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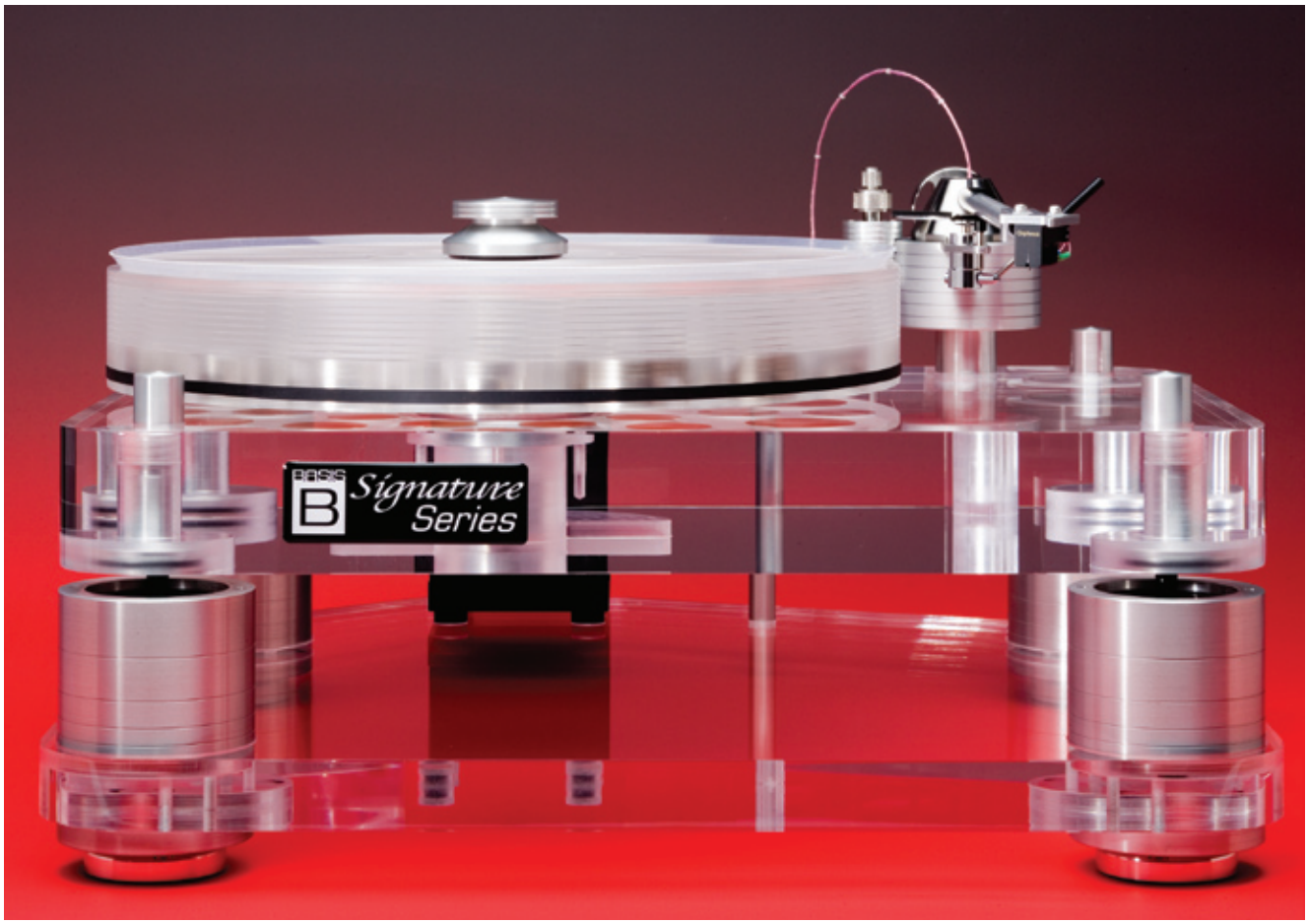
Two Decades of Research Produce a Masterpiece

BASIS AUDIO 2800 SIGNATURE TURNTABLE AND BASIS VECTOR TONEARM

Robert Harley



I've met quite a few fanatical design engineers in my 18 years of full-time audio reviewing, but Basis Audio founder A.J. Conti is among the most obsessed with engineering detail. For the past 23 years, he has attacked every subsystem in LP playback with a missionary zeal, pursuing tighter bearing tolerances, greater mechanical precision, ever-thinner and more precise drive belts, lower speed instability, and less noise and vibration reaching the platter and arm. Conti believes that turntable performance is very much an exact science, and that better measurable mechanical performance directly correlates with better sound.

