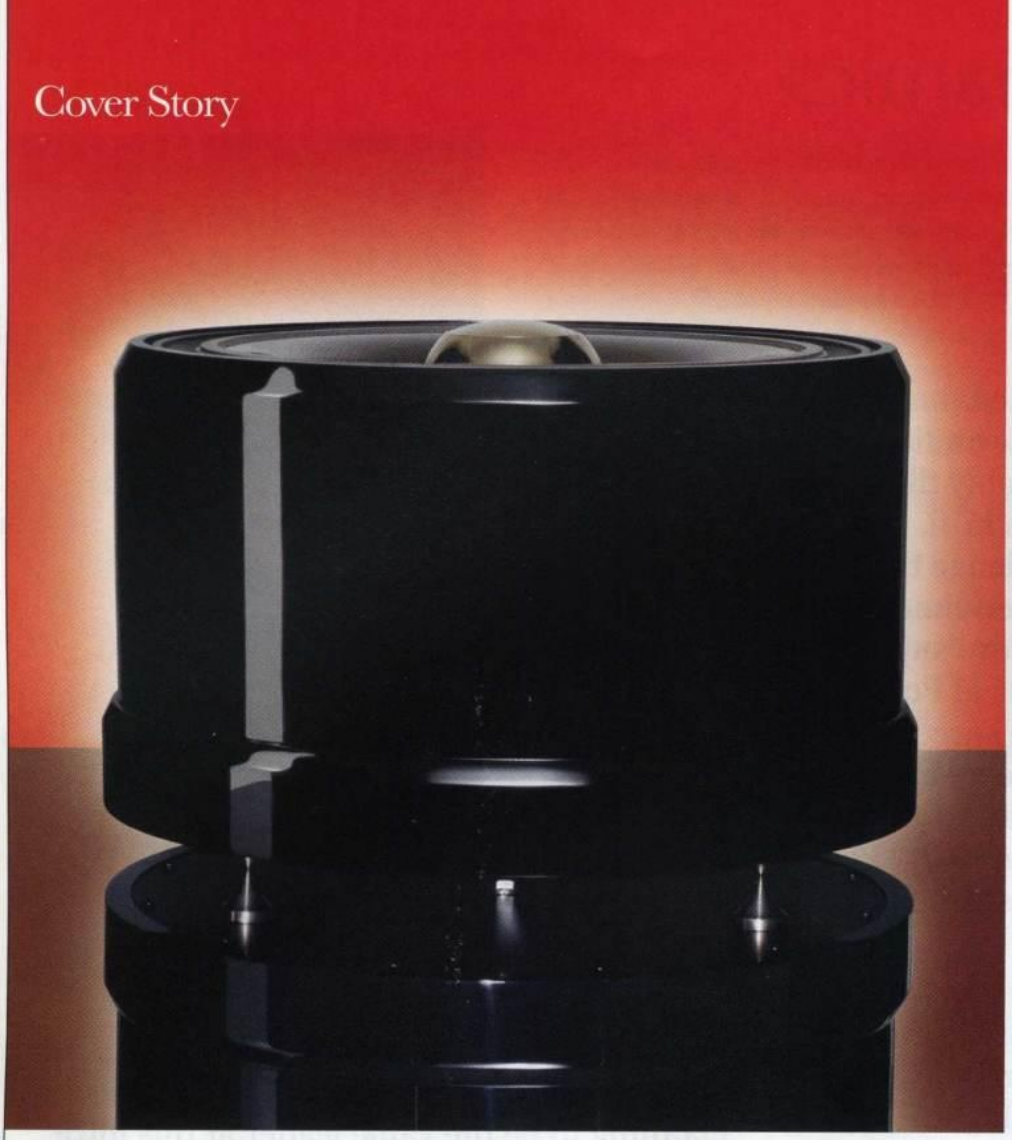


Wilson-Benesch Torus Infrasonic Generator

(and the MAGICO Mini "Super-System")

Jonathan Valin

Before I heard the Torus—the revolutionary "Infrasonic Generator" from Wilson-Benesch, the British hi-fi firm that put carbon-fiber enclosures, drivers, tonearms, and turntables on the audio map—my rule of thumb about adding a subwoofer to a fast, bass-shy speaker was the same as my rule of thumb about switching from an analog to a digital system: If you want to live happily with a subwoofer, then don't *ever again* listen to your main speaker without one. (And if you want to go all-digital, then don't ever listen to a record player again.)

Granted, good subs add "floor" and air to the soundstage, lifelike weight and color to the bass (and midrange) response of lower-pitched instruments, and floor-shaking extension and dynamics to grand pianos, bass drums, organs, acoustic and electric basses, synths, big bands, and full orchestras. The trouble is subs don't do these things for free. There is always a sonic trade-off involved that, to a greater or lesser extent, degrades the sound of the main speaker.

