

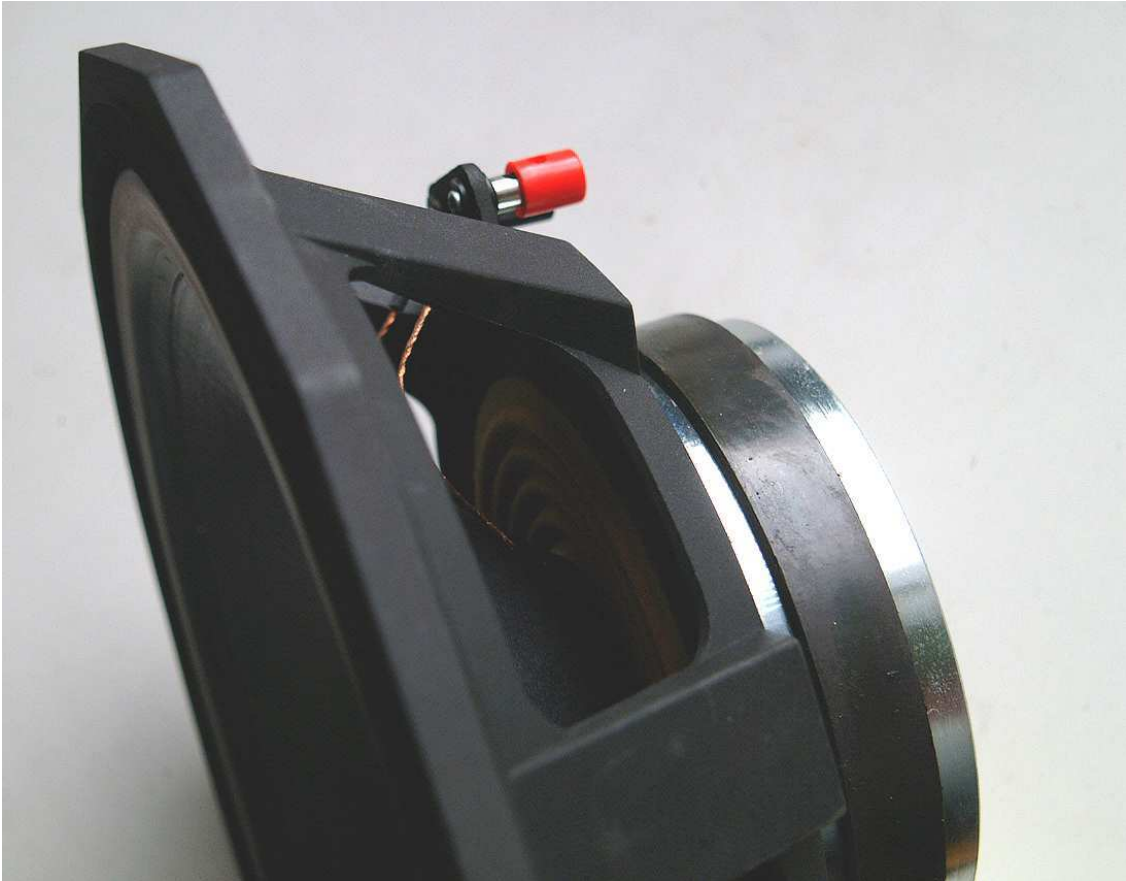
Wilson benesch

torus

**White Paper**

## INTRODUCTION

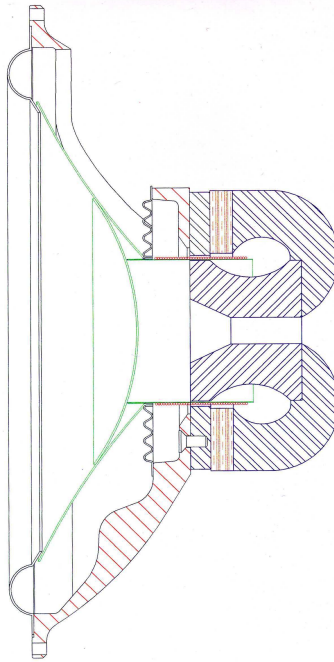
Because These  
Don't Work.....