The culmination of his decades-long obsessive quest for engineering perfection in turntable design is the Basis 2800 system reviewed here. Although the 2800 has been in the Basis line for some time, many of the turntable's subsystems are either new or significantly upgraded from previous versions. Moreover, this is the first U.S. review of the Basis Vector tonearm, a device that employs an innovative yet elegantly simple bearing that solves a fundamental problem in LP playback.

Overview and Pricing

The 2800 Signature is part of the "High-Mass" Series of turntables that includes the 2500 and Debut. The 2800 is identical to the model 2500, but with the addition of a vacuum hold-down system. The base price of the 2800 is $12,900. Options include the Calibrator Base ($1800), a 1"-thick piece of machined acrylic that increases the turntable's isolation from vibration; the Synchro-Wave Power Supply ($3600), an outboard box that drives the motor; and the VTA Micrometer ($800), a VTA measurement and calibration system. My review sample was fully loaded and mounted with the Vector Model 4 tonearm ($3450). I actually had two Vectors along with an external tonearm mount that holds the unused tonearm, thus allowing very fast switching of tonearms and cartridges.

The accompanying sidebar and interview with A.J. Conti provide more details of the engineering behind the 2800 and Vector.

Listening

Most of my listening was through a Transfiguration Orpheus cartridge supplied by Basis. After auditioning several cartridges, the Orpheus turned out to be the best musical match for my system. Although it didn't quite have the dynamics of the other contenders, it was the most musically involving and had the greatest sense of ease.

I don't have anywhere near the experience with mega-buck LP front ends as, for example, Jonathan Valin (who, incidentally, owns a Basis Debut). But I have a fair amount of experience listening to microphone feeds and analog mastertapes made

Specs & Pricing

2800 SIGNATURE TURNTABLE
Dimensions: 17.25" x 15.75" x 7"
Weight: 51 lbs.
Warranty: Ten years parts and labor
Price: $12,900

VACUUM HOLD-DOWN
Dimensions: 5.85" x 2.25" 10.25" (control unit)
Dimensions: 8" x 5" x 8" (pump)
Weight: 6 lbs. (control unit)
Weight: 15 lbs. (pump)
Warranty: Ten years parts and labor
Price: Included with 2800

CALIBRATOR BASE WITH CABLE ISOLATION SYSTEM
Weight: 13 lbs.
Warranty: Ten years parts and labor
Price: $1800

SYNCHRO-WAVE POWER SUPPLY
Dimensions: 13" x 2.25" x 10.5"
Weight: 12 lbs.
Warranty: Ten years parts and labor
Price: $3600

VECTOR MODEL 4 TONEARM
Effective mass: 11–15 grams
Warranty: Ten years parts and labor
Price: $3450
Optional VTA Micrometer: $800

BASIS AUDIO
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ASSOCIATED EQUIPMENT
Wilson MAXX 2 loudspeakers; Aesthetix Rhea phonostage; Mark Levinson No.326S linestage preamplifier; Mark Levinson No.433 power amplifier; Shunyata Hydra-8 and Hydra-2 power conditioners, MIT Z-Center power conditioner, custom isolated AC ground system; Shunyata Antares and MIT Magnum MA interconnects; MIT Oracle Maximum Articulation loudspeaker cables; Acoustic Room Systems acoustic treatments; Acoustic Sciences Corporation (ASC) 16" Full-Round Tube Traps (x3); Billy Bags equipment rack

Four Resonance Annihilators isolate the subchassis and damp unwanted vibration.

from those mike feeds, as well as to LPs cut from those tapes.

