass principle by replacing the higher-frequency vent with a series of additional cavities that are connected by tubes or acoustic transmission lines), which are computer-optimized to increase the speaker's efficiency, decrease its distortion, and widen its bandwidth.

Does this elaborate enclosure really deliver on the claims made for it?

WHISE

Rated Frequency Response: 20 Hz to 150 Hz, ±2 dB.
Rated Sensitivity: 89 dB at 1 meter, 2.83 V rms applied, half-space acoustic load.
Rated Impedance: 8 ohms, nominal.
Rated Power Handling: 200 watts.
Rated Output: 114 dB SPL at 1 meter at 25 Hz, half-space acoustic load.
Dimensions: 19 in. H x 22 in. W x 29 in. D (48 cm x 56 cm x 74 cm).
Weight: 115 lbs. (52.3 kg).
Price: $4,900 each; available in limed oak, golden oak, grand walnut, and Victoria rosewood veneers, satin black, piano gloss black, stainless steel metal, and custom finishes.
Company Address: c/o TMH Corp., 3375 S. Hoover St., Suite J, Los Angeles, Cal. 90007; 213/742-0030; www.whise.com.au.

Actually, attempting to separate the system into cavities and adjoining tubes is a bit dicey, because a cavity can be viewed as a short, large-diameter tube, and a tube is nothing more than an elongated cavity! This calls for a unified analysis approach that treats all the elements equally in a detailed, consistent manner. The PAM technique presumably fills this need, because it treats the constituents not as lumped elements but as distributed continuous elements.

The Profunder 320 has a large, heavy enclosure, finished on five sides, containing a specially designed, heavy-duty 15-inch driver with a maximum excursion rating of 1¼ inches! Although Whise is quite open about the subwoofer's general operating principles, the company is secretive about the exact details of the cabinet's internal configuration. All I know is what is evident from examining it from the outside.

The cabinet is mounted on a 3-inch high base. On the back of the base is a set of gold-plated, double-banana, five-way binding posts. The front end serves as an outlet for the sound, with the bass energy exiting from a slot that extends across the width of the cabinet. The slot is fed by a wide, central flared tube and two smaller rectangular duct openings to the sides. Presumably the flared tube connects to one side of the driver and the outer ducts to the opposite side.

But of course, the question remains, does this elaborate enclosure really deliver on the claims made for it? Long before I got the subwoofer for testing, I started investigating this question on a theoretical basis. After reading the March "Fast Fore-Word," I immediately logged onto Whise's Web site and downloaded, printed, and read more than 12 pages of technical information. My skepticism persisted. Subsequently, I gathered additional information, including the two technical papers Huon and Cambrell gave at the 1995 Australian Regional Convention of the Audio Engineering Society (one describing the enclosure and the other the driver), a press release and promotional information, a TMH white paper, and copies of the overhead transparencies from two presentations (the original AES presentation and another much more recent) that Huon and Cambrell had given. None of this material succeeded in dispelling my doubts.

Don't get me wrong: Huon and Cambrell's work, as described in their technical papers, is very good. Included are a very detailed and careful analysis of the enclosure system and the prior art, using electrical network analogs modeled by the latest SPICE analysis software. They analyzed the enclosures using not only the traditional "lumped" modeling elements, but also including more sophisticated distributed transmission-line elements to improve the accuracy of their simulations. These Parametric Acoustic Modeling elements enable the simulations to extend higher in frequency than lumped elements would allow.

Another nice piece of work is their use of what they call the enclosure characteristic

The Profunder 320 proved to be one hot contender, besting all other subwoofers I have evaluated.

curve of driver displacement, or ECCDD (a mouthful!). This is a particularly good performance figure of merit—a direct way of relating a speaker's output SPL to the driver displacement that produced it. ECCDD is thus an excellent way to compare the operation of different types of bass enclosures.

Still, what about Whise's performance claims? Let's take them in the order they were presented in the March issue.

