

ABSOLUTE FIDELITY

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Editor's Say

"You cannot manage what you cannot measure" Tom DeMarco (software engineering and design guru) taught me many, many years ago and in another life.

The problem we have with designing loudspeakers is that there are things that we can measure but cannot hear, and there are things that we can hear, but cannot measure, or don't know how to measure.

For example, there is software available that can design a crossover with a flat frequency response, time-aligned and phase perfect. But the resulting loudspeaker sounds boring, un-involving, and unmusical.

So, how do we manage the loudspeaker design process if we do not know how close we are to "absolute fidelity"? In particular, we need to get back to first principles - how we

hear, what we are listening to, and what we can hear.

If we know this goal, then, we can design music reproduction systems that approach the ability of the ear, which can detect the faintest audible sounds that impart no more energy at the ear-drum than thermal noise 4 zJ (zepto-joule - 4×10^{-21} that is twenty-one zeroes after the decimal point!!) and yet has a dynamic range of over 7 orders of magnitude - from 0dB-140dB.

The latest medical findings throw out some of what we "know" to be the limits of hearing, and we are now exploring how some of this research can translate into new products.

Cheers!
Gary

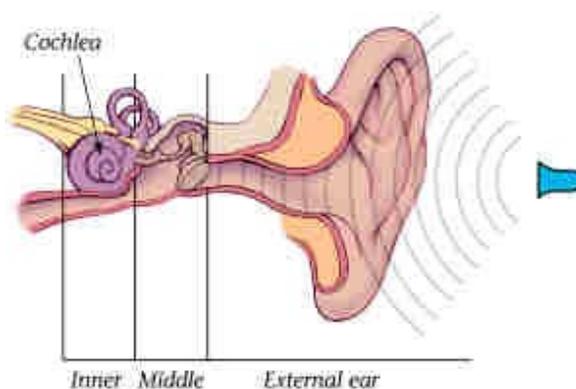
How We Hear

By Gary Leonard Koh

20/20 vision is supposed to be perfect eyesight, and 20Hz to 20kHz is supposed to be perfect hearing. However, as perfect eyesight doesn't mean that you see everything, perfect hearing doesn't mean that you hear everything.

In order to properly design playback systems, we need an understanding of how and what we hear... at least so that we know what is important and the priorities when we have to make trade-offs. For example, is 20Hz to 20kHz +/- 3dB good enough?

The basic principle of how we hear is



actually very simple. Sound waves are collected by the external ear, and funneled down the ear canal to vibrate the eardrum. Within the middle ear, the ear bones mechanically carry the vibration of the eardrum to the cochlea.

Must Have! By Jerry Pomeroy
President, Pacific Northwest Audio Society
<http://audiosociety.org>

Love is a Cirque du Soleil show that opened in Las Vegas in June of 2006. It was born out of a friendship between George Harrison and Guy Laliberte' founder of Cirque du Soleil.

When I first heard that a Beatles remix would be used in a stage production, the image in my head was not positive. I have great respect for the music fashioned by the Beatles, the albums were the team effort of a highly talented group of producers, engineers and the *Fab Four*, John, Paul, George and Ringo. The thought of changing their songs would be like painting a mustache on the Mona Lisa, it was inconceivable that the soundtrack would wind up in my collection. I couldn't have been more wrong!

One of the strengths of the Beatles' albums is the great variety in rhythm and pace. *Love* encompasses all, spanning the gamut from

Here Comes the Sun to John's overdriven guitar on *Revolution*.

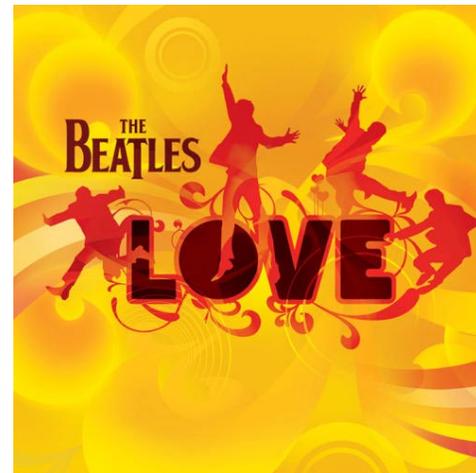
According to the liner notes, the only new music used in *Love* is an orchestral score by George Martin for *While My Guitar Gently Weeps*.