Listening to records on the 2800/Vector was revelatory; the sonic shortcomings of the LP format (which are readily apparent when LPs are compared with analog tape) seemed to disappear. The 2800/Vector had an astonishing transparency to the source and lack of coloration, tonally and dynamically. It was like hearing music—for the first time—without the turntable and arm in the playback chain.

Even compared with the Basis 2500 (which I reviewed about 10 years ago), the 2800/Vector took LP playback to new heights. The descriptions that kept coming up in my listening notes share a commonality: "clean," "transparent," "crystalline clarity," and "pristine." All describe the Basis' lack of a signature sound—no false midbass warmth, no thickness through the midrange, and no patina overlaying the music. As a result of this startling clarity, instrumental timbres were reproduced with stunning realism. But the naturalness of instrumental timbre was not just the result of the Basis' transparency; it was also related to its retrieval of inner detail. This front end digs way down and resolves the finest musical nuances. I've heard Peter McGrath's wonderful recording of *Water Music* [Harmonia Mundi] on many different systems over the years, but when I played this record on the Basis, I sat slack-jawed at the richness of texture and vivid palpability of the period instruments. There was simply another level of micro-detail in the timbres that transformed their sounds from good hi-fi to pure music.

Conti believes that turntable performance is very much an exact science

One would think that realism of instrumental timbre is important on period baroque instruments and less so on distorted electric guitar. But the Basis reproduction of timbre was no less stunning when resolving the beautifully textured distortion of Steve Morse's guitar on the Dixie Dregs' *Dregs of the Earth*. His expressive and moving solo on "Hereafter" had a palpability that fostered the impression of sitting directly in the presence of a guitar amplifier. Because of the Basis' resolution of low-level decay I could even hear the studio's rather dry acoustic surrounding the amplifier's sound. The distortion now had a beautiful complexity that made perfect musical sense. It's odd to describe distortion as beautiful, but when reproduced with such resolution, there's no better description. Listening to this record, I heard for the first time the subtle (and not so subtle) differences in the guitar's sound from track to track, recognizing how each sound perfectly fit the composition. It gave me a new appreciation for this record, which I've been listening to on a regular basis for the past 25 years. (Incidentally, Neil Young's main complaint against CD-quality digital audio was that it destroyed the distortion of his guitar.)

This experience of discovering greater expression in familiar music is the overriding reason for owning this LP playback system. The level of musical involvement fostered by the 2800/Vector was unparalleled in my experience as a reviewer. It's been said that great hi-fi allows you to immediately become involved in the

Design Details

A.J. Conti set up the 2800/Vector in my home, took me through the design details, and showed me some of the techniques he uses at Basis in both the design process and production.

A fundamental design goal is to reduce as far as possible relative motion not caused by groove modulation between the LP groove and the stylus. The cartridge can't distinguish between relative motion caused by the signal in the groove (music) and motion caused by resonances (tonearm, record, platter, etc.), air- or structure-borne vibration, motor noise, and other forces. These spurious movements add non-musical colorations to the signal, reducing realism in timbre, dynamics, soundstaging, rhythmic drive, and many other qualities that separate a reproduction from the live sound. Once these colorations become part of the signal at the phono cartridge, nothing downstream can remove them.

Vibration Isolation and Damping

The 2800's main line of defense against spurious vibration is the four fluid-damped "Resonance Annihilators" on which the 2"-thick subchasssis is suspended. These pods contain series and parallel springs and dampers that not only isolate the subchassis, but also damp vibration. The optional Calibrator Base ($1800) precisely aligns the pods with the subchassis, adds another layer of vibration isolation, and supports and aligns the free-standing motor. The Calibrator Base also comes with a tonearm cable isolation system (for use with the Vector tonearm) that further decouples the turntable and arm from vibration that might travel along the tonearm cable.

