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ABSOLUTE FIDELITY

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Editor's Say

Just as this issue was going to print, I was shown a tweak that I could neither explain nor dispute. It boggled my mind. All it comprised was a little loop of wire inside a cotton sleeve with a loudspeaker spade connector at one end. It attached to the negative terminal of the loudspeaker, and it improved almost every aspect of the sound. According to Bud Purvine the inventor, it is a low impedance pool of electrons that acts as a signal wave-guide. Huh? I thought. But it works.

It is called the Ground Control and is marketed by Audio Prism. MusicDirect has a 30-day money-back guarantee on them, so what have you got to lose? Try it!

In this issue, we feature the thinking behind an award-winning year with an article on some of the design principles that went into the G7.1f.

In other articles, we introduce a new product from Genesis – loudspeaker cables – because general-purpose loudspeaker cables from the large (and small) cable companies are not optimized for the unique impedance load presented by Genesis loudspeakers. Also, we follow the article on How We Hear in the last issue, with an exploration of What We Hear.

This year has been a tough one. Here's a wish for a better 2010.

Happy New Year Everyone!

Cheers!
Gary

What We Hear

Internal Structure of the Ear

In a previous newsletter, we explored the structure of the ear, and the physiology of *how* we hear. There is a lot of information in that article, and if you have not read it, we suggest that you go back and read it as background understanding for this article. The human ear is far more sensitive than has been conventionally thought for years – with far greater than 20hz to 20kHz sensitivity. Hence, it is important to understand *what* it is that we are hearing – so that we can understand how far we need to actually go in developing and setting up loudspeakers to reproduce a musical event with almost life-like accuracy.

The first problem is that we don't have a good grasp of the important frequency range. The figure of 20Hz to 20kHz is often referred to and because of that, when asked what the "midrange" is, the usual guess by an audiophile is anywhere from 3kHz to 10kHz. This is quite far off the mark.

For example, the midrange of music corresponds to the middle of the piano. This note, middle-C, is

What We Hear (cont'd from page 1)

generally accepted to be around 256Hz. The frequency range of the notes of a piano range from 28Hz to 4.2kHz, while the open E-string of a stand-up double bass goes down to 40Hz. The range of the human voice goes from about 80Hz to about 1kHz at the top of a soprano's range.

The highest frequency from a musical instrument comes from the piccolo at 5kHz, and the lowest from a pipe organ at 16Hz. However, those are just the fundamental frequencies. Musical instruments and even everyday objects have a much wider range.

In a study by James Boyk at Caltech[Ref 1], he found that 68% of the sound energy of a bunch of keys jangling resided above 20kHz. Of musical instruments, a crash cymbal has 40% of its energy above 20kHz and harmonics are visible to above 102kHz (which is the upper frequency limit of the study). A muted trumpet had 2% of its energy above 20kHz and harmonics were present to over 80kHz.

While it is well accepted that we cannot hear sounds above 20kHz, studies have shown that it still affects us. In an experiment conducted by T. Oohashi, et al of Kyoto University[Ref 2], listeners felt that music was more pleasant and relaxing when frequencies above 22kHz was present.

Using music played on a Gamelan, an Indonesian musical instrument, it was shown that alpha-EEG activity increased in the brains of the listeners when they were exposed to high-frequency sound. What was surprising was that *the listeners' subjective rating of the sound quality went up even when the listeners themselves explicitly denied that the sound was affected by the high frequency content*.

At the other frequency extreme, a team of UK researchers[Ref 3] subjected listeners to a low-level 17Hz tone during a piano recital in the Purcell Room, London in May 2003. Psychologists studied the reactions of the audience, and the conclusion was that the infrasound enhanced the emotional state of the listeners, even though they were unaware of its presence.

Church organists have known of the mood-enhancing effect of infrasound for over 400 years. It adds a sense of awe to the music, and is used enhance the mood of the congregation.