First, efficiency. I don't think Whise makes its case that its design is more efficient in terms of the fundamental relationships between box volume, low-frequency cutoff, and efficiency, as defined by Thiele and Small in *their* pioneering papers. Apparently, Huon and Cambrell's work essentially extends the upper-frequency operating range of a double-tuned bandpass enclosure up to the point where the added transmission-line elements themselves resonate. The bottom end of the system remains exactly as in a conventional double-tuned bandpass (CDT) system modeled with lumped parameters, including both the frequency response magnitude and phase. However, a point may be made that the operating bandwidth of the bandpass (considering both its low- and high-frequency cutoffs) is increased beyond that of a simple double-tuned system. Hence an efficiency relationship relating operating bandwidth, box volume, and efficiency is definitely improved.

Huon and Cambrell state that their system is designed without the use of any deliberately lossy elements. This is quite evident in the abrupt onset of strong resonances and anti-resonances just above the system's upper operating limit, as seen in the frequency responses in their papers and presentations (and in my measurements for this review). These resonances make the subwoofer harder to cross over.

Huon and Cambrell also note that their enclosure designs are optimized by trial and error using SPICE simulations, and thus there is no methodical way to arrive at an optimum design. This is one area where Thiele and Small made an extraordinary contribution to the state of the art by describing in simple terms, using lumped parameter approximations, how to design an optimum system based on desired specifications of performance.

Whise's second major claim is lower distortion. The new enclosure definitely does decrease distortion, as judged by the ECCDD, but only in the range above the upper tuning frequency. At the upper tuning frequency and below, the Whise enclosure is essentially the same as a CDT system.

With regard to Whise's third claim, of more precise control of frequency response, the new enclosure does allow a greater degree of freedom and hence control. Again, however, only in the range above the upper tuning frequency. At lower frequencies, the control remains the same as in a conventional CDT system.

The fourth claim is the one perhaps most likely to raise eyebrows: control of group delay independent of frequency response. This was not shown or proved anywhere in the information I read. As I noted earlier, the phase of the system at mid to low frequencies should exactly follow that of a CDT system, which is minimum phase, and hence the phase would be directly computable from the magnitude response and not independent. These same comments

TEST RESULTS

The Profunder 320's frequency response is shown in Fig. 1, with and without the 80-Hz, fourth-order, Linkwitz-Reilly low-pass filter Whise recommends. The responses are based on ground-plane measurements taken at 2 meters from the center of the slot with 2.83 volts rms applied. This condition corresponds to a 1-watt/1-meter measurement in a full-space anechoic environment. Note that all of Whise's specifications are referenced to a half-space acoustic load, and consequently their cited levels will be 6 dB higher than measured here.

The sub did what it was designed to do: produce gobs of loud, clean bass all the way down to 16-Hz.

Without the low-pass filter, two features of the response jump right out: the moderate 30-Hz hump and the peaky response above 150 Hz. Relative to the level at 80 Hz, the response is 3 dB down at 20 Hz and 6 dB down at a low 18 Hz, while the hump at 30 Hz is 2 dB higher. Below 18 Hz, the response rolls off at 24 dB/octave. Above 150 Hz, the response is extremely rough, with two main high-Q peaks at 170 and 355 Hz, which rise about 9 dB above the level at 80 Hz. Between these peaks and at higher frequencies, the response undergoes wild gyrations before finally dying out above 2 kHz. Fortunately, the low-pass filter completely suppresses these artifacts, and the response rolls off smoothly above 60 Hz at about 12 dB/octave.

Averaged from 20 to 80 Hz, without the low-pass filter, the Profunder 320's sensitivity measured 83.4 dB SPL. This would appear to be substantially below Whise's 89-dB rating, but when the differences in measurement methods are accounted for, they are in excellent agreement.

I measured the subwoofer's phase response and calculated the group delay and waveform phase. The Profunder 320 definitely is not a linear-phase system. Its phase and group delay are typical of a 20-Hz high-pass system, exhibiting the usual nonlinear phase and group delay that increases as frequency decreases. The group delay levels out above 70 Hz in the range of 2 to 2.5 milliseconds. The group delay increases at lower frequencies, passing through 10 milliseconds at 40 Hz, 20 milliseconds at 30 Hz, and 34 milliseconds at 20 Hz, rising to maximum of about 40 milliseconds at 12 Hz. The waveform phase (often called phase intercept distortion) indicates that the subwoofer will not preserve waveforms in any band within its operating range; this is typical of conventional loudspeakers, however.