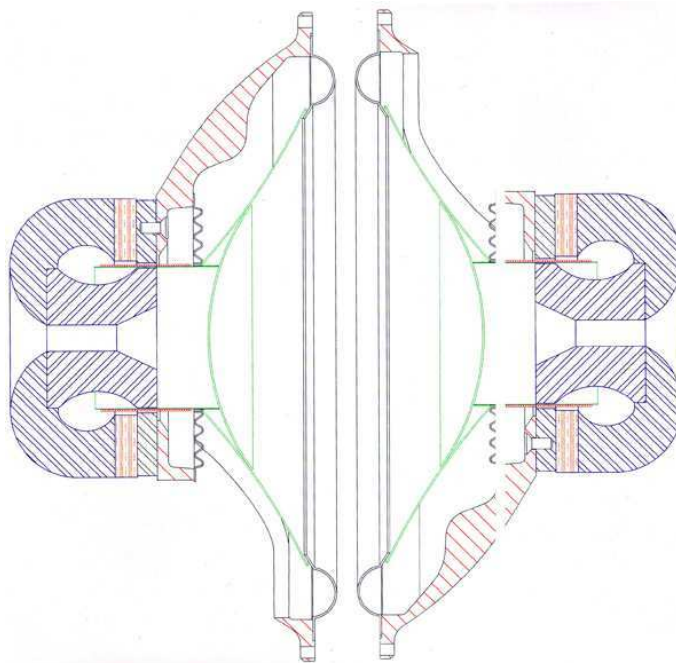
We Designed Something That Does!

So we started here!

And created this

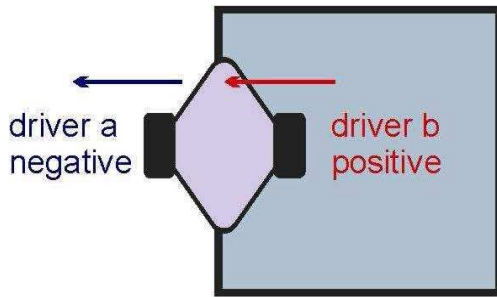


To do this

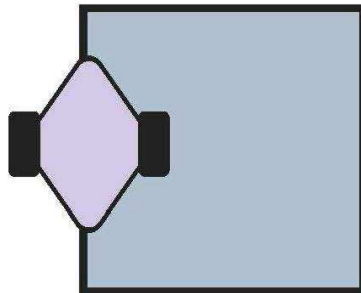


Isobaric Tactic<sup>®</sup>

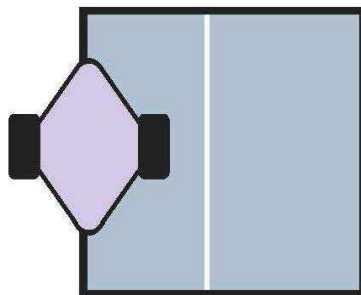
# Benefits of the 'CLAMSHELL' Design



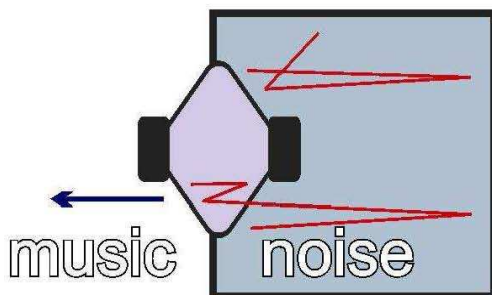
CLAMSHELL orientation of Tactic drive unit cancels third order non-linearity's.



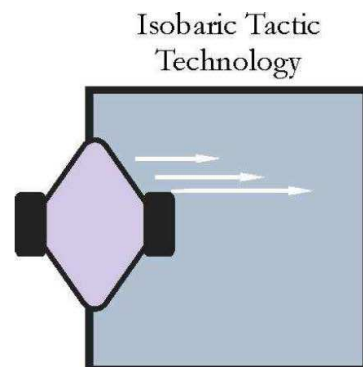
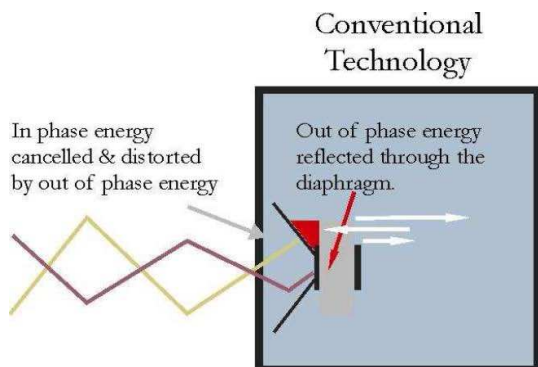
At 200 Hz and below the composite diaphragm is coupled and can be seen as a solid, super lightweight structure.



