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EDITOR'S CHOICE

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# Priceless!

Continuum's £115k Caliburn has set a new benchmark for vinyl replay

**PRODUCT** Continuum Caliburn, Cobra and Castellon

**TYPE** Turntable, tonearm and stand

**PRICE** £115,000

**KEY FEATURES** Size (WxHxD): turntable 61.5x20.5x40cm; stand 64x102.5x50cm • Weight: turntable 73kg; stand 80kg • Speeds: 33,45,78rpm • Cobra dual-pivot tonearm • Motor drives up to 80lb • Computer-controlled start-up • Battery-powered DC motor • Finishes: Black lacquer or various wood veneers

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**T**urntables come in all shapes, sizes and prices. But here's one so extreme in its pursuit of perfection it breaks the mould. The Continuum Caliburn is not only the most expensive turntable ever made; it's also one of the heaviest, one of the most solidly engineered and (not least) one of the most functionally attractive and elegant too. The Caliburn is undoubtedly a *tour de force* – a labour of love. The design aim was simple: produce the finest turntable possible, regardless of cost.

But this is 2009, not 1979. That the 'obsolete' vinyl LP still fascinates fresh generations of listeners is nothing short of remarkable. The creators of the Caliburn are living proof of this. They didn't start as vinyl aficionados; being of a certain age, their introduction to hi-fi came via CD. The love affair with analogue LPs began when they

encountered a top-class turntable and experienced a quality of sound CD didn't approach. This led to a desire to produce a new 'super turntable' – one designed from the ground up and without compromise.

**“The Caliburn is a labour of love. The design aim was simple: produce the finest turntable possible, regardless of cost.”**

Access to universities with advanced testing and measuring facilities meant the early part of the design process could be 'simulated' using advanced computer software. After certain fundamentals were established, prototypes were built and evaluated. While no single factor explains the Caliburn's superior performance; there are several significant design details.

Among the most important is the motor – a battery-powered DC-type, developed to be free from the 'cogging' effects common to virtually all motors. It has sufficient torque to drive the 30kg platter and is in absolute control – power isn't reduced once the platter reaches speed, nor is any deliberate belt slippage allowed (two-ways lesser turntables reduce the cogging effect). The motor is built in-house and constitutes a significant part of

the Caliburn's cost. Speeds of 33, 45, and 78rpm are available, with +/- fine-tuning.

The Caliburn's chassis is made from solid magnesium alloy, chosen for its strength and low resonance properties. However,

magnesium is a difficult material to work with and not easy to finish, so the front and sides of the deck were given aluminium panels, creating a more attractive appearance, with the top section veneered in French walnut as standard.

A magnetic suspension system was developed for the centre bearing and plinth suspension. With the latter, powerful magnets are placed with their poles opposite one another to create a 'floating' system that's firm, but de-coupled. While the platter weighs a hefty 30kg, magnetic part-suspension ensures the Oil-Pressurised Hydrostatic centre-bearing only supports a load of around 2kg. Magnets also play a similar role in the Castellon stand.

A great turntable deserves a special arm and the Cobra looks quite different to most tonearms on the market. Its shape was dictated by the desire to avoid symmetry, which might lead to common resonance modes. The arm shell is made from fibrous resin and is inherently self-damping. Many different types of bearing were considered, but eventually a kind of stabilised uni-pivot arrangement was chosen. This has the advantage of very low friction, high torsional stability and excellent rigidity.

Cartridge vta and azimuth can be precision-adjusted while the disc plays and the counterweight is placed below the tonearm's centre of gravity to improve stability and the tracking of warped LPs. Not that warped LPs would trouble this deck; the Caliburn incorporates a special vacuum mat with air pump that sucks the (continues p39) ▣



We spoke with Dr Murali Murugasu, Continuum's head of development, about the Caliburn.



**HFC: Why the choice of a battery-powered DC motor?**

**MM:** We chose a suitable battery power supply to provide an adequate filter and instantaneous current supply for the motor-drive electronics. We take the incoming local AC and drop it down to low voltage via transformer and other circuitry to trickle DC into the battery system. The drive electronics then regenerate clean three-phase AC from the battery power supply to drive the brushless DC motor topology we've built. We generate each of the three pure sine waves by means of DSPs and combine this into a true zero-cogging drive. That means no magnetic cogging, no hall transition effect, no hysteresis, no back EMF, no PWM chopping etc.