If subs stopped playing *exactly* at their crossover point—producing great bass below, say, 40Hz and no sound above that—everything would be dandy. But, of course, subs don't do that. All you have to do is turn off your main speakers while listening to a recording of a baritone vocalist to hear the sub playing on, ever so faintly, up into the midrange. Moreover, it isn't just the sub's driver that keeps sounding where you don't want it to sound. The big, generally-rectangular box the driver is housed in keeps speaking from all its planes and angles, too, as do the floor and walls around that box. The result is that you now hear two substantially different sound sources—each with its own timbral signature, phase and transient characteristics, radiating pattern, distortion, resonance, coloration, room interaction, and (generally) amplification—layered on top of each other, like a coarse wool sock pulled over a sheer nylon one. It is no wonder that this combination often *sounds* like two different things or like one satyr-like thing that degrades the coherence, transient speed, timbre, resolution, transparency, imaging, and

soundstaging of the quick, coherent, high-resolution, low-noise, bass-shy loudspeakers you started with.

After better than a decade of experimenting with subs of every size and type, I've concluded that if you want deep bass from a hi-fi system then buy a full-range speaker designed to reproduce deep bass. Don't buy a mini-monitor, add a sub, and hope for the best.

This, in fact, was the advice I gave potential purchasers of the MAGICO Minis—the 2006 TAS Product of the Year Award-winning two-ways that I reviewed in Issue 163. Great—in fact, virtually unbeatable—on chamber music, folk, acoustic rock, small combo jazz, and much symphonic music, the Minis are not the speakers for power-music lovers. Though they play with unusual clarity and nuance in the low end, like any two-way they won't do the 20–40Hz octave with lifelike authority and extension. While your first thought might be "subwoofer," asking the Minis to play alongside a lumbering sub is, as I once said about another speaker, like asking a sprinter to pass the baton to a weightlifter; it will just screw up most of what the MAGICOs do so well.

Or so I thought.

The trouble with subs is that they are being asked to do two incompatible things: to start and stop like your main speakers, while moving massive amounts of air

How I came to try the Minis with a pair of Wilson-Benesch Torus Infrasonic Generators (W-B doesn't use the word "subwoofer," for good reason as it turns out) is a story you can read on-line, at our AVguide.com Web site. (See the threads "War Declared over Magico Mini" and "MAGICO Minis and the Wilson-Benesch Torus" in the Speaker forum.) In a nutshell, I was goaded into it by a couple of readers who'd bought Minis and were curious to know if the MAGICO's virtues could somehow be extended into the bottom octave. As noted, I didn't think so, but the Toruses (then unknown and unreviewed in the U.S.) were novel enough to prick my interest.

The trouble with subwoofers is that they are being asked to do two incompatible things: to start and stop with the same speed, low distortion, and high resolution as the main speakers, *and* to play with chest-crushing power, volume, and extension down into the region where sound isn't so much heard as felt. To do the first thing you need an extremely nimble, relatively short-throw, small-diameter driver; to do the latter, you need a stiffly-suspended, long-throw, large-diameter driver. Alas, a large-diameter driver cannot start and stop with the speed of a smaller-diameter woofer; and a smaller-diameter driver can't move air like a big woofer. In both cases, you still have to house your drivers in an enclosure that is, itself, likely to interfere with stopping and starting on schedule because of its own resonances.

There have been any number of schemes intended to solve this conundrum—push-push woofers, push-

pull woofers, servo-woofers, bipole/dipole woofers, woofers loaded via transmission lines, woofers loaded via ports, woofers in sealed boxes, woofers without boxes. Wilson-Benesch's is, I believe, unique.

The problem was to develop a driver that had a large surface area (to move lots of air at very low frequencies) but that also had very low mass (to move that air with high speed and low distortion). Wilson-Benesch's brilliant chief engineer, Craig Milnes, reasoned that a large carbon-fiber diaphragm would have the necessary stiffness and low mass (the Torus' 18" carbon-fiber diaphragm tips the scale at less than an ounce and can withstand mass loads 100,000 times its own weight), but how could Milnes make it function, make it move air, without attaching a stiff surround, a spider, a basket, a large magnet, and an enclosure—in other words, without adding substantial and highly resonant mass?

There was an obvious solution, of course, but it involved a completely different kind of drive system. Electrostatic and planar speakers, which comprise extremely lightweight electro-conductive diaphragms that are essentially pushed and pulled between fixed poles in a electromagnetic field, can generate low frequencies without the attachment of stiff surrounds and massive spiders, baskets, magnets, and enclosures. But an electrostatic or planar-magnetic bass panel has to be very large and, of course, it will function as a dipole, with subsequent room-cancellation/augmentation effects that make it a generally poor choice for low-frequency reproduction.