The 20-pound, 2"-thick acrylic platter is riddled with 32 holes into which brass plugs are inserted, a technique that reduces platter resonances and spreads them out in frequency. A vacuum hold-down system tightly couples the record to the platter to prevent the record from vibrating. This system consists of a small control unit, a larger vacuum pump, tubing, and a raised rubber ring along the platter's outer diameter to hold the vacuum. A multi-turn knob and vacuum gauge on the control box allow highly precise adjustment of the vacuum. The spindle bearing is part of the vacuum system, passing the vacuum to the platter without compromising the bearing's performance. The vacuum system is designed to rapidly pull a vacuum, yet maintain a minimal vacuum level of just 0.5PSI of negative pressure to prevent dust on the record underside from being pressed into the vinyl.

The result of this heroic engineering effort is a turntable that is extremely inert, damped, and isolated from vibration. After setting up the 2800, Conti conducted a number of tests demonstrating the turntable's freedom from vibration. With the stylus on a lead-out groove on a stationary record and the gain turned up quite high, Conti struck a pencil firmly on the record an inch away from the stylus with absolutely no sound from the loudspeakers—the vacuum hold-down and

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music, at a greater depth of immersion and for a longer period of time. That definition fits the Basis; as soon as I started playing music, my attention was immediately rapt. As for the depth of involvement, I can say that I had many listening moments that transcended the threshold from musical enjoyment to euphoria.

> It was like hearing music—for the first time—without the turntable and arm in the playback chain

Getting back to specific sonic description, the 2800/Vector also excelled at dynamics, transient fidelity, and bottom-end impact. I thought I had reached the edges of the Wilson MAXX 2's performance envelope in these areas, but the 2800/Vector revealed that this remarkable loudspeaker is capable of even greater dynamic coherence, bottom-end resolution, and sheer visceral slam. I just had to pull out the direct-to-disc Sheffield 23, *James Newton Howard and Friends*, for its explosive drum dynamics and bottom-end punch. This record has one of the best drum sounds ever captured, but I didn't realize how great the drum sound was until I heard it on the 2800/Vector. The steepness of the snare's leading-edge transient and equally sudden decay was mind blowing. The system resolved the initial "pop" of the drumstick hitting the head as well as the weight behind the initial transient created by the drum's resonance. In fact, playing this record on this system rendered the most realistic and startling reproduction of dynamics I've ever heard in reproduced music.

The Syncro-Wave Power Supply and vacuum-control unit

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platter combination effectively damped the impact's energy. We also placed a stethoscope on the subchassis and hit the top of my equipment rack—I heard no hint of sound through the stethoscope. (The stethoscope is quite sensitive; when it is placed on the equipment rack itself, gently running a finger over the rack's surface produced an intolerably loud noise.)

Mechanical Precision

In addition to this obsession with vibration isolation, Conti is fanatical about mechanical precision. He pursues smaller and smaller numbers—numbers such as bearing tolerances, platter run-out (out of round), and platter-speed variations. For example, we measured the platter run-out on my review sample at ±5 microns, or 0.0002". This measurement shows the sum of all rotational errors, including an out-of-round platter, bearing-centering error, or oil-film float ("shaft walk"). (You can get a rough idea of a platter's run-out on some turntables by holding the edge of a business card against the spinning platter and looking at variations in the gap width.) The bearing tolerances are at the limits of mechanical precision; the bearing shaft diameter tolerance is just ±1.2 microns (one one-thousandths of an inch is 25.4 microns; a human hair is about 75 microns in diameter). The bearing's oil gap is 6 microns, and each platter is hand-matched to the bearing. The bearing and platter are marked for the most precise orientation, so that the dealer or customer can repeat the optimum orientation. Note that these tolerances are achieved on a production basis in currently made turntables, and represent an improvement over previous Basis 'tables.