Hence, it is clear that we can detect, if not consciously hear, sounds that are above and below the "accepted" frequency range of the human ear. Not only can we detect infrasound and ultrasound, the presence is emotionally important and enhances our enjoyment of music.

Besides the frequency range, the other area of what we hear is how we localize sounds – how the brain develops a soundstage based on what sound comes out from two loudspeakers and goes into our two ears.

As early as 1907, John William Strutt, Lord Rayleigh, theorized that the ear localizes sound by detecting the difference in waveform phases between the two ears. Studies have shown that in the forward direction, listeners can detect that a sound source 10 feet away has moved by as little as 4 inches (1 to 2 degrees of azimuth).

This initially seems impossible since the human neural system has delays of the order of a couple of milliseconds, and the time difference of the waveform arriving at each ear of such a small movement in the sound source is 12ms at 500Hz[Ref 4]. This was only explained recently with the discovery that the eardrum and middle ear "stretches" out the incoming soundwave before presenting it to the basilar membrane to read.

Nevertheless, after over a century of research,

there is still much about what we hear that is not well understood. What we do know is that research suggests that hearing is distributed throughout the brain, from the peripheral centers to the higher cognitive centers of the brain where it is evaluated for self-consistency and plausibility and then compared to what has been experienced.

This also explains why we become better listeners as we grow older, even when our steady-state hearing has deteriorated.

References

1. *Boyk, James; There's Life Above 20 Kilohertz! A Survey of Musical Instrument Spectra to 102.4kHz. Music Lab, California Institute of Technology*
2. *Oohashi, T., et al; Inaudible High Frequency Sounds Affect Brain Activity: Hypersonic Effect, The Journal of Neurophysiology,Vol 83 No. 6 June 2000: http://jn.physiology.org/cgi/content/full/83/6/3548*
3. *Angliss, S., et al (The Infrasonic Team); May 2003 http://www.spacedog.biz/extras/Infrasonic/infrasonicResults.htm.*
4. *Hartman, W. Professor of Physics, Michigan State University; How We Localize Sound http://www.aip.org/pt/nov99/locsound.html*

The Absolute Fidelity® Loudspeaker Interface

This has been a problem that we've had for years – finding a suitable loudspeaker cable for a pair of Genesis loudspeakers. Whenever we demo at a show, we have always tried to use an established brand of loudspeaker cables that our audience would be familiar with. This is so that they would have a frame of reference when listening to the speakers.

Unfortunately, that is easier said than done. Genesis loudspeakers are quite unique in two ways. First, they have a servo-controlled powered bass section. With the built-in amplifier providing the "heavy lifting", very little current is carried in the loudspeaker cable at the frequencies handled by the powered bass section. This is totally unlike other loudspeakers where the lower the frequency, the greater the current needs.

Second, they have a ribbon tweeter that is almost completely resistive – again unlike the characteristics of typical dynamic tweeters which have rising impedance with frequency.

This means that the typical design of loudspeaker cables is not optimized for Genesis loudspeakers. Usually, you will find that the more expensive the cable, the larger

Absolute Fidelity Loudspeaker Interface Cables

it will be and the more current it can carry. When such a large cable is used, it can make music sound slow and ponderous on Genesis loudspeakers. Attack and transients may be good, but then decay will be truncated, with the micro-dynamic details swamped by the macro-dynamic bombast. Such a cable may also make the Genesis tweeter sound aggressive and bright.

So, we ended up having to design our own loudspeaker cables with optimal characteristics for Genesis loudspeakers.

We started out with individual strands of high-purity copper, and put a thick, smooth plating of pure silver on it. These strands are then twisted very tightly together so that they don't rattle, and are sheathed (again very tightly) with PTFE Teflon (dielectric constant=2.1).

Four of these wires are braided together into twin twisted pairs in a balanced structure to cancel out external EMI. Each pair is given a banana plug at the loudspeaker end, and a spade lug at the amplifier end. These are pressure cold-welded on for a perfect gas-tight connection.

The four wires are then sheathed in a conductive metallized polypropylene sheath for static resistance, and then again sheathed in an insulating polyamide net.