Strokes of genius are rare in any field, but I think Milnes' Torus qualifies. Putting two of one and two of another together, as it were, Milnes reasoned: "Why not make a push-pull *cone* driver?" By attaching a voice coil to the top of an upward-firing, lightweight 18" toroidal diaphragm (essentially a ridged circle of carbon-fiber with a hole in its center) and another to its bottom, and connecting these voice coils to fixed magnets that aren't otherwise attached to the driver but, rather, to a precisely machined thirty-four-pound steel pole (called "the core" by W-B) that runs through the hole in the center of the toroidal

How can you make a sub function without adding substantial resonant mass?

diaphragm and is itself grounded not to the enclosure but to a massive steel plate at the foot of the enclosure, a lightweight cone could be made to function like an electrostat or planar-magnetic diaphragm. *Voilà*, a cone Magneplanar!

All sorts of side benefits accrue from this push-pull design. First, because of the equal opposing force of the two massive rare-earth magnets between which it is suspended, the lightweight carbon-fiber diaphragm will return instantaneously and automatically to the zero point between the twin poles as soon as the signal it is being fed ends—in other words, it will stop on a dime. Second, because a stiff surround is no longer necessary to act as a "spring" to restore the driver to the zero point (the highly flexible surround of the Torus functions solely to seal off the acoustic-suspension carbon-fiber cylinder in which the diaphragm and core are housed), the one-ounce diaphragm does not have to overcome the resistance of a suspension (or its own mass) to begin moving—in other words, it will start in a flash. Third, because of its extremely low mass, the Torus' diaphragm can be made large enough to move lots of air without any sacrifice of transient speed—velocity and control and massive air-moving power achieved through a single engineering masterstroke. Fourth, because the core and the diaphragm are more or less "free-standing" (not physically connected to the cylindrical enclosure around them but to the steel base plate and, through tiptoes on the plate's bottom, to the floor beneath it), all structural-borne energy is essentially grounded to earth, rather than to the enclosure (and hence to the room). Fifth, because the Torus is little more than an extremely lightweight, freestanding piece of carbon-fiber, the enclosure itself does not have to support a lot of mass and can thus itself be extremely lightweight—a small, sleek, beautiful black cylinder, like a small bass drum made of carbon-fiber, with no parallel sides and very low material resonance.

To drive the Torus Infrasonic Generator, Milnes made another series of thoughtful choices. Most modern-day subwoofers have built-in crossovers and amplifiers, a setup which is compact and convenient but which also adds considerably more vibrating mass to the enclosure. Milnes chose to make an outboard crossover/amplifier—removing another source of structure-borne resonance. Like REL and Vandersteen, he equipped his amp with high-level inputs that are fed, via a supplied Neutrik connector, from the positive and negative posts of

the main amp. The W-B amp—a 200W discrete solid-state unit—then boosts the current it samples from the outputs of the main amp, giving the entire system the sonic "flavor" of the main amplifier. (There are low-level inputs, as well, for systems sourced from home-theater controllers with their own crossovers—but see below for qualifications on home-theater use.)

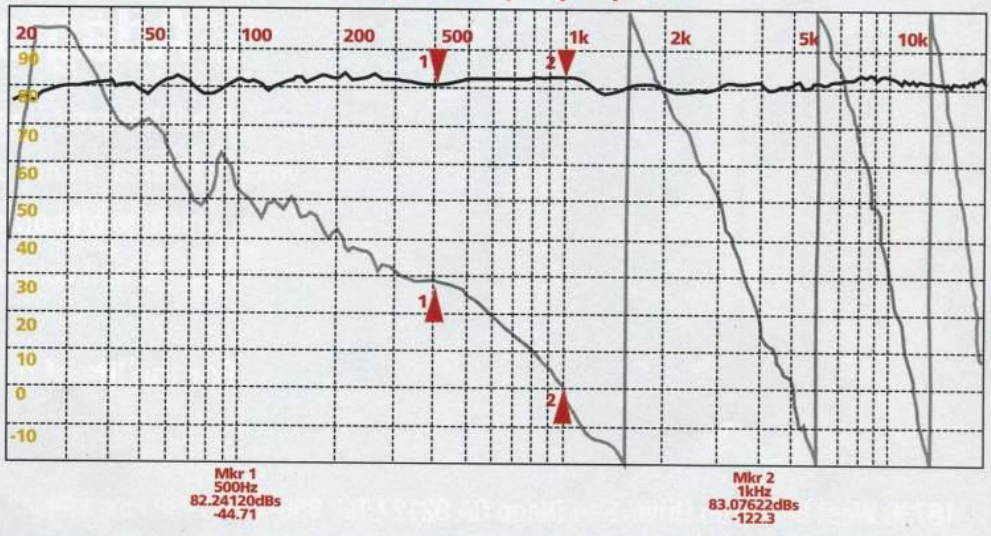
Though its crossover slope is fixed at 24dB/octave, the Torus' amp/crossover control unit does allows you to choose a low-pass crossover point from 30Hz up to 150Hz (in 3Hz increments), to set the Infrasonic Generator's output level via a rotary control knob at virtually any level within its 360° radius, and to adjust the phase anywhere from 0° to 180°. It also has a set of amplifier binding posts on its back panel, which are connected via speaker cable (not supplied) to one of two sets of binding posts on the Infrasonic Generator. A short pair of jumpers (supplied) is then hooked from the first (connected) set of binding posts to the second (unconnected) set of binding posts (from the hot terminal to hot terminal and ground to ground), so that both of the push-pull magnetic engines of the Infrasonic Generator's core are being fed the same signal. On the bottom of the control unit are a series of DIP switches that can be adjusted to provide boosts at select frequencies. (For more on optimizing these parameters see the sidebar on setting up and optimizing the Torus.)