Revolution Drive Belt

The drive belt is a story in itself. Five years ago, Conti discovered, to his great surprise, that a turntable with a smoother belt had a two-to-one speed-stability advantage over a similar turntable with a platter four times heavier and with one-third the platter run-out. Since then he's pressed belt manufacturers around the world for tighter and tighter tolerances in the belts' thickness variations. Although this approach yielded smoother belts, Conti finally bought precision grinding machines to build the belts to his specification. The result is the new Revolution Belt, a drive belt with a thickness variation along its length of just ±0.6 microns, an astonishing achievement for a compliant material. Why is such precision necessary when the belt is connected to 20 pounds of rotating mass? Variations in belt thickness along its length modulate platter speed because the effective outer surfaces of the two pulleys (the motor pulley and platter) are in the middle of the curved belt. Belt thickness variations momentarily change the effective ratio of the two pulley sizes, introducing speed variations. According to Conti, we hear such speed instability not overtly as pitch fluctuation, but as a reduction in instrumental realism, a less convincing soundstage, and degradation of low-level decay. (Incidentally, there's a company using DSP to remove speed variations in analog master tapes that has reached similar conclusions

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Each drive belt is measured for thickness consistency

In addition to this macro-scale "jump factor," the presentation had a resolution and clarity in a micro-sense that let me hear fine shadings of pitch and small-scale dynamic contrasts. As a result, the music also had a flow and rhythmic bounce; the previously mentioned *Water Musick* was reproduced with a playful dance-like rhythmic interplay between the instruments on the Minuet of the Suite in F Major.

I was struck by the sonic similarity between the 2800/Vector and the results of the 2002 acoustic upgrade of my listening room (which I had built from the ground up). Acoustic Room Systems installed a computer-modeled acoustics package that, among other attributes, dramatically tightened up the music's bottom end. After the ARS installation, low frequencies had much better pitch definition, steeper transient reproduction, quicker decay, less bloat, greater dynamic agility, more upper-bass and lower-midrange clarity, and the feeling that the music wasn't being dragged down by a weight. These impressions are all fostered by a reduction in room resonance. Room resonances are nothing more than vibrations of the air within the room that are not parts of the signal produced by the loudspeakers. Room resonances cause transient information to be spread out over time, prevent sudden decay of transient energy, add tonal coloration, reduce pitch articulation, and overlay the music with a bass thickness that masks midrange clarity and transparency.

I think a parallel phenomenon is happening with the 2800/Vector; the dramatic reduction in spurious vibration at the stylus/groove interface confers a reduction in the same distortions that cause listening rooms to color the sound. The resonances in LP playback are mechanical and occur at the micro level; the resonances in listening rooms are acoustical and occur at the macro level. (The effects of micro-level resonances in

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about the effects of speed instability. Watch for a full report in an upcoming issue.)

Conti also discovered that when the material from which his belt is made is thinner, the sound was better. Although he couldn't measure any improvement in speed stability, he did measure greater isolation from motor noise. This led to the Microthin version of the Revolution belt, which is so thin it is translucent.

Synchro-Wave Power Supply

The Syncho-Wave power supply ($3600) drives the turntable motor's two coils with two sinewaves 90° phase-shifted, each powered by separate amplifiers. These two sinewaves are independently generated, in contrast with the more common technique of using a capacitor to create a phase-shifted replica of a single signal. The benefit of this approach is smoother motor rotation, something one can demonstrate by simply holding the running motor; it is impossible to tell if the motor is spinning or stationary. Conti claims the 2800's motor has the smoothness of a DC motor (which has no cogging) without a DC motor's servo-related problems. The Synchro-Wave power supply has been shipping since May, 2006, and can be added to any Basis turntable.

Vector Tonearm

This is the fourth-generation Vector that includes Basis' newly developed tonearm cable that reportedly eliminates phase distortion and incorporates "High-Mu" electromagnetic shielding. The Vector is a variation on the unipivot arm in that it does have a single-point bearing rather than gimbals. But Conti has eliminated a source of distortion in LP playback by devising an ingenious new design that is unique in tonearms. That innovation is to asymmetrically weight the arm (with a cutout in the counterweight) so that it "leans" over onto a second bearing. This technique completely eliminates the possibility of dynamic azimuth error despite the fact that the vertical load rests on a point-loaded pivot. (Azimuth is the perpendicular relationship between the stylus and the groove; an angle less than or greater than 90° is azimuth error. Record warps can cause conventional pivoted tonearms to "roll" or constantly change their azimuth alignment.) In addition, Conti claims that this design completely eliminates audible tracking error, even on the most difficult-to-track passages.