The Profunder 320's impedance magnitude (Fig. 2A) is very energetic, with three main peaks and two dips in between. This is the characteristic signature of a double-tuned bandpass vented-box system. (A classic single-tuned vented box—i.e., a bass-reflex enclosure— has only two peaks with a single dip in between.) The 6.6-ohm impedance dips at 20 and 50 Hz coincide with the vented-box Helmholtz acoustic resonances that dramatically decrease distortion and increase output. The double-tuned bandpass enclosure spreads the very beneficial effects of the resonances over a much wider range than does a single-tuned enclosure. The pronounced, narrow impedance peaks at 10, 29, and 141 Hz are indicative of a strong, high-efficiency woofer motor with low mechanical losses,

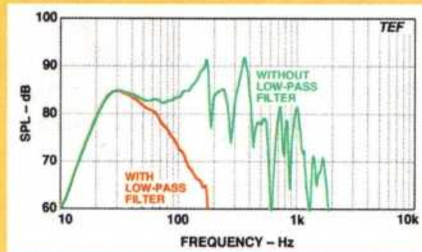


Fig. 1—One-meter, on-axis frequency response.

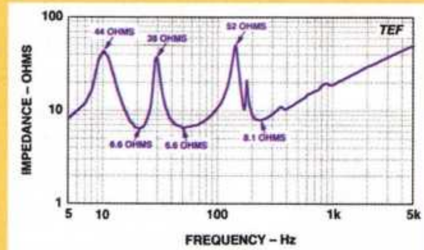


Fig. 2A—Impedance magnitude.

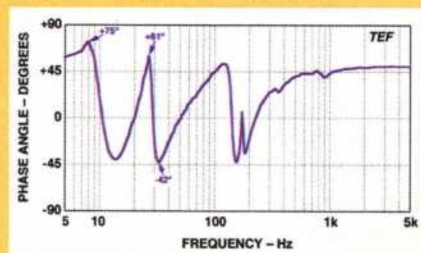


Fig. 2B—Impedance phase.

which are just the characteristics of a well-designed vented-box woofer.

A secondary dip-peak pair occurs slightly above the third main impedance peak and coincides with the first high-Q peak in the frequency response. This impedance variation presumably is due to the tuned ducts that load one of the vented-box ports, which are an integral part of the Whise design. The Profunder 320's impedance phase (Fig. 2B) exhibits a passband peak of +61° (inductive) at 27 Hz and a minimum of –42° (capacitive) at 33 Hz.

Although the 320's passband impedance variation of 6.6 to 38 ohms is fairly large, the relatively high minimum impedance relaxes cable requirements somewhat. If you want to keep cable-drop effects from causing response variations greater than 0.1 dB (very tight for a subwoofer), cable

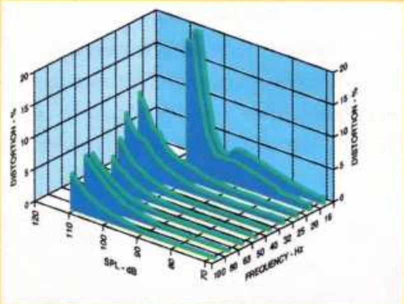


Fig. 3—Harmonic distortion versus frequency and level.

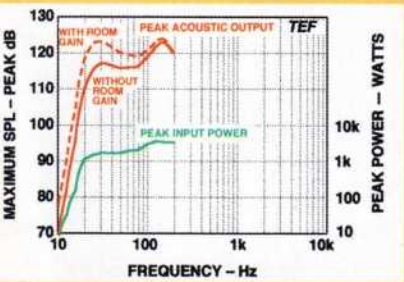


Fig. 4—Maximum peak input power and sound output.

series resistance should be kept to a maximum of 93 milliohms. For a typical run of about 10 feet, that would correspond to 16-gauge (or heavier) copper wire. Two paralleled 320s can be handled easily by any competent power amplifier.

When energized with a high-level swept sine wave, the 320's cabinet was essentially inert and exhibited no noticeable side-wall vibrations. Even at the highest input powers, vent turbulence and wind noise was very low.