Since I used the Torus—a stereo pair, actually—with the MAGICO Mini loudspeakers, there is really no way to talk about how well the Infrasonic Generator works without talking about the combination. In many ways, the Minis are a worst-case scenario for a subwoofer. Where they play (from the mid-40s up) they are so fast and clean and of a piece (and so free of box colorations) that I was convinced no "subwoofer" could keep up with them. That conviction was only reinforced by experiments I made with other subwoofers (prior to the arrival of the Toruses), all of which seemed to be playing in a different time zone than the Minis. Oh, the subs boosted the bass, of course, but at the same time they dragged the Minis down like a boat anchor caught in the weeds, slowing transients, obscuring details, and thickening textures to a point where the MAGICOs were no longer recognizably the world-class two-ways that won our 2006 Product of the Year award but merely good loudspeakers with nothing extraordinary to commend them.

The Toruses, however, were an entirely different breed of infrasonic generator. The moment I put them in I was impressed—not so much by what I heard from the subs but by what I heard from the Minis. The thing was *they still sounded like Minis*. Oh, beyond the improvement in the low bass, there were, I suppose, very slight losses in speed, transparency, and detail through the Mini's lower midband (and actually in the mid and upper bass). But you had to strain to hear them and with further refinements in setup even these small losses were reduced to a more-than-acceptable minimum—to a point where I preferred the Mini/Torus to the Mini Solus, to a point where I thought I had hit on a "super-system" that virtually any well-heeled music lover would want to hear.

As I did when I reviewed the Minis, let me show you one reason I'm so high on this combo. Though it is not typically in character for me to trot out frequency-response charts like a string of show ponies, this is a case (as with the Minis) where the test results speak volumes, simply because they jibe so closely with the way the Mini/Torus system sounds. Printed below you will see the quasi-anechoic frequency response (made with Bill Waslo's Praxis suite of measurement tools) of the optimized MAGICO Mini/Wilson-Benesch Torus super-system.

Loudspeaker Frequency Response



Specs & Pricing

THE SOUND ORGANISATION (WILSON-BENESCH)
159 Leslie Street
Dallas, Texas 75207
(972) 234-0182
soundorg.com

MAGICO
3240 Peralta Street, No. 5
Oakland, California 94608
(510) 653-8802
magico.net

WILSON-BENESCH TORUS
Type: Powered Infrasonic Generator
Power ouput: 200W RMS
Power handling: 1000W peak program
Frequency response: 10–150Hz, -6dB@18Hz
Input sensitivity: 1.0V (high-level)
Slope: 24dB/octave @120Hz
Dimensions: 11.8" high, 17.7" diameter
Weight: 75 lbs.
Price: $9395 (with amp/crossover); $5400 for Torus alone

MAGICO MINI
Type: Two-way acoustic-suspension loudspeaker with stands
Frequency response: 40Hz–40kHz ±3dB
Sensitivity: 87dB
Power handling: 200W
Dimensions: 16" x 12" x 17" (Mini); 26" x 15" x 18" (stand)
Weight: 80 lbs. (Mini); 120 lbs. (stand)
Price: $26,000 (with stands)