A cup holds silicon damping-fluid in which the upper portion of the bearing and arm tube rests. Conti personally assembles the pivoting assembly of each Vector, and signs off the QC form (the arm is also QC'd by another person). The optional VTA Micrometer ($800) allows you to precisely measure and repeat VTA settings. (Note that the VTA Micrometer is a measurement system, not a VTA adjustor.)

The Vector has a unique quality; when playing a record with the volume turned down, the arm is perfectly silent. You can hear other tonearms "talk" or "chatter" as they vibrate in response to the stylus movement. This phenomenon appeared to translate into the complete absence of mistracking during the auditioning. **RH**

LP playback, however, become macro-level distortions when amplified.)

The 2800/Vector system's portrayal of space, depth, and air around instrumental outlines, and particularly the interplay between instruments, was simply peerless. The impression of individual instruments separated by air and surrounded by an acoustic space greatly added to the sense of musical realism.

Finally, the 2800/Vector combination had another quality that is unique in my experience—a sense of ease, particularly on loud and complex passages. A shortcoming of the LP format is the tendency for the sound to congeal and harden at high signal levels. A related phenomenon is the "shattering" sound on forte piano passages played in the instrument's upper register. Both are caused by the imperfect tracking of the groove by the stylus (the stylus momentary loses contact with the groove)—a phenomenon exacerbated at the inner grooves where tangent error is the greatest and the linear velocity as seen by the stylus is the lowest.[1] Several times I found myself "tighten up" to brace for passages I knew would sound hard and distorted, only to discover that the Vector sailed right through them with a sense of ease and composure. I heard no tracking error on any LP. This freedom from distortion on challenging passages fostered a deeper and more sustained immersion in the music.

Conclusion

The Basis 2800 Signature Turntable and Vector tonearm are models of insightful design and exquisite execution. I don't know of any turntable—at any price—that is designed and built to the level of precision exhibited in the Basis 2800. I think of the 2800 as the "thinking person's turntable"—it's short on bling but long on substance. Although nearly $22k is a substantial chunk of change by any measure, I think there's no wasted money in the design. It is possible to pay far more for a turntable and get far less performance.

I'm hard pressed to recall a component that has elevated the musical experience for me as much as the Basis 2800/Vector combination. Playing records on this turntable was nothing short of exhilarating, leaving me counting the hours until the next listening session. I can think of no higher praise for an audio component. ***TAS***

[1] Tangent error is a difference in orientation to the groove between the cutting and playback styli. (Tangent error occurs in pivoted tonearms but not in tangential-tracking arms.)

As the stylus moves toward the inner grooves, the linear velocity as seen by the stylus gradually decreases. The recorded wavelengths become shorter and shorter, making it increasingly difficult for the playback stylus to accurately track high frequencies as well as high groove modulation. A CD, by contrast, varies its rotational speed as a function of recording radius to maintain a constant linear velocity of 1.2–1.4 meters per second. This translates to about 500 rpm at the innermost tracks to about 200 rpm at the outermost tracks.

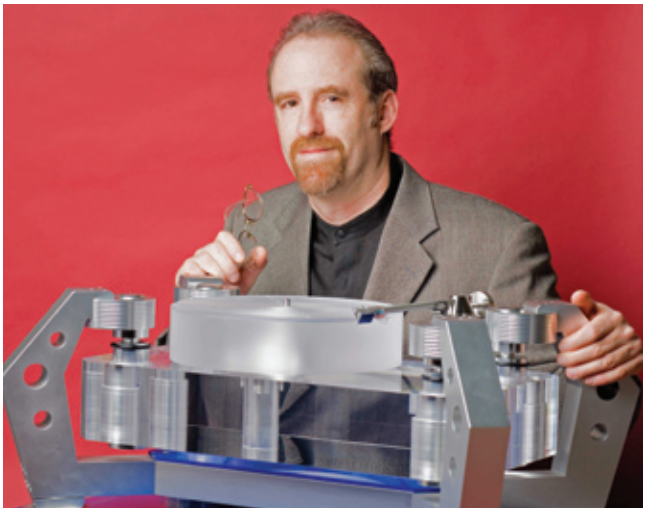
It's an unfortunate coincidence that LP technology performs at its worst on the climaxes most prevalent in Western classical music—the climax of a symphony's fourth movement occurs nearly invariably on the innermost grooves. It also coincides with the point in the music where the intrusion of distortion is least welcome.

the absolute sound®

Pursuing Perfection

BASIS AUDIO FOUNDER A.J. CONTI TALKS WITH ROBERT HARLEY

Robert Harley



Robert Harley: Let's start with a little bit of history about how you began making turntables.