Figure 3 displays the Profunder 320's harmonic distortion versus frequency and sound-pressure level. I ran the tests at nine frequencies, spaced ⅓-octave apart, from 16 to 100 Hz, at fundamental output levels ranging from 70 to 116 dB SPL. The measurements were near-field measurements but are referenced here to 1-meter free-field levels, with room gain taken into account. I arrived at the graphed distortion levels by summing the power in the first 10 harmonics of the fundamental and then referencing this power to the fundamental's power and calculating the distortion percentage. Effectively, this method yields results quite close to total harmonic distortion (THD) but uses only the first 10 harmonics and does not include noise.

At 25 Hz and higher, the distortion stays below 10% while maximum levels are in the very loud range of 112 to 116 dB SPL. In the lowest bands, 16 and 20 Hz, the distortion rises above 20%, but maximum levels are still very robust at 106 dB SPL. At 40 Hz and above, the Whise's maximum output keeps up with that of my current champ, the Paradigm Servo 15, although at somewhat higher distortion. At 32 Hz and below, however, the Whise 320 bested all subwoofers I have tested, achieving maximum levels some 4 to 10 dB higher. At 16 and 20 Hz, the Whise outperformed the prior best subwoofer, the Hsu TN 1220 HO, by 4 to 5 dB. In short, at high bass frequencies the Profunder 320 could play as loud as or louder than any other subwoofer I have tested, and at low bass frequencies it could play significantly louder.

Whise claims an acoustic output of 114 dB at 1 meter at 25 Hz (half-space acoustic load). Did the 320 meet that spec? Yes! In my tests, the 320 generated 116 dB SPL, including room gain, with 11% distortion. When 8 dB of room gain is subtracted and 6 dB is added to account for the difference between full-space and half-space loading, the net result is 114 dB SPL, exactly as specified.

The Profunder 320's short-term peak power input and output are shown in Fig. 4. The 320 is an extremely powerful performer here. The peak input power rises very rapidly to a very high 1,250 watts at 20 Hz and then levels out somewhat, reaching 2,200 watts at 80 Hz and 3,700 watts above 125 Hz. Below 32 Hz, the Whise's power handling is the highest I have ever measured.

The 320's peak output with room gain was also extremely high, reaching levels of 106 dB at 16 Hz (which is actually below its passband) and in excess of 120 dB at and above 20 Hz. At 32 Hz and below, the 320's maximum output exceeded that of any other speaker I have tested.—*D.B.K.*

would apply to the fifth claim, of the ability to make group delay very low.

After all is said and done, it appears that most of Huon and Cambrell's work was applied essentially to extending the operating range of a CDT system to frequencies above its upper tuning frequency. For the Profunder 320, this range corresponds to frequencies at and above the recommended crossover point of 80 Hz! In this situation, the PAM technology serves only to make the task of crossing over the subwoofer more difficult, because of the extremely rough and peaky response of the 320 above 150 Hz. As to the claim of higher efficiency, I suspect that an equally or more efficient pure CDT system operating between 20 and 80 Hz, without the PAM-driven extra cavities and channels, could be designed to work using the same 15-inch woofer operating in the same internal volume available in the 320.

But enough about the theoretical advantages and disadvantages and the claims and counterclaims. How does the system sound and perform? In a word, like dynamite! In both my lab and listening tests, the Whise Profunder 320 proved to be one hot contender, besting all other subwoofers I have evaluated. It did exactly what it was designed to do: produce gobs of loud, clean bass all the way down to subterranean 16-Hz territory.

One might expect that from the 320's size and weight. But after struggling with the transport and unpacking of the sub, I was rewarded several times over by its extremely fine looks and equally impressive performance. Although I don't agree with some of the designers' claims, the end result is certainly first-rate.

My 320 came finished in a very handsome Victoria rosewood, a finish with a decidedly red-tinged hue, which Australians call Jarrah. The 320 looks as though it were hand-crafted from one large block of wood. The finish blends seamlessly on all surfaces and is the equal of the best I have ever seen. The cabinet's rounded edges and corners add much to the total look.

I evaluated the Profunder 320 in my stereo listening setup, using it as a low-frequency adjunct to my B&W Matrix Series 3 reference loudspeakers. As my B&W speakers are no slouches in the bass department (they have a better and more extended low end than most speakers I have tested, including some of the subs), I was interested to see what the 320 would add to my setup. In short, a bunch!