The result is a supremely fast and transparent cable that matches the impedance and sonic characteristics of Genesis loudspeakers.

When compared to general-purpose loudspeaker cables, the Absolute Fidelity Loudspeaker interface has much better micro-dynamic resolution. As a result, the decay of notes is more extended and the music has better tonal color.

Bass is also tighter, more tuneful, and has better pace and rhythm. The coherence makes the various singers and players in an orchestra or band gel together better to bring about a much better musical performance.

Designing the Genesis 7 floorstanding loudspeaker

Insiders and dealers all know that the gestation of the Genesis 7.1f was a long one. After we released the G7.1c in 2005, and then the G7.1p in 2006, they all expected the floor-standing version in 2007. They ended up waiting over three years. I hope that they all felt that the wait was worth it.

In order to achieve a value-priced product for the Genesis 7-series, we had to be a lot more creative in design and engineering than developing a flagship, cost-no-object product like the Genesis 1.2. Since we wanted the G7.1f to have much wider appeal than to the audiophile in his “man-cave”, it had to be elegant and beautiful, and family-friendly. And yet, it had to perform like a true absolute fidelity® Genesis product.

Right out of the gate, the G7.1f won the top award for design and engineering excellence from the Consumer Electronics Association of the US and the Industrial Designers Society of America – the 2010 Best of Innovations Design and Engineering Awards. I thought that this was great recognition for over four years of work in completing this design.

An Elegant, Beautiful Cabinet

The design of the G7.1f actually started out with what we wanted it to look like.

In the early 1930’s, the Pratt Institute of New York asked several hundred art students to comment on what seemed to them the most pleasing of a bunch of regular rectangular proportions laid out as vertical frames. The least liked was when the width to height ratio was 1:2, and the most favored by a very large margin was when the proportions was 1:1.618 – the Golden Mean.

The ancient Greek sculptors were masters of proportion. Sculptures that were admired from afar, such as the Caryatids, were sculpted to a

A contrasting dark shield on a light background was used to enhance the classic pleasing proportions

different proportion to those sculptures that are meant to be admired from nearby. Since the G7.1f is a small loudspeaker, we borrowed the proportions of the *pedastal* on which Greek sculptures were displayed.

While this resulted in an elegant cabinet, the internal cavities were too long and narrow for good sound (see later). Hence, the cabinet had to be made a little wider than would have been ideal. We turned to the fashion world to bring the elegance back.

Taking a cue from the lines used by fashion designers, we used a dark curved shield on a lighter background to narrow the width of the slightly too-wide-to-be-pleasing cabinet. The subtle flare at the top and the slightly pinched waist with the taper down to the bottom all help to accentuate the elegance of the cabinet. Colors were also very carefully chosen to match.

Since it was going to be used in a family room, the speaker had to be physically very stable, and withstand the possibly of a 3yr-old bumping into it. Hence, a "foot" was added to enhance stability. This served as the frame of the acoustic suspension to isolate the speaker from the floor upon which it sat so that it would sound the same whether it was sitting on concrete, carpet, hardwood, marble, or uneven hewn slate.

Delivering Absolute Fidelity®

The G7.1f, being a full-range loudspeaker unlike the G7.1c and G7.1p, presented new problems due to the low bass frequencies expected of the loudspeaker. As low bass requires large cabinets, the tight, elegant proportions created special problems of how to deliver the amount of bass that defines a Genesis loudspeaker. Deep bass also presents large energies, and generate vibrations and resonance that can really mess with the sound and imaging.

From our previous design experience, we knew that we wanted to keep to the classic Greek proportions on the internal cavities. If you ever get the chance to go to Athens, don't miss the 3rd level of the new Acropolis Museum where the architects created a rectangular cement core that has the exact dimensions of the Parthenon.

Despite having no acoustic treatment, with bare walls and marble floors, you don't hear the usual echoes and hollow reverberations that plague large, open spaces. Voices sound extremely natural and there is an openness to the sound that is astonishing.