Thanks to the application of digital

technology to manipulate cuts and the large archive of Beatles material available during the production of *Love*, it is impossible determine the exact origin of all the sounds on the album just by listening to it; it could have been sourced from Capitol Records or from a live performance.

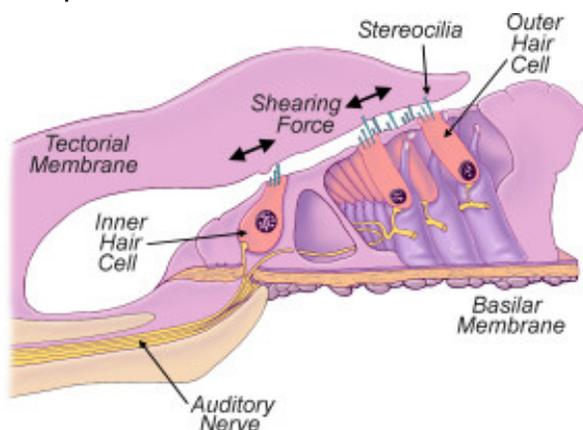
As the first track *Because* started, I approached my speakers to figure out why I had no sound. The track opens with the faint sound of birds, gone is the guitar. The vocals don't begin till ten seconds

Continued on *Must Have!* page 4



How, and What We Hear (cont'd from page 1)

Coiled around the inside of the cochlea, the Organ of Corti contains hair cells that convert the sound waves into electrical signals, which are transmitted by the auditory nerve to the brain where it is interpreted.



The Organ of Corti

There are two types of hair cells – inner hair cells and outer hair cells. These cells are called hair cells because they grow stereocilia (or hairs), and it is the bending of these stereocilia that create the electrical signals detected by the auditory nerve. Sounds simple enough!

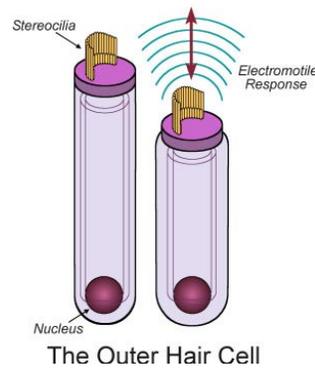
Until 20 years ago, it was thought that the cochlea was a passive receptor of sounds. Now, it is well known that we actually have “active hearing”.

1. **Otoacoustic emissions.** It was discovered in the late 70's^(ref 1) that sound is generated by the inner ear. It “sings” to help with the detection and resolution of incoming sound^(ref 2). This

would be equivalent to light coming out of our eyes to help us see.

2. **Cochlear amplification.** The outer hair cell can be made to elongate and shorten by electrical stimulation. Now, the outer hair cells are known to be an active amplifier that refines the sensitivity and frequency selectivity of the mechanical vibrations of the cochlea. This contributes to the huge dynamic range of the ear – with a sensitivity range of 140dB.
3. **Non-linear critical underdamping.** In the past, we thought that the hair cells in the Organ of Corti acted like a bank of harmonic oscillators. Now, we realize that the cochlea responds primarily to formant frequencies, extracting the defining features of the input sound. Two important things: response amplitude equalization and tone-to-tone suppression. However, latest research has shown that the amplification from the electromotile response of the hair cells is a Hopf bifurcation. Hence, while the steady-state sine-wave sensitivity of the ear is known to be only up to 20kHz, the theoretical sensitivity of the formant frequency analysis of the human ear extends to over 100kHz!!
4. **Time dimension analysis.** We always thought that the ear was a one-dimensional measurement. However, we now know that it analyzes incoming soundwaves in time, and does its own fast Fourier analysis. The eardrum and middle ear changes the impulse and stretches it out in time like an oscilloscope, not a frequency analyzer.