For a given limit of low frequency, the enclosure volume required by the Isobaric is half that of the single driver, conventional option.

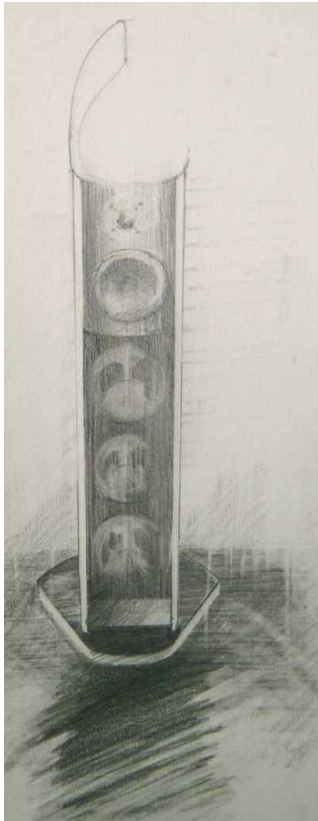


The composite diaphragm defeats the communication of internal reflections and other distortion that is unwanted energy acting against the music.



# Which led to The Bishop Reference (1999)

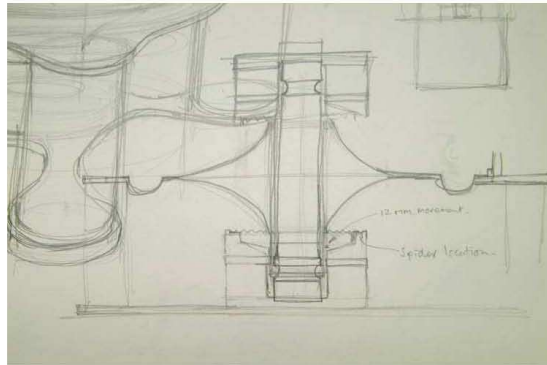
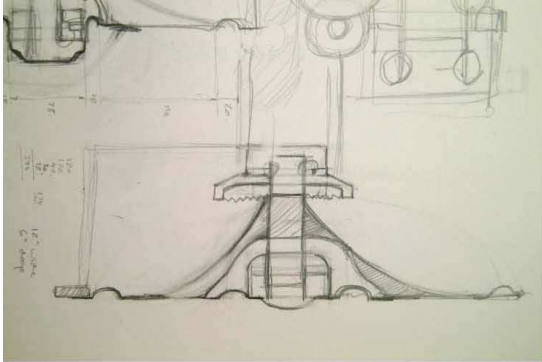
**8 Motors driving 8 cones to achieve dynamics**



Five years later a feasibility study grew out of this work that led to this



Which then led to these ideas



That enabled this!



# **WILSON BENESCH DESIGN PHILOSOPHY AND LOW FREQUENCY SOUND**

To date, all audio designers attempting to create low frequency sound have produced a variable of the ubiquitous Subwoofer. In reality, the only option available to the consumer, has been to opt for brand A's version of the collection of parts, as opposed to brand B's version. As competition has grown, the variables have changed. Bigger amplifiers to drive more inefficient woofers or different cabinet materials, essentially they have remained the same. After three years of research and development, the Torus System can be seen to offer a significant departure from the Subwoofer solution for developing infrasonic sound. This product is so different, that it clearly demonstrates the fundamental flaws in the design of the Subwoofer and provides a real alternative for Music and Cinema effects. Wilson Benesch designs have always been driven by the goal of introducing something that is alternative and superior. The Isobaric Tactic" is one good example of this approach It demonstrates how one innovative development can make another possible.