JV'S REFERENCE SYSTEM
Loudspeakers: MAGICO Mini with (2) Wilson-Benesch Torus subwoofers, MBL 101 E, Ascendo M-S MkII, Omega Max Hemp
Linestage preamps: Audio Research Reference 3, MBL 6011 E, Aesthetix Callisto, Lamm L-2
Phonostage preamps: Audio Research PH-7, Lamm Industries LP-2 Deluxe, Aesthetix Io
Power amplifiers: Audio Research Reference 210, MBL 9008, MBL 9011, Lamm ML-2
Analog source: Walker Audio Proscenium Black Diamond record player, Kuzma Stabi XL turntable, Kuzma Air Line tonearm
Phono cartridges: Air Tight PC-1, London Reference, Clearaudio "Titanium"
Digital source: MBL 1621 A transport, MBL 1611 DAC, ARC CD7
Cable and interconnect: Tara Labs "Zero" interconnect, Tara Labs "Omega" speaker cable, Tara Labs "The One" power cords, Synergistic Research Absolute Reference speakers cables and interconnects
Accessories: Shakti Hallographs; Walker Prologue Reference equipment stand; Walker Prologue amp stands; Richard Gray Power Company 600S/Pole Pig line/power conditioner; Cable Elevators Plus; Walker Valid Points and Resonance Control discs; Winds Arm Load meter; Clearaudio Matrix record cleaner; HiFi-Tuning silver/gold fuses

Folks, from about 26Hz up this is *astonishingly* flat response for a two-way mated to a sub (or for any speaker system), with far fewer of the peaks and dips than you might expect to see (and certainly to hear) in the crossover region—and no major peaks at all. This combo truly speaks with one voice—and at one speed.

I'm not going to kid you—it took considerable time and effort to achieve this blend and balance, much experimentation with placement, crossover point (I'm still vibrating between 33Hz and 36Hz, though this chart was made at 36), gain (in my 17' x 16' x 11' room a setting on the rotary dial of about 9:15–9:30 worked best), phase (in my setup, 90° produced the best Mini/Torus blend), speaker cables, and room treatment. But the sonic results were well worth the effort. All told, with acoustic instruments and analog sources this is the most lifelike stereo system I've yet heard.

However, it has its limitations. Somewhat ironically, the Mini/Torus sounds like a "super-Mini," which is to say that its strengths are the Mini's strengths: unusually neutral and natural timbres, extraordinary transparency to sources (hardware and soft), sensationally lifelike transient speed, superior imaging and soundstaging, a disappearing act second only to the MBL 101 Es, the most (and most realistic) inner detail I've heard from a dynamic speaker, and the most consistently realistic reproduction of voices and acoustic instruments I've heard from *any* speaker. What the Mini/Torus is not—and here the MBL 101 E comes in again—is thrillingly visceral, sonically spectacular, limitlessly dynamic, and seemingly unfettered in the subterranean range, circa 25Hz and below.

Oh, the Mini/Torus will reproduce the big bass drum strikes at the start of George Crumb's *A Haunted Landscape* [New World Records] with the kind of through-the-floor impact that'll make you jump (and it will sustain those big bass waves and keep them rolling towards you from the back of the stage for what seems like forever). It will reproduce the dark, clanking, bottom-octave *sforzandos* of the Steinway on Decca Head's great recording of Roberto Gerhardt's *Astrological Series* with something very close to the power, size, and color of an actual Steinway played *sforzando*. It will reproduce the explosive, deep-reaching Bösendorfer and gunshot percussion on Nova's superb LP of Reiner Bredemeyer's *Schlagstück 5*—an amusing post-modernist piece that, like so much avant-garde music of the 70s and 80s, sounds a little like acoustic instruments imitating the pitches and durations of electronic ones—with such presence and immediacy that you would swear you were listening to a vintage Sheffield direct-to-disc recording. And, speaking of Sheffield, it will capture the 16- and 32-foot pipes of the E.&G. G Hook organ on Sheffield's famous LP (not direct-to-disc, BTW) of the Mendelssohn First Sonata with perfect pitch and room-shuddering authority, and it will do this without any lumps in the sonic gravy, from the organ's deepest notes right up to its fluting highest (as you would expect from a speaker system that is this flat and clean and high in fidelity). Keep in mind that the Mini/Torus system does all this in the 26-100Hz range while retaining in full the Mini's magical ability to make voices and higher-pitched instruments sound "there in the room with you." Indeed, it hasn't been since the days of the Magnepan 1-U that I've heard a system that can more consistently give you the kind of goosebumps you get when you hear something or someone on record sound "real."

Now for what the Mini/Torus system won't do. Because the Torus is an acoustic-suspension speaker back-loaded by a relatively small volume of air, its resonance point is higher than what you would get in, say, a massively boxed feed-forward subwoofer like the Krell MRS. Were its enclosure (and the volume of air it is working into and against) larger, the Torus would go somewhat deeper. As it now stands, Wilson-Benesch (realistically) rates it as down 6dB at around 18–20Hz, and that is the way it sounds and measures in my room (where it is down about 6–8dB referenced to 1kHz at 20Hz, not counting room lift). In other words, the Infrasonic Generator is more of a truly great woofer (or a great cross between a woofer and a subwoofer) than a subterranean noise generator. This works out just swell with a two-way like the Mini, which, frankly, could use a great woofer. But it does not work out so well with certain kinds of music.