Translating these proportions into the internal cavities in the speaker gives the same results – less resonance and a more natural sound. It also means that we don't have to resort to exotic, expensive construction and materials. Damping

The Parthenon at Acropolis

can be minimal for a more dynamic sound.

We knew that we wanted to maintain the slim, elegant profile, which also resulted in excellent imaging and soundstage, but needed to find some way to deliver enough bass out of it. Some time ago, we learnt that having woofers on just one side of the cabinet destroyed imaging. The old Genesis APM-1 with a single side-firing 15" woofer had an image that lost stability with increasing bass. This was fixed in the G6.1 by using two identical horizontally opposed woofers to cancel the vibrations.

We knew that had to be the solution for the G7.1f, but with such a slim cabinet, there was no space to put two horizontally opposed woofers that would be large enough to deliver sufficient bass. A single side-firing woofer would have worked, but we did not want to lose the stable, precise image.

The solution was both simple and elegant.

Most speakers with a side-firing woofer would be anchored at the base. Hence, the bottom of the cabinet would be the fulcrum of the lever. This means that any movement generated by the woofer near the fulcrum would be multiplied at the top of the lever and destroy the image. If we were to move the fulcrum up to the middle of the cabinet, then it would substantially reduce the movement at the top of the cabinet.

Leverage and Balance

As the G7.1f is a powered loudspeaker, we had to have a large, heavy transformer anyway. Using this transformer as a polar moment of inertia bolted to the middle of the loudspeaker instead of bolted to the bottom, it could act as the "fulcrum".

The bottom of the loudspeaker already had a compliant mounting for the acoustic suspension. All it took was to figure out the compliance needed on that suspension and the weight and position of the moment of inertia in relation to the woofer, and the vibrations caused by the sideways movement of the woofer could be almost perfectly damped. Easy!

Extended Appeal

In order for G7.1f to have broader appeal, it had to be extremely easy to drive. This meant that we had to make sure that it would perform well with budget receivers and amplifiers.

Nevertheless, we did not want to sacrifice the clarity and transparency for which Genesis loudspeakers are renowned. Our task was to design an absolute fidelity loudspeaker that would allow a budget amplifier driving it to perform at its best. Yet, when used with the best amplifiers such as the Genesis Reference Amplifier shows its absolute best.

We found that many budget amplifiers firstly skimped on the size of the power supply, and secondly on the quality of the parts. As a result, they could not deliver high current and thus sound harsh and hard when the volume is high.

At the other end of the scale, they did not drive micro-dynamics well and sounded muddy at very low volume. Nevertheless, within a narrow power band, most well engineered amplifiers did

sound pretty good.

With the G7.1f having a 180W built-in servo-controlled bass amplifier, half the battle was already won. The internal amplifier does all the 'heavy lifting' in the bass, and the external amplifier needs only drive the speaker from about 100 Hz up – which most budget amplifiers should be well capable of.

What we needed to do in addition was not to draw too much current and yet get the amplifier over the hurdle to the 'good part' of the power band. To do that, we went back to loudspeakers that were to be designed in the 1960's with high impedance. That would require the amplifier to turn over a higher voltage to get over the muddy sounding part, and yet with the high impedance, the speaker does not draw large amounts of current that would tax a small power supply.

The result was a pair of speakers that could be driven by almost anything, including a $40 battery powered T-amp, and yet sounds fabulous with a high-quality power amp. As a reviewer put it, a speaker that succeeds on almost all counts and truly excels in a few.

Building a Music Server

Nearly five years ago, during CES 2005, when I first used a computer to conduct demos, people laughed at me. Now, however, everyone is asking me how to build a music server. Over the past few years, we hardly demo with a physical CD at shows anymore. About the only time we demo with a CD is when someone brings one in,

Fortunately, building an audiophile music server is not rocket science. There are a couple of things that you would have to watch out for if you want a computer music server to coexist in your audio rack.