This makes the ear capable of discriminating small differences in the structure of sounds,



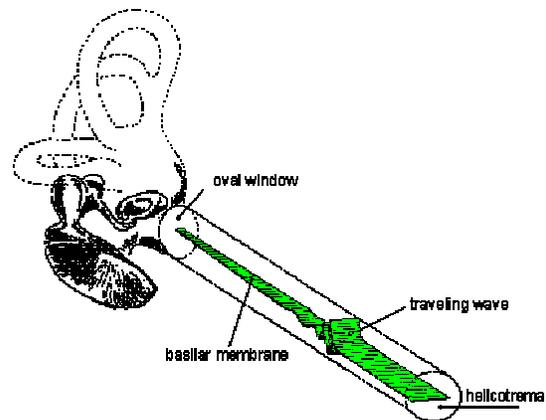
and their attacks. In particular, pulsed sounds and the formants, much better than any device so far invented.

The cochlea acts as a time-dimension frequency analyzer that exhibits resonant vibrations at

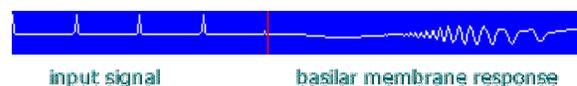
characteristic frequencies that vary with position along the basilar membrane.

This “unraveling” of sound in time has significant implications to how we hear. This unraveling is able to detect minute differences in phase of the sound between the two ears, resulting in exquisite sensitivity to imaging.

This is a simple experiment to do. Locate a piece of music that has good imaging in space (e.g. Track 2: Peace on Earth, FIM SuperSound III, First Impressions Music with



Cochlea uncoiled – detecting a traveling wave in time – making the ear able to analyze an incoming soundwave in the 4th dimension



A click that arrives at the eardrum (red bar) is “unraveled” by the ear for the brain to interpret.

Cont'd *How We Hear* from page 3

the shaker going from low left to high right).

Listen to it and make slight changes to the volume balance. Note that this does not affect this image (unless you have a really badly implemented volume control in your pre-amp). However, moving one loudspeaker forward and backward by as little as ¼ inch changes the image of this shaker.

That's all for this issue. In the next issue, we explore what we hear – the waveforms of music, speech, and why they are is so difficult to reproduce.

References

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3. Andor, D.; Duke, T.; Simha, A.; Julicher, F.: *Wave Propagation by Critical Wave Oscillators, Auditory Mechanisms, World Scientific, 1999.*
4. E. de Boer, *Auditory physics. Physical principles in Hearing Theory, 1980.*
5. *How the Ear Works - Nature's Solutions for Listening*
<http://www.bcm.edu/oto/research/cochlea/Volta/index.html>
6. *The Cochlea Homepage: <http://147.162.36.50/cochlea/>*

Cont'd *Must Have!* from page 2

in, and when they start the first thing I noticed was a more pronounced reverb. The vocals move at the same tempo through each line as on *Abbey Road*, but time has been added between each line. Being familiar with the song as recorded on *Abbey Road*, I sat anticipating the next line while the birds chirp in the background begging you to listen closely or you will miss details such as a fly cruising between your speakers. By the time I finished the first song I was impressed with the ingenious engineering.

From the start of the second song to the end of the CD I was obsessed with identifying from what song the guitar licks, keyboards, percussion, sound affects and vocals came from. There is no transitional mix between the first song and the second song *Get Back*; and there are few breaks in the music after that. I believe *Get Back* starts with the orchestra and piano ending from *Day in the Life*, the opening chord to *Hard Days Night* and drum solo from *The End* before the distinctive guitar of *Get Back* begins. A crowd of screaming fans was added to the mix, and it is so convincing that I ask myself if they ever performed that song in front of an audience. As the song starts to wind down *Get Back* is mixed into *Glass Onion*.

The soundtrack just keeps going like this, song after song; melded together in a way that enhances the songs we know and love. The jacket list 26 track selections on the CD, many of these contain primary portions of two or more songs such as number 19; *Come Together / Dear Prudence and Cry Baby Cry*.

Love is not the best sounding CD I have but it is pretty good. The detail and image are good and deserving of time on a premium system, but if you don't like the Beatles the audio quality won't carry the music. The LP version of *Love* sounded really good, low noise and it sounds like the cutter was set up very well, in some tracks the LP had more bass than the CD. I will use the LP not the CD when company comes over.