A.J. Conti: The audio bug bit me when I was about ten years old, and by my early 20s I had a nice system with Snell Type A speakers and a Linn turntable. I didn't know that there was a high-end industry and didn't read *The Absolute Sound*, but I lucked out to get such good equipment.

I was playing music at a family get-together when someone walked across the room and the footfalls were picked up by the turntable and blew the woofer in my Snell speaker. I thought back to my first year in engineering school [*Conti has a B.S. in Mechanical Engineering*—RH], where I learned about mass-spring-damper systems, and thought that with the proper critical damping and isolation that woofer wouldn't have blown.

I decided to make a suspension system for my Linn, then a platter, and suddenly realized I should design an entire turntable from scratch. This was 1984. I had just started a small retail audio business out of my house. I had a great job with Teledyne Corporation and had my eye on the presidency of my division. I wasn't looking to get into the business of making turntables for a living—I thought perhaps three or four people would want to buy my product. I made the prototype and was only expecting that it would never skip from someone walking in the room, and perhaps that I'd *maybe* hear a small difference in the bottom end. That was all I was expecting. When I cued the first record—Thelma Houston's *I've Got the Music in Me*—I was absolutely shocked. Her voice was so effortless and out of the speakers. I started demo'ing the table in my small retail dealership, and everyone who heard it wanted one. Word got around, and [Krell founder] Dan D'Agostino talked me into exhibiting it at CES with him. I showed the prototype and walked away with 50 orders. It was crazy.

RH: This was the Debut.

AJC: Yes, the Debut. I went from knowing nothing about the high-end industry to becoming an obsessive-compulsive perfectionist. A year after I started shipping the Debut I quit my job and devoted myself full time to building turntables.

RH: You've said that turntable design is more science and less art than, say, loudspeaker design.

AJC: I probably oversimplified a bit because I do think there's a lot of science in speaker design, but with a transducer a lot of what happens is so difficult to measure. The ideal speaker designer would be willing to make small changes to voice the speaker, even if those voicing changes are difficult to measure or if they contradict a purely technical approach.

Listening is an important part of turntable design, but I've never had the experience of making a change based on listening and then saying: "Science wouldn't lead me in that direction."

RH: So there's a direct correlation between what you can measure and sonic performance?

AJC: Exactly. The correlation seems so uncannily repeatable, which isn't the case with loudspeaker performance. The science points us in a very logical direction. Listening is important, but we corroborate that listening with measured performance or seat-of-the-pants tests we've developed, like cuing a stylus down on a platter and putting ringing tuning forks of different frequencies on the platter to excite the platter in different ways and listening to the cartridge output. When we make a platter that's less ringy and more linear across a wide frequency range, the sound is more neutral. When we achieve better speed-stability numbers, it translates to better sound. We make a belt that is ten times more precise in terms of thickness variation, and it sounds better than a conventional belt. It's a no-brainer. Theory seems to always coincide with what you hear.

Turntable design looks complex because there are so many subsystems, but each subsystem can be optimized totally independently. Look what I did with belts. I consider the belt

a subsystem of the drive assembly, which is the motor, pulley, platter, and belt. But I broke that subsystem down even further to the simple question of perfecting the belt.

RH: How do minute variations in belt thickness affect the speed stability of 20 pounds of rotating mass?