**In choosing materials for the deck (i.e. plinth, platter), what criteria were you guided by? Did you avoid certain materials?**

Firstly, in our opinion, all turntables have a plinth. Even the 'plinthless' ones. Whatever material the bearing/platter assembly sits on becomes the 'plinth'. That means choice of materials is critical. Our engineering experience led us to understand that any moving mass (such as a platter) would generate flexural modes in the attached bearing and chassis (or plinth) assembly. The ability of the material (used for the 'plinth') to handle the 'platter' vibrational modes is critical. Measurement analysis using Young's Modulus, Poisson Ratio, Damping Factor, Coefficient of Expansion etc, had a profound impact on our choices.

The platter mass (chosen for inertial stability) drives the choice of bearing material and associated design, which drives the chassis material and associated design. We always try to use off-the-shelf materials where possible, but found many of the engineering problems we encountered required us to create specifications for application-specific materials. For example, where a portion of the design indicated a need for more damping factor, we engineered the materials to address the need.

Our experience with advanced metallurgy meant we could customise the material properties to address the underlying engineering need. Where polymers or aramids were appropriate, we selected the properties required by the design objective.

**How big a part did measurement play in the design? Was there a clear correlation between measured performance and sound quality, or were there instances where, say,**

**a chosen material measured well but didn't sound as good as a material that measured less well? And if so, which did you choose?**

Measurement plays a big part in our methodology. We believe an engineer can't fix what they can't see. To that end, we have access to some of the most advanced measurement technology currently available today. That includes an NDT ultrasonic, laser interferometer, three-axis accelerometer and other well-respected measurement tools. However, these tools measure an end outcome: the finished product. That means the design has to anticipate the problems, which the measurements will disclose. We use advanced visualisation technologies such as Finite Element Analysis (FEA) and shape optimisers to refine designs.

We also believe the ultimate measurement is how it sounds. If a design or material sounds 'wrong', it is wrong. As engineers we're trained to avoid subjective arguments, but as audiophiles we understand the music must come first. Our design methodology allows the engineering and audiophile viewpoints to co-exist in harmony. If the audiophile in us hears a sound effect, then the engineer in us will work to explain the cause and effect. In this way we increase our knowledge base and develop accurate models to predict the behaviour of designs.

That means what we measure must actually sound 'correct'. An example is the Castellon. After the design and FEA work, we used three-axis accelerometers and broadband noise sources to stimulate the stand. We then measured the attenuation of the device and were satisfied as to the efficacy in real-world operating conditions. When we turn the levitation feature in the Castellon to the 'off mode', the sound is less optimal than with it in the 'on' position. In this case the measured and actual sonic performance agree.

**Were you guided by subjective appraisals of sound quality, or was it more a question of producing a deck that met specific technical criteria? Or was your aim to achieve both?**

Our reference is live music, both acoustic and amplified. The bandwidth within the constraints of the media should be open and even. The technical design criteria had one goal in mind: accurate rendition of the source material. Our listening panel is comprised of experienced audiophiles and music lovers. Many of us play instruments or attend regular live performances of classical, jazz, blues, rock and other genres.

We expected the Caliburn system to 'get out of the way' and let whatever is in the groove out by not interfering with the LP and the cartridge. If the recording engineer let the music in, we will let it out. Our design approach has been proven in other fields, such as aviation, where we spent many years solving complex engineering problems.

With the turntable, ideas were taken from their DNA to reality through a mixture of deterministic and systematic design methods and principles. These still allow for the wild card of a passionate designer and team thinking outside the box. The many key design elements such as the 'floating' arm board, which were new to turntable design, led to breakthroughs in sonic performance.

While we have a heavy reliance on software design tools, we don't allow these tools to corner us into a box of systematic conformity. Though a design can always be optimised with the help of software, we allow our designs to be free and unconstrained, yet proven by physics and reality.