My favorite album used to be my Japanese LP of *Abbey Road*. Now, it doesn't hold my interest like *Love* does. *Love* has passed the continuous play test. For the last 2 weeks, I have played *Love* over and over again, I haven't gotten tired of it, and I still listen from start to finish when I can. This is a musical masterpiece, a demonstration of the Fab Fours' contribution to popular music and culture in a package that will appeal to music lovers in 2007.

Jazz Journal – Sax Players

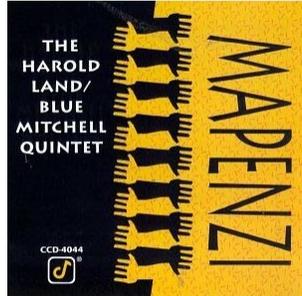
by Dick Mueller – honorary Music Reviewer

Harold Land Mapenzi

1977, Concord Jazz 44

Harold Land grew up in the San Diego area. Except for a short stint of lessons when he first got his horn, he was pretty much self-taught. He played around the San Diego area for a few years after high school, but then decided to move to LA. He fell right into the scene there, gradually gaining prominence, and in 1954 he became the tenor chair in the Clifford Brown/Max Roach Quintet. That gave him his big break. He remained in California (except for occasional foreign tours) forging alliances with many of the West Coast notables. He has done some exceptional work with Bobby Hutcherson, and for years had been the tenor soloist with the Gerald Wilson Jazz Orchestra.

This album, one of his best, finds him in the company of trumpeter Blue Mitchell, along with an all-star rhythm section. A great CD to have in your collection!

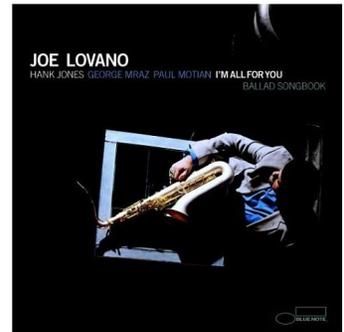


He came out of retirement to appear at the Montreux International Jazz Festival because of his meeting with the young Michael Petrucciani, the sensational pianist on this live concert performance. The result is an exciting piece of work that most jazz lovers would be thrilled to have in their collection... though it might be hard to find.

Joe Lavano I'm All For You

2004, Blue Note CDP 91950

Joe is a Blue Note star, having come up in the 60's under the influence of Coltrane. He has stayed pretty much in the bounds of bebop, and post bop style, as can be surmised in this album by the choice of the rhythm section – all famous, all skilled old soldiers – Hank Jones on piano, George Mraz on bass, and Paul Motion on drums. It is a nice CD, ballads by famous composers, all beautifully played and well recorded.



Charles Lloyd Montreux '82

1982, ElectraMusician 9 60220

Here's what I can tell you about Charles Lloyd:

- His influence was primarily Coltrane
- He is a spiritual person
- He resides in Big Sur California

- He is a skilled musician
- He records with other skilled musicians

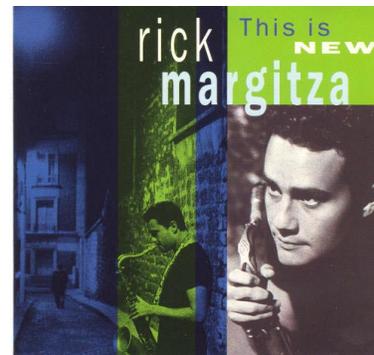
Rick Margitza

This is New

1991, Blue Note CDP 97196

Rick was pretty young when this was recorded. He had just been out to Seattle to play at the University of Washington in a group with Kei Akagi on piano. A special night. Rick is in heavy demand, both as a soloist in jazz orchestras, and as a member of various combos. He plays in the contemporary idiom.

This is a great CD with excellent tune selection, masterfully played by the quartet including the outstanding Joey Claderazzo on piano.





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The Final Cut

Genesis loudspeakers are comparatively rare in the United Kingdom, and it was with great pleasure that we read our first review from "across the pond" in the July issue of HiFi World. The reviewer, Mr. David Allcock, seemed pleased with the G7.1c's - our MTM standmounts - saying:

"The G7.1c offered remarkable extension for a standmount, and threw an image which genuinely surprised in both size and focus. ...the music floats freely, effortless filling the room with sound, extending wall to wall and beyond... The Genesis simply melts into the background, leaving behind a superbly focused soundstage populated with totally believable music."

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