## **SUBWOOFER HISTORY**

Richard Lord of R.E.L. was the architect of the Sub woofer. It was and still is today, two decades later, still based around three elements (i) the wooden box (ii) woofer (iii) built in amplifier. Almost without exception every other audio company has followed the same formula. Even those who claim to have achieved something different can be seen to use the Woofer and an identical formula, with subtle variations, such as two drivers instead of one, or different materials for the cabinet. Which ever design you chose to look at, for the last fifteen years the entire audio industry has devoted all of its energy to creating designs based upon the same formula. Notably, Wilson Benesch has always rejected this solution. In fact to its credit it has never seen fit to use large drive units to solve any low frequency problems. There is no way around the fundamental problems that come with the large woofer designs, either in loudspeakers or Sub Woofer designs. Insurmountable obstacles stand in the way of the successful Sub woofer solution, whether it is large or small.



**Small option:**

Here the drive unit will be unable to move large amounts of air instantaneously, because in order to move any real volume of air, the small diaphragm will need to travel a long distance to make up for its small size. This pumping action will be incapable of reproducing the explosive timpani. The main benefit of this design comes from the relatively small sound signature from the cabinet. However the small volume of air available will create a strong spring effect on the moving parts that will elevate the resonant frequency of the drive unit, severely limiting its ability to produce energy below 35 Hertz.

**Large option:**

Making the parts larger confounds the designer in a different way because the large diaphragm becomes more difficult to control, so stiffer suspensions are needed. These stiff suspensions elevate the resonant frequency of the drive unit. What follows is a balancing act between adding mass to the diaphragm to lower the resonant frequency and the Stiffness of the suspension. Both these options impact upon the movement of the coil through the air gap. This often requires increases in the air gap and consequential decline in power. There are severe limits here also, due to the inexpensive drop forged components and ceramic magnets that are used almost without exception in the vast majority of Woofers.

**THE WEAKEST LINK**

The most important problem that is accepted without exception in every sub woofer is in fact the woofer itself. Although large diaphragm systems are commonly accepted, it is easy to demonstrate that they cannot integrate with the fast small drive units used to reproduce the mid range sound energy. The laws of physics dictate that you cannot accelerate and decelerate large systems like you can small ones. Woofer designers have attempted to reduce the problems by using stiff suspensions, and in some cases doubling the numbers deployed, in order to provide the restoring force to the diaphragm. This solution defeats the dynamic capabilities even more! The problems do not end here. The next major compromise of the woofer, is its dependence upon the external structure. The Woofer is of course attached directly to the external structure. The huge forces injected into this structure cause massive sympathetic resonance's that are clearly audible and impact directly upon the sound that is heard. As the cabinet increases in size, so do the resonance problems. In fact it must be accepted that there will be an exponential increase in cabinet resonance's.

## Summary of major flaws of the Sub Woofer:

- The woofer is fastened to and relies fundamentally upon the cabinet structure.
- The inefficiency of the woofer.
- The inaccuracy of the woofer components.
- The amplifier is housed in the same enclosure as all the high levels of energy being produced by the system.

## Summary of the major design elements of the Torus System:

The first and most important design element of the Torus solution is that it is not based upon the Woofer and this is why it is not called a Subwoofer. By designing out the woofer, all the design flaws that have been tolerated to date are eliminated at the beginning of the design.

### THE CORE



As its name suggests, the Core is at the heart of the Torus design. It is a formidable structural element of Brunelian proportions. Weighing in at over 16 kg, the precision machined assembly, combines with high energy Rare Earth magnets to create a dual motor / push pull drive.

The Core also provides a number of other important benefits that are elaborated upon below:-

1. Converts electrical energy into kinetic energy.
2. High capacity metal sink conducts all structural borne resonant energy directly to ground with zero reference to the outer enclosure.
3. High metal mass efficiently conducts all heat away from the coils.
4. Unlike in the Woofer where high hysteresis suspensions are axiomatic, the control of the diaphragm in the Torus is achieved electrically. The two powerful motors subsequently waste no energy overcoming these losses.
5. The combination of two high power motors, low mass moving parts, and low stiffness suspensions, is quite unlike anything seen before, and enables a dynamic performance, and level of control that is beyond the capabilities of any sub woofer.

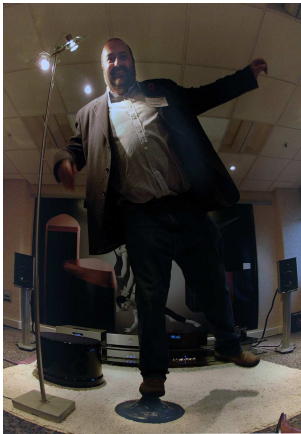
6. Huge 82 mm diameter motor coils are deployed on both sides of the diaphragm in order to provide for perfectly balanced kinetics. This novel “push pull” is often seen in other engineering applications, where maximum control and power transfer is required. It can be compared to a four wheel drive system and its advantages over only two wheel drive. In cycling it can be seen that high power demands require that the pedals be pushed as well as pulled. The Woofer could never achieve the control afforded by this design. To achieve the same control in a Woofer, stiff restoring suspensions are required, that instantly compromises the transient attack and dynamics of the system.