For instance, the lava-flow synths on Paula Cole's "Tiger Lily" go through-the-

(Cont'd on p. 104)

Setting Up and Optimizing the Torus Infrasonic Generator

It sometimes amazes me that reviewers blithely recommend adding subs to fill in the bottom octaves of your main speaker without warning you that this will not be a simple task nor a sure-fire improvement—and that you will always remain a little haunted by the thought that one more tweak of the volume knob or phase control or crossover hinge point or woofer's positioning will improve the "blend." Do yourself a favor and put away these childish thoughts. It's hard enough to get the damn things close to right without torturing yourself for the next five to ten years with daily doubts and second guesses about a sub.

Because of its relatively small size and compact enclosure, the Torus Infrasonic Generator is relatively easy to place and move around (one relatively strong and fit person can do it, although I'd recommend two). If you are using a pair of them, as I did, the best spot is immediately to the outside of each of the main speakers with the Torus' top magnet (which looks rather like the end of a chrome barbell) bisecting the plane of the main speaker's tweeter. If you are using a single Torus, the best spot is directly between the speakers, equidistant from both and, once again, with the top magnet bisecting the plane of the tweeters. Each Torus comes with a dust cover, packaged separately. Do not use (or consume) it. And do not use the Torus' DIP-switch "room-correction" circuit, either. Just play the thing in the "bypass" mode (which is how it is set when it arrives).

To come into the amp/crossover unit high-level, which is what W-B recommends (and so do I), you must connect your main amplifier to the Torus' amp/control unit. Wilson-Benesch supplies you with a long length of cable to do this, with a Neutrik connector at one end and three different colored strands of wire (yellow, red, and black) at the other. If you're using a single stereo amp, you will (after stripping all three wires) want to connect the yellow strand to the left positive binding post of your main amp, the red strand to the right positive binding post, and the black strand to the right negative binding post. The other end of the supplied cable plugs into the Neutrik receptacle on the back of the amp/crossover unit. If you are using two Toruses—and this is not made clear in the manual, although it is commonsensical—you will connect one of the two sets of red and black leads to the positive and negative binding posts of each channel of your stereo amp (or of each monoblock). The yellow leads will not be used and I would advise wrapping them in electrical tape and tucking safely out of the way under your amp stands. Once again, the Neutrik connectors plug into the backs of the two amp/crossover units.

I have explained how to hook the Torus up to the amp/crossover unit, but as the instruction manual is a little bewildering on this topic, let me repeat: You run one set of (really good) speaker cables from the binding posts on the back of the amp/crossover to one of the two sets of binding posts on the Torus proper. (It doesn't matter which set you choose—top or bottom.) You then use the supplied jumper cables to connect the two wired binding posts to the two unwired ones (hot to hot and ground to ground).

So much for the easy part.

Dialing in the right levels, crossover points, and phase is what will take you forever—and torture you forever. I've tried doing these things by RTA and SPL meter, but frankly, at least at first, by ear is best, provided that you know the sound of your main speaker by heart. If you don't, then...good luck. If you do, what you are listening for—as closely as you can—is the signature sound of your main speaker *without the subwoofer*. Play records or CDs with lots of information in the 40–400Hz range and see how much of what you usually hear in the way of detail, timbre, dynamics, imaging, and soundstaging from your main speakers is still retained—and how much has gone missing. With most more-or-less full-range loudspeakers or with a beefy two-way like the Mini, I would start my experimenting at a crossover point of around 40Hz (39Hz on the Torus' amp/crossover's LED readout) and a level of about 9:30 on the volume dial, going down and up (more likely down) in crossover point and level as your ear guides you. After you've come to a point where the crossover region sounds "right" to you—and the virtues of your main speakers shine through relatively untarnished—you may want to run an RTA curve or use an SPL meter to see if there are largish bumps or dips that will, over time, annoy you. Be especially careful of the 60–80Hz range and the 120-160Hz range, where most speakers in most rooms tend to lump up. (Some of these problems can be ameliorated by room treatment. You might also consider a DSP, although I wouldn't.)

Adjusting phase is trickier. You can do this by machine or by ear. Once again, I think ear is better at first. Remember: What you want is not just the most bass but also the clearest bass. Generally, both will be found at the right phase setting. Using an organ record (like the Sheffield disc I mentioned), listen closely to passages where the bigger pipes are playing. You're not listening for room-shuddering 32Hz notes. You're listening for continuity—for equal volume, pitch definition, and clarity at all bass-to-lower-midrange frequencies. (An organ will tell you if you've got a 60Hz hump more quickly than any other instrument I can think of.) Setting the phase correctly will not only improve the bass, it will improve the overall sound. Note well: If the midband starts to sound phasey on vocals, you need to re-set and start again. The object is the cleanest and fullest low-frequency response you can achieve without adding phase anomalies to the midrange. **JV**

floor deep with the Toruses, but not quite as powerfully deep as they do with the MBL 101 Es' bandpass subwoofers (but *only*, let me quickly note, when the 101 Es are driven by the $76k MBL 9011 amps at very loud volumes). Ditto for the synths and percussion on Trent Reznor's "The Perfect Drug" from the *Lost Highway* soundtrack CD. And neither the MBLs nor the Mini/Torus approach the sledgehammer impact and room-commanding authority of the mighty Krell MRS on any bottom-octave noise or note. All of which is a roundabout way of saying that if really low synthesizer is your thing, you can probably do better in a subwoofer. And if you're planning to use the Torus in a home theater—or a dual-function system—you can probably do better in a subwoofer (and for much less dough).