The listening test is crucial for us. We believe the real-world performance of a component when playing music is the ultimate test. We lessened the engineering challenge by using advanced software to optimise the performance in the virtual world. This isn't simple Computer-Aided Design (CAD), but a revolutionary approach where shape-optimisation software is used to prototype and measures the performance of a device in the virtual world based on accurate material properties and constraints.

The design is the work of the designer, who places these virtual objects into the optimisation process. Due to our prior experience with these tools, we expected an accurate correlation between our design, the software [see [www.advea.com](http://www.advea.com) and [www.mscsoftware.com](http://www.mscsoftware.com)] and the end result. We were delighted when both the technical and performance objectives were met. The virtual world when fashioned into a real product worked beyond our expectations.

**Would you say there's a particular aspect of the Caliburn's design that gives it its unique quality? Or is the design all of a piece?**

There is a balance of the individual components that make up the whole design. While each area was addressed as a separate module, the overall goal was always in mind. The core design concept of 'quiet' zones meant that the motor had to reduce cogging and hysteresis to hitherto unrealised levels. We understood jitter would be influenced by servo-correction systems, so that meant a holistic design where belt drive was chosen over direct drive. The platter had to exist in its own 'quiet' zone, so that required a nested platter, where inertial and support loads are segregated to reduce plate modes under the LP surface. The chassis, while appearing to be non-suspended, was actually designed to address the flexural issues from having a large platter mass in motion. The arm board technology was also a breakthrough in design terms. A revolutionary approach to fixing an arm board rigidly, while creating an isolation-and-damping mechanism so that any tonearm could sit in a 'quiet' zone. ▶

◀ Other parameters such as vacuum hold-down had been done before, but we extended this to include an ultra-quiet pump that turns off during playback. An oil-pressurised hydrostatic bearing was chosen over air, to again lower the noise floor. We partially levitate our platter by magnetic means to avoid the springing and bouncing an ungrounded design would suffer from. This vertical bouncing modulates the music signal. We took great care to design our bearing system to prevent 'bounce' modes, which arise from precessional rocking of any spinning mass. Again, we show evidence of this in finite element models on our website, showing dynamic conditions of a rotating platter across a broad frequency range. Our design for the Caliburn revealed that without a tonearm and matching stand, the performance would be limited in ultimate potential.

**How important is the Castellon stand? Given the design of the Caliburn, isn't it relatively independent (sonically speaking) of what it sits on?**

Anyone who's heard the difference the Castellon makes will attest to the performance increase. The heavy damping the Castellon provides can be measured using active broadband noise sources in proximity to the stand. The Castellon is also designed to address the residual motions of the Caliburn chassis, bearing and motor system, as well as lessen the effects of external inputs. In some space-limited installations, we've placed the system directly in the path of very powerful speakers with no deleterious effects.

**False modesty aside, is the Caliburn/ Cobra/ Castellon the best that could possibly be achieved for vinyl replay at this point in time? If some rich, crazy audiophile wanted to spend even more, could you possibly come up with something even better?**

The Caliburn/Cobra/Castellon, while a no-holds-barred approach to vinyl playback, was limited by some commercial constraints. For example, there were more exotic materials that were only available in non-commercial samples at the time we formalised the Caliburn system. Some of these held great promise and we look forward to the day when they'll be more readily available.

We are pleased that the Caliburn system has generated so much interest in vinyl as an ultimate quality source and has been recognised by industry peers and experts as having broken new ground. Our R&D process is ongoing, and we invest heavily in engineering research on many fronts. Fortunately we have access to many tools and technologies not usually found in turntable-design companies. Our website highlights the backgrounds of the team who worked on the Caliburn and Criterion systems.



◀ record flat to the platter. This virtually eliminates LP dishing and warpage, while dampening resonances that might occur within the vinyl LP itself. The pump takes a few seconds to achieve suction; after that, it's switched off while the record plays. Our review Caliburn was pre-fitted with a Koetsu Red K Signature which sounds absolutely magnificent – rich, tactile and highly detailed – even if it could be considered a bit 'low-priced' in this context!