Firstly, computers are noisier and vibrate far more than the typical hifi component. Hence, physical noise and vibrations need to be taken care of or they will degrade the sound of the nearby audio components.

Secondly, the computer is full of digital circuits which will radiate EMI/RFI and usually uses a large switched-mode power supply (SMPS) which may leak noise through the ground into nearby components. It will definitely degrade the power if the SMPS is plugged into the same power strip as your other components.

The second problem is the easiest to solve. Just

The Genesis Music Server is built around a Shuttle XPC and a 1 TB RAID2 drive

make sure that all computer components – CPU, screen, any external peripherals – are all plugged into a separate power conditioner and if possible into a different power circuit. We've found that plugging a computer's large SMPS directly into the same outlet in which the power conditioner for the rest of the hifi system is plugged into can degrade the sound.

The solution to the first problem sounds simple – build a computer that does not vibrate, and does not make any noise. However, computer components generally generate a lot of heat and the typical way that they are cooled is with forced air – and that is with lots of fans. The digital circuitry also produces a lot of radiated interference.

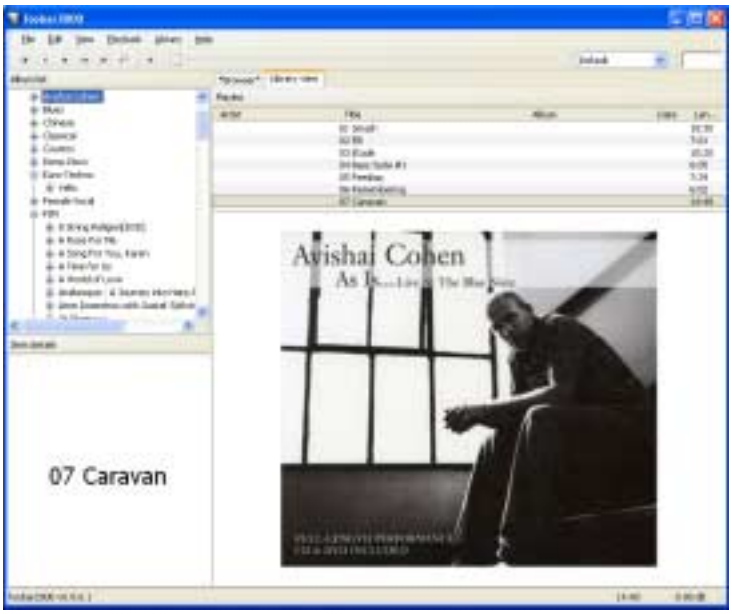
To reduce noise and vibration, we build a fanless computer – and the way to do this is with very large heatsinks. Such parts are fairly easily available to the hobbyist. A second source of noise and vibration is the hard-disc that stores data in the computer. Solid-state discs with no moving parts are now available in sizes up to 256Gb or more to replace the hard-disc.

The component that causes the most noise and vibration in a computer is the power supply fan – however, fanless power supplies, and outboard SMPS are now available. A linear power supply can also be designed and built.

In order to keep the radiated interference inside the computer, we use a spray-on EMI/RFI shield on the inside of the computer case – such as MG Chemical's SuperShield.

Once you have built your music server, the next question is how to get your CD collection into it. If you have been following the Black CD saga, the answer is pretty obvious – EAC or Exact Audio Copy using the same settings as you would use for ripping CDs for burning.

The solution for playback is less obvious. What is not so straightforward is how to make the server play at its best. If you built the music



server around on the Apple platform, it would be fairly easy, although you would have to shell out some bucks to buy the Amarra Music Player software.

On the Windows platform, I use Foobar2000, but you would have to bypass Windows Kmixer, which "helps" you by re-sampling your music files "transparently" (not good, I assure you!!). So, download ASIO4All, or if your DAC comes with its own ASIO driver, use that.

Finally, there is the choice of a DAC to use with your music server. There are currently two interfaces choices available – USB and Firewire.

I prefer using Firewire because it can reduce the jitter problem with using the high-quality clock in the DAC to control the data. I use the Weiss Minerva for this, but there are other Firewire DACs available that are able to do the same thing.