## **BORON NITRIDE**



The huge Core assembly already affords the motors’ system with a huge heat sink capacity several orders of magnitude superior to the limits of the Woofer. To maximise conduction, Boron Nitride has been exploited, a materials technology that is not yet commercially available! Developed by an Oxford scientist, it provides for an electrical insulator that is capable of conducting heat like copper. Boron Nitride is applied to the coil former, to enhance conduction.

## **CARBON FIBRE DIAPHRAGM**



The powerful push pull motors are capable of handling 500 amperes, converting over 1,000 watts of electro magnetic energy into kinetic energy. Huge compression and decompression forces are involved, and this demands the most advanced materials technology to avoid being literally torn apart. The most advanced manufacturing technology in the world has been designed and created by Wilson Benesch in order to form this material, and you will only see this technology applied in the future, in the most advanced engineering applications. Once again Wilson Benesch is the first company in the world to exploit the world’s latest technologies. In this case the novel weave of the carbon fibre makes multiple axis draping achievable with ease. The result is the stiffest, lightest and most highly damped diaphragm ever made. It takes the performance of large diaphragm structures to a level never achieved before. It is in fact so strong, that the 18gm structure will cope with a mass load in excess of 100,000 times its own mass!



Moving large amounts of air in an instant demands a large moving surface that small systems simply cannot deliver, it is a matter of physics. The Torus exploits one of the biggest diaphragms despite its petite dimensions. The 18 inch diaphragm displaces huge volumes instantaneously. There is no pumping or long throw demands. Transients are handled with ease, giving rise to the chest moving kick drum and attack that is quite

impossible with Sub Woofers. Rarefied and compressed air is generated in an instant, with even small amounts of movement, not dissimilar to a drum! The most important effect is not the infrasonic sound, but how all the sound is transformed in the principle loudspeakers. The Transient information tells the ear everything about the instrument, and when it is reproduced accurately, the results are totally different to what has been accepted from Subwoofers.

## EXTERNAL AMPLIFIER



The passive design immediately frees the amplifier of the severe low frequency energy distortions that have been happily accepted by Sub Woofers designers to date. Consider for a moment a world where audiophiles pay small fortunes for isolation systems to protect their equipment, yet happily accept the same amplifier technology being housed in the same enclosure, only millimetres away from the ground shaking resonance's of the sub Woofer! Absurd! In the Torus, the low frequency structural borne energy developed by

the system has no link, except for cables to the amplifier. The Torus Amplifier enables both high and low level inputs to be fixed independently for both Music and Cinema. This approach will also provide for upgrades in the future, and of course the idea of multiple Torus systems for large set ups, executable with ease.

## **So, why is it that this has not been done before?**

Innovation is expensive and full of risk. To do something different is potentially life threatening for any company. Years of development costs, investment in plant and equipment and initial production runs all contribute to the reason why many audio companies simply avoid embarking upon such work. Because of this it is sadly the case that many companies no longer have the infrastructure to undertake original engineering. In contrast Wilson Benesch has invested in manufacturing systems on an on going basis, and is in fact the only company in the audio world that can boast of engineering facilities in C.N.C. metal machining and carbon fibre composites under the same roof as the State of the Art 3 D CAD facilities. This engineering capability has empowered the company and allowed it the luxury of being able to reject the large drive unit or Woofer. More importantly, it has perhaps assisted in providing access to significant Government S.M.A.R.T. funding with which to develop new solutions like the Isobaric Tactic system. The company was also successful in winning funding for the Torus project in 2004. In retrospect this product can be seen as an intellectual stepping-stone that placed the Torus concept within reach. These innovations have important technical advantages that will always compare favourably with large, slow and heavily damped woofer based designs.

The listening experience is the test. It can be seen that the Torus provides the perfect partner to the super fast, linear phase, Wilson Benesch loudspeaker.