Although the Caliburn is highly inert and very well isolated, the Castellon stand is an integral part of the package. It provides a solid, stable platform for the turntable, houses the motor power supply and pump, and raises the deck to mid-chest height, making it easy to use. The complete package comes in six boxes with a total shipping weight of about 450kg and an actual weight of 300kg. Installation is a two-man job, taking about eight hours.

**SOUND QUALITY**

So – what might the 'perfect' turntable actually sound like? While CD sets a benchmark in terms of pitch stability and overall security, it lacks other qualities. The Caliburn certainly equals CD on its home territory, giving an exceptionally solid, secure and stable musical presentation. It sounds absolutely unflappable – as though nothing short of an earthquake could upset it.

On instruments such as piano or acoustic guitar, there's no wobble or pitch waver.

Playing a recording of Beethoven's *Pathétique* piano sonata, the heavy chords that open the work decayed with absolute steadiness. There was no hint of pitch variation – none.

Not knowing, most listeners (this one included) would assume that a CD was being played – it's that stable. And the Caliburn boasts another type of stability. Voices and instruments stay put in the stereo soundstage and don't shift or wander as the music alters – each individual strand maintains complete independence and individuality, while overall the music sounds cohesive and coherent.

Playing the live 1982 LP *Ongaku Kai* by the Crusaders, the turntable creates a coherent, yet holographic soundstage with huge amounts of percussion detail. Partnered by darTZeel amplification and Magico V3 loudspeakers, it reveals previously hidden space and detail. On the 1989 LP *Sybil*, the spatial width and depth of the various layers of voice and backing are almost palpable; the music seems to hang in free space – behind, above and around the loudspeakers. The bottom end is very deep, with impressive weight and power. ▶



It's like listening to master tapes rather than LPs. The music has the sort of effortless ease and fine subtle detail you get from first-generation masters. Soundstaging is airy and holographic – very 'out of the speaker boxes' – extremely dynamic and lively. The Caliburn offers an intriguing mix of opposites: exceptional tightness and control, allied to extremes of bandwidth, dynamic contrast and tone colour, topped off with a creamy-smooth effortless ease.

It's capable of the utmost subtlety and delicacy, quiet passages possessing considerable refinement. Yet there's nothing fragile about the sound; it's always solid and full-bodied and the overall presentation has an impressive robustness. The deck is like the best CD you never heard; it presents the music with comparable security, but brings extra finesse and broader dynamic extremes to the mix.

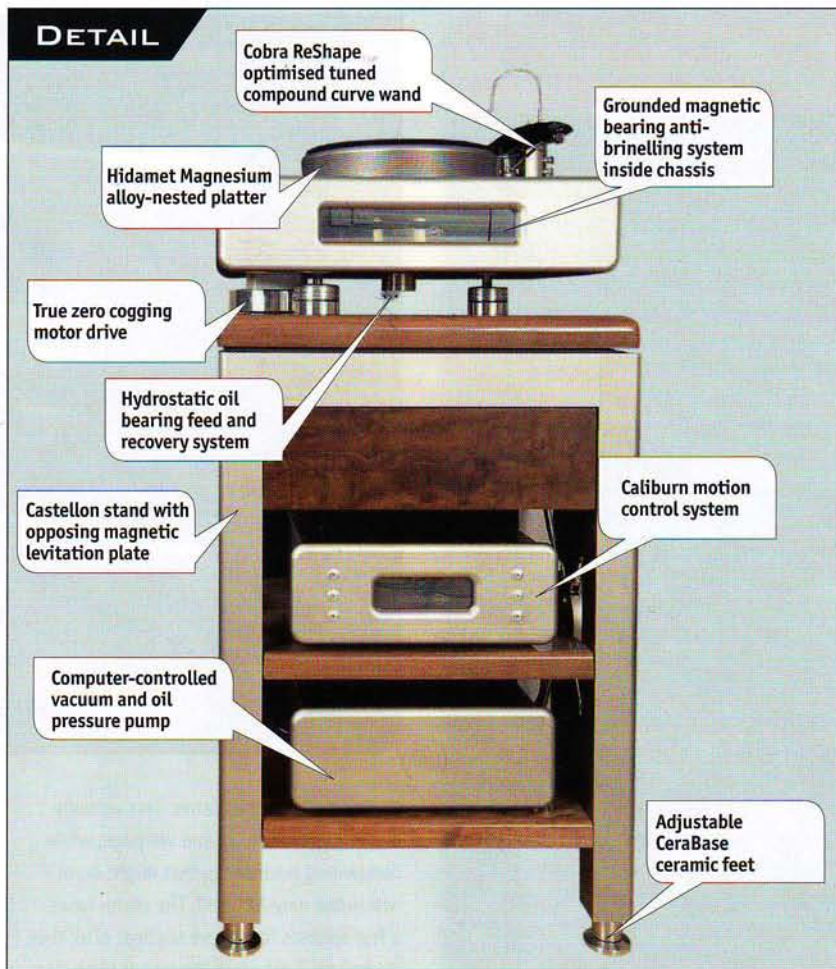
The Caliburn also has the ability to keep surprising you. One minute it sounds smooth and honey-rich, the next it's sharp and tactile. But, to be accurate, it's not the turntable surprising you; it's the music and the original recording. The Caliburn liberates your recordings – allows them to be more like they really are, rather than constrained by limitations in the playback equipment. As a result, voices and instruments display a greater range of tonal colours.