The choice of a USB DAC is far wider – pick one that buffers the incoming data stream and re-clocks it with a high-quality built in clock and/or runs in async mode.

A white paper with detailed instructions on Building an Absolute Fidelity® Music Server is available for download at:

http://www.genesisloudspeakers.com/support_papers.html

Good luck and remember to have fun!

The Latest….. on CD Burners and Gold CDRs

Almost seven years after the first "Black CD White Paper", no one questions that re-recording a store-bought redbook CD can change the sound. Improving it is another matter, but many of the principles that I had established in that first paper have stood the test of time and critical evaluation.

Unfortunately, time marched on, and redbook CD technology seems to be headed to the junk heap even though we are now getting some of the finest sounding CD's ever produced. Witness the K2HD version of Misa Criolla with Jose Carreras by First Impression Music.

Nowadays, it is difficult enough to find a CD burner, let alone the high quality CD burners that I had recommended for burning music CD's – the Yamaha CRW-F1UX, the Plextor Premium-U, the Plextor Premium-2. They are no longer made. Once in a while though, you can still find them being sold on eBay. The Premium-2 was never sold in the US, but is sometimes available on eBay.co.uk.

With the Music Server at hand, I rip every CD I buy to hard disk, and almost never play the physical CD's anymore anyway. I still need the CD for portability, and I keep a few units of the internal version of the Plextor Premium-2 when I need to burn reference quality CD's.

A recent upgrade that made a big improvement was a linear power supply for the burner that makes the new CDs sound even better. This came about as a result of building the music server, and discovering that the quality of the power supply affected the resulting sound, even though the DAC I used buffered and re-clocked the incoming digital data.

The good news is that there is now a better CDR available. MAM-A has a 99.9999% pure *silver* CDR in a 74min version that sounds fabulous, and is easily available off the MAM-A online store. MAM-A also has the Pro Audio Master Gold CDR, that are specially made for low-speed burning.

The silver is slightly more dynamic, and the gold has a slightly warmer sound, but both are tremendously musical. Because Black CDRs are so difficult to find these days, and the sonic quality deteriorate pretty rapidly after burning, I no longer use the Black, and have converted almost exclusively to the silver disc.

The FIM Ultimate Disc

Over the past couple of years, I had been working with my friend, Mr Winston Ma of First Impression Music to hone and perfect the CDR. The result of that is now available to the public – the best sounding CDs in the world – the FIM Ultimate Disc (UD).

The UD comes in two versions – the Collectors Edition is a 24K gold CD certified to have under 10 averaged BLER which is Resonance Control Coated and individually numbered.

The Direct-from-Master Edition, though, is the one to have. It starts life as a hand-selected version higher quality version of the MAM-A Pro Audio Gold which is then washed in de-ionized water, and then given a Resonance Control Coating. This damps vibration and resonance on the disc, allowing the laser to read the CD better. Finally, the disc is dynamically balanced for a perfect CDR.

Then, each disc is handcrafted on a modified Plextor Premium-2 using my special outboard power supply from a Ultimate Disc CDR. It is individually numbered, and laser engraved with the name of the customer. A special code is also added to enable the tracing of piracy. This is because these discs are of the quality that FIM uses for production.

For more information, check out the website at www.firstimpressionmusic.com.

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Wishing one and all a very Happy New Year!

"*Discovery consists of seeing what everybody has seen, but thinking what nobody has thought*." That epitomizes much of the thinking that went behind the Genesis 7.1f, and possibly the reason behind why it was the "Best of" the best at the 2010 CES Innovations Design and Engineering Awards. This is a prestigious award honoring outstanding design and engineering in cutting edge consumer electronics products sponsored by the Consumer Electronics Association of the USA and the Industrial Designers Society of America.

What a nice cap to the end of 2009 after winning the Select Component award from UltraAudio for the Genesis Reference Amplifier earlier in the year.

Cheers!
Gary

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