AJC: The speed of a driven pulley—in this case, the platter—is determined by the ratio of the diameters of the two pulleys. With a flexible belt going around the pulleys (the drive motor and platter), the *effective* radius is the distance from the pulley center to the neutral axis of the belt. By this I mean the point within the bent belt where the fibers are in neither compression (as in the inner part of the bent belt) nor extension (as in the outer part of the belt). When the thick part of the belt hits the pulley, the pulley's effective radius increases and it speeds up the platter. When the thin portion of the belt hits the pulley, the effective radius decreases and the platter slows down. Immense fluctuations in platter speed can be caused by variations in belt thickness along its length. We can easily measure it; if you have a belt with three bumps you will see—even with a 20-pound platter—three different speed-ups and slow-downs per revolution.

Turntable design looks complex because there are so many subsystems, but each can be optimized

RH: Do we have the hearing acuity to recognize those speed variations?

AJC: Boy, do we! Most people, including me twenty years ago, thought: "If I don't hear speed instability of a turntable, then it's below threshold—so who cares?" But long below the point where someone might recognize fluctuation of the actual tone, the phase is changing, because that tone is slightly changing frequency. It affects the decay of instruments and is quite easily audible. The music sounds clearer without speed fluctuations.

When you measure something for 20 years and keep improving it, a thousandth of an inch starts to look like a mile. Sometimes we laugh because a belt that varies in thickness by one thousandth of an inch is completely unacceptable to us now, yet that variance is one-quarter the thickness of a sheet of notebook paper.

I talked to all kinds of manufacturers of belts, and no one wanted to even attempt doing tighter tolerance than we were getting with our existing belt manufacturer. So I brought belt-making in-house and designed a specialized machine to grind belts to precise tolerances. We achieve thickness uniformity—on a production basis every day—of ±0.6 microns.

RH: Give us an overview of the technical innovations and the 2800.

AJC: People always want to hear about what's new. Our vacuum hold-down system is fifteen years old, but it still represents an innovation, because, as far as I know, it's the only vacuum system done with an oil-well bearing, which is the smoothest type of mechanical bearing there is. The two generally don't go together.

The Synchro-Wave power supply is relatively new. It drives the motor in the ideal manner, with two independently generated sinewaves 90° apart rather than with a single sinewave that's been split with a capacitor. It's more expensive—you need two amplifiers—but it results in a huge increase in motor smoothness.

RH: What led you to develop the Vector tonearm?

AJC: I wanted a pivoted tone arm that everyone could play and that would approach or equal the non-resonant sound of a great air-bearing tonearm.

In tonearms that use gimbal bearings I could hear bearing resonance unless the bearings were tightened so much that there would be very high friction. Unipivot tonearms had certain tradeoffs in terms of azimuth, float, and lack of impact, because there is an azimuth reaction to a balanced tonearm. Pull on the stylus, and that arm's going to rock.

I was working on a gimbal-bearing design and had the idea to side-load the arm—put more weight on one side—so it leans to one side and takes up any bearing slop. Then it struck me that I could do the same thing with a unipivot—make it lean in one direction, let it fall over, and give it something to fall over on: a lower bearing.

There's no way that any stylus could possibly pull the side-weighted tonearm up off the lower bearing. It's absolutely dead perfect in azimuth, and stays that way during the entire play of the record.

The design is certainly not a unipivot, but it's not a gimbal-bearing design, either. Engineers are taught that you make tradeoffs—an improvement in one area of performance has a price in another area. With the Vector, there are no tradeoffs—it has the azimuth precision of a gimbal-bearing arm without the problems introduced by ball bearings.

The Vector is the most important product we make in terms of musical satisfaction and preservation of records, which I think is not talked about enough in this industry. The most precious things aren't anything I make; they're the records. With any decent cartridge the Vector totally eliminates mistracking, which I think is an incredible thing. For me, it solves the worst sonic problem of analog playback, which is hashy, spitty, aggressive mistracking—that high-distortion sound toward the center of the record, when the going gets tough, the volume gets loud, or the signal complex. Eliminating that, for me, makes the musical experience so much more seamless while playing a record—and it saves records.

The Vector isn't the most expensive product we make, but the payoff isn't measured in money. You end up being pretty miserable if money is how you measure your life, or success, or happiness. The real payoff is when folks are thrilled, when they just love what you do. ***TAS***