There is this, as well. While the Torus is relatively unlimited in acoustical power output, the two-way Mini isn't. At *very* high volumes (steady +100dB SPLs), the Mini rather runs out of dynamic steam ahead of the Torus, ironically holding it back dynamically. The Torus still wants to go (although it won't go far beyond +100dB SPLs!); the Mini does not.

However, neither the Mini nor the Torus were designed for head-bangers or for home theaters. Both were designed to reproduce acoustic music with the highest fidelity, and separately and in combination both do just that. I have never heard a subwoofed system that is more of a piece or (with the right sources) more consistently "fool-you" realistic—or a subwoofer that does less sonic damage to the sound of a superlative main speaker. For classical, folk, jazz, and much rock, this is, indeed, a "super system," well worth the $45k that two Toruses ($19k with amps/crossovers) and two Minis ($26k with MAGICO stands) currently command. You can do better in a sub below 25Hz, and you can do better in a speaker system in overall dynamic range and sheer visceral thrills (or what's an MBL 101 E for?), but, in my opinion and in the here and now, you will have a hard time getting closer to the absolute sound, particularly in a small-to-medium-sized room, than you get with this MAGICO/Wilson-Benesch combo. If ever I've heard a five-star speaker, the Torus/Mini super-system is it.

A Chat with Craig Milnes of Wilson-Benesch

Jonathan Valin: Craig, you might want to start by telling us a bit about yourself.

Craig Milnes: Well, I'm Craig Milnes, and I'm one of the founders of Wilson-Benesch, and I'm responsible for product design and development.

JV: The Torus was entirely your brain-child, was it not?

CM: Yes, but it might be a good idea to go back to where the concept came from. The starting point actually was the first loudspeaker we ever made, the A.C.T., which was quite a success for us. The problem with success stories, as far as distribution is concerned, is that they then put pressure on you to do something bigger and better. However, as soon as we started trying to make the system bigger and create the low frequencies that were important to a larger design, we immediately found that we couldn't achieve that without losing everything that was nice about the A.C.T., which, because it was a two-and-a-half-way, was really well integrated. As soon as we started using large diaphragms—even eight-inch units—driver integration was the first victim, and the timbre and quality of dynamics were completely lost. The only way that we found we could overcome this was actually to cheat—to use exactly the same drive unit we were using then, which was a six-inch Scan Speak, in an isobarik configuration. This gave us the kind of response we were looking for—nice, dynamic, controlled, accurate, low-frequency extension. But the problem then, of course, was that, in the design we were looking at, we'd've had to use far too many of these drivers. Happily, we got "smart-funding" from the British government to help us design a drive unit of our own.

JV: How long a design process are you talking about?

CM: It took us a little over a year to create what we call the Tactic drive unit.

The only way we were prepared to reproduce low frequencies was with something that was fully integrated with the midrange

Now, the Tactic was intended to serve a multi-role function. It was designed to be a midrange driver and a bass driver in the form of a clamshell isobaric. The Bishop speaker came out of this. It was the starting point that set the direction we followed—a development path that was completely different than everyone else's. Essentially all other speaker-builders were using woofers to generate low frequencies, and what we basically did was say this is not what we're about. The only way we were prepared to reproduce low frequencies was with something that was integrated fully with the midrange system. The Tactic enabled us to do that—to keep the same-size diaphragm and fundamentally the same dynamics as the midrange unit. But, even though it was a completely new development path, the Tactic could never generate the instantaneous high volumes of compressed and rarified air that you get from a big kettle drum, for example. It would reproduce low frequencies, but it couldn't move large amounts of air instantaneously. We had to develop something that was larger, without all the problems of the woofer.

When you're moving a large amount of air, there is enormous inertia; there are many forces trying to stop that diaphragm from moving. Our first idea was to create a larger isobaric Tactic in a clamshell, but

as soon as I started to do the drawings with the diaphragm, it was obvious that we could sink the motor right down into the diaphragm and get rid of the basket altogether if we could find a way of aligning the coils. And whilst it seemed like a really difficult problem at the beginning, it actually turned out to be not such a big problem, because when you create this precision-machined Core, it naturally aligns everything very, very precisely.