As Whise did not supply a crossover for the 320, I used a Paradigm Servo 15 crossover I had on hand, set for 80-Hz low-pass operation with a third-order (18-dB/octave) slope, the steepest available from it. I used one channel of my Crown Macro Reference power amplifier to drive the 320 (the Crown is rated at 750 watts per channel with both channels operating). The B&W speakers were driven by a Krell KSA-250 amplifier (200 watts per channel into eight ohms). Other equipment included the Onkyo CD player and Straightwire Maestro cabling.

As I have for many past subwoofer evaluations, I derived the sub's drive signal from the main power amplifier's speaker lines through a passive summing network. This network compensated for a passive 100-Hz first-order high-pass RC filter inserted in the tape loop of the Krell preamplifier, which rolled off the low frequencies to the B&W speakers. This scheme eliminates the need to run unbalanced line-level cables back and forth between the power amps, which are at the speaker end of the room, and preamp, which is at the other end.

Whise packed no manual with the 320 subwoofer, but TMH supplied a five-page document that the company gives to its professional customers. TMH suggests that the 320 be mounted on a pliant surface that prevents direct contact between its cabinet and the floor. This serves to minimize rattles and "early sound." Early sound is solid-borne sound directly transmitted though walls, floors, and so forth and re-radiated into the room. Because solid-borne sound travels faster than airborne sound, the early arrival of the former may smear transient sounds. The paper also points out that the physical characteristics room and the location of the subwoofer can have far greater effect on what you hear than the basic characteristics of the subwoofer itself.

I placed the 320 in the right front of my listening room, about an inch from the right wall, with the front of the sub facing the wall behind it and about 4 inches away. This located the sub's sound-output slot about as close to the corner as I could get it. The Profunder 320 takes up so much floor space that I could barely get the B&W speakers returned to their standard operating positions.

On a wide range of program material, some with considerable bass and other with moderate amounts, the Profunder 320 proved to be an extremely agile performer, generating the loudest, cleanest, and lowest bass that I have heard in my listening room. What was particularly noteworthy was its effortless and seemingly nonstop high peak sound output capability. On my favorite woofer-destroying demo track, the cannon on Telarc's *Tchaikovsky 1812 Overture* (Telarc CD-80041), the 320 took all I could give it, generating awesome levels of bass while sounding very clean, even though the Crown amp was driven to hard clipping!

I did listen to the 320 by itself on male speaking voice, with the Paradigm crossover set to the 80-Hz low-pass operating frequency. This trick is always worthwhile on any system with a subwoofer. Ideally you should hear only bass coming from the sub, with minimal overtones that might draw attention to its location. I was easily able to understand what the announcer was saying, however, which implies that the 320 requires the steepest crossover you can get. Fortunately, the higher frequencies coming from the main speakers mostly mask upper overtones coming from the sub.

I found myself getting out all my favorite bass CD's, including several I haven't listened to in quite awhile. The 320's low-bass capability was very strong in the range below 20 Hz, with plenty of extension and output. The sub was equally at home with kick drum on loud heavy-metal rock music played at concert levels, with full orchestra kettle drum, and with special effects, from jet and prop planes to explosions. One of my young friends from church was very impressed with how well the Profunder 320 would reproduce the bass on one of his auto-sound demo discs, *Maximum Boom, The Ultimate Collection* (Pandisk Music PD-8878).

On band-limited, ⅓-octave noise, the 320 easily bested the B&Ws, even with both of the B&Ws operating! This was true for every band, from 20 to 200 Hz. At 20 and 25 Hz, the 320 could play much louder and

The Whise generated the loudest, cleanest, lowest bass I have heard in my listening room.

cleaner than the B&W's, and without the significant wind noise that the B&W's port generates. At higher frequencies, where the B&W's output would grow harsh at high levels, the 320 was still going strong. I did notice significant ringing and smearing on the 160-Hz burst when played on the 320. The B&W, however, was perfectly tight and clean sounding on the same burst. Of course, you would not normally operate a subwoofer to such a high frequency.

The Whise Profunder 320 is a big, expensive subwoofer, but it gives you an extremely big bass wallop in return. Its performance, looks, and workmanship are the best of any subwoofer I have tested. If you want all of this along with a lot of the latest technology, the 320 is for you. **A**