It's this that distinguishes the turntable from even the best CD players. The Caliburn produces a wider variety of sounds. Given a reasonably good LP, the music keeps on surprising. By comparison, CD has a degree of 'sameness' – LP offers subtler individual tonal colours, plus more finely shaded dynamics.

Of course, the vinyl experience encompasses more than just sound quality. There are all those enjoyable little rituals – removing the disc from its sleeve, wiping the surface, cleaning the stylus, cueing the arm. Playing LPs is a very 'hands-on' personal thing. Because you're part of the process, you're more involved.

And there's something else. When you play an LP – especially a vintage original – something intangible happens. Your listening experience changes. It's almost as if the living, breathing aura of the musicians permeates the LP sleeve and grooves, making the music sound and feel different. Fanciful, perhaps – but often, that's how it seems as the stylus touches down...

The Caliburn/Cobra/Castellan is an exceptional combination, producing results far greater than the sum of its parts. It offers outstanding focus and solidity, allied to incredible detail and stunning dimensionality.



## “...how do you define ‘expensive’? Aston Martin recently launched its One-77 sports car in Geneva – at a cool £1.25m...”

Of course, it costs a bomb. But you definitely get what you pay for.

Value is a tricky subject. A product that offers class-leading standards of performance, a genuine pride of ownership, plus an exceptional finish and battleship build quality can be said to offer good value even if its price is very high. And anyway, how do you define 'expensive'? Aston Martin recently launched its One-77 sports car in Geneva – at a cool £1.25m, it makes the cost of a Caliburn look like small change.

But equipment like the Caliburn is worth celebrating. Yes it's expensive, but it also sets standards. It takes a certain dedication to the cause to push the theoretical performance limits of a format beyond typical price constraints. And as Dr Murugasu says in our Q&A, the quest for absolute perfection was only limited by the restricted amount of exotic materials his team could get their hands on. Will anybody else put this much

effort into finding perfection ever again?

The Caliburn is for life. It's not inexpensive, but how do you value a lifetime's pleasure and enjoyment? **HFC**

*Jimmy Hughes*

VERDICT	
<b>SOUND</b> ★★★★★	<b>PRO</b> Represents the absolute ultimate in vinyl replay. In terms of both engineering and sound quality, the Caliburn is quite simply in a class of its own.
<b>FEATURES</b> ★★★★★	
<b>BUILD</b> ★★★★★	<b>CON</b> Very big, very heavy and very, very expensive! Sadly, perfection doesn't come cheap. And there's no lid or cover included.
<b>VALUE</b> ★★★★★	
<b>CONCLUSION</b> The Caliburn is one of those elite products audiophiles dream about – a pinnacle to aspire to, a benchmark by which others are measured. It's hardly cheap, but for those able to afford the best, it's an inspiring product that sets new standards.	
<b>HI-FI CHOICE</b> OVERALL SCORE ★★★★★	
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