JV: Explain the Core for our readers.

CM: The Core is the key component of the Torus. It reduces everything down to a big, solid billet of steel and rare-earth magnet technology. Essentially what you have is about 34 pounds of steel, which is machined to very, very close tolerances which produces the main structure, as well as the push-pull motors and all the conduction facilities in terms of heat and structural-borne energy. The Core is where everything happens in the system. In conventional woofer design, you've got a large motor that is usually based on a ceramic magnetic material and occasionally a rare-earth magnetic material. This is then perched on what's called a basket, which for a woofer usually has to be quite large, and a die-cast basket, even when it's extremely well engineered, is still flimsy compared to a solid billet of steel. So the difference in mass and rigidity is quite large. But the most important difference is that all the energy that's generated in the motor in a conventional woofer goes straight through the basket and then straight into the outer enclosure, which is a key component of the structural integrity of any subwoofer. We're dealing with frequencies here that can make doors and walls and all sorts of things vibrate, so it can easily make a conventional subwoofer enclosure resonate. Designers can overcome this, but it takes a very, very strong metal structure to absorb that level of energy. The Core sidesteps all these problems essentially in one, single, high-precision component. All the resonant energy that's generated in the Core just goes straight down into a steel plate and then into the ground. The outer enclosure is not an integral part of that equation, it is completely separate, which is fundamentally different from conventional subwoofer design and is what really makes it possible for the enclosure to function without being excited.

JV: And the push-pull part?

CM: The Torus is essentially based upon the concept of controlling the diaphragm with a push-pull motor, which again is housed in the Core. The push-pull motor means that you can reduce the inductance of the coils. It also means that you can get rid of very, very stiff suspensions because the coils, being push-pull, naturally return the moving parts back to zero without the need for stiff suspensions. As soon as you get rid of these stiff suspensions, you have a system which is far easier to control. It's much easier to accelerate it and decelerate it, stop and start it, and therefore you get much more accurate response. If you can overcome the initial transient-defeating hysteresis of very, very stiff spiders, and usually quite stiff rubber surrounds as well, then you get rid of one of the biggest inhibitors of the movement of the diaphragm, and because you've got a push-pull motor system, the diaphragm will always return back to zero naturally. The suspensions and spiders in the Torus are extremely soft. The outer suspension, for example, has more to do with constraining the air than returning the diaphragm.

JV: Now, tell the folks at home why you called the Torus "Torus."

CM: A torus is a cylinder which is curved around another cylinder, essentially—a shape that is intrinsically and naturally incredibly stiff. Since the Torus' diaphragm has got to cope with very high loads, in terms of compression and decompression of the air that's inside the cylinder, we started with a toroidal shape that's incredibly strong and then used incredibly strong carbon fiber to realize our concept. By the way, this Torus' diaphragm material had only just become available when we started the R&D on this project. It was quite an important part of the actual development because if we hadn't had this material, we would have had to do the diaphragm in petals of carbon composite, which would not have been nearly as strong as the design we actually ended up with. What we have in fact is just one sheet of carbon that is woven, but woven in a way that doesn't have a warp and weft. Essentially the fibers are stitched on to one another and therefore when you bring the fibers over the form they distort and conform to the shape quite naturally, and align themselves in the best direction to deal with the forces that they're going to be subjected to.

JV: Let's talk a bit about how you're driving the Torus. Do you have to buy the amplifier as well?

CM: No, you can buy the Infrasonic Generator by itself. People who have a multichannel system and a processor to tell the amplifier what to amplify and what not to amplify, can use it to drive the Torus. But for people who are listening to music, who are the people the product was aimed at, we believe very strongly that a high-level input delivers the most natural and most integrated sound, and if you use the Torus amplifier you can take a high-level input directly from the amplifier that's driving the main speakers and feed it to the amplifier for the Torus, and it will give a very, very nice signal to the Generator that blends seamlessly with the main speakers. That's the main concept here in the amplifier—a seamless blend.

JV: Given how many advantages accrue from push-pull drive, why not use it on the midrange?

CM: There is work being done on that, and it is something that is likely to become more achievable when magnet technology becomes more powerful than what it is today. Essentially the neodymium motor has allowed us to reduce the magnet's diameter dramatically, and I'm quite confident that in a small number of years it's going to be possible to create even more powerful neodymium motors that you can get down to about the size of a bullet. Then not only can you have the benefits of the bullet design in terms of slimmer cabinets, but you can also begin to incorporate the benefits of push-pull in smaller diaphragm structures. It's just a question of devoting time to it and trying to look for the best solutions—for Wilson Benesch. I think there is also a scope for interesting product developments with this concept from other companies.

JV: It's rare to come across something that is a path into the future, but the push-pull Torus certainly strikes me as one. ***TAS***