

**Event** Toronto AES: **Mastering for Stereo and Surround**  
**Presented by** **Bob Ludwig, Gateway Mastering & DVD**  
**Date** Tues 22 Feb 2005  
**Time** 7:30 pm  
**Location** Lib 72 Lecture Theatre, lower level, **Library Building**, Ryerson University  
**Address** [350 Victoria Street](#), Toronto

Introduction by Sy Potma

Our presenter for tonight's meeting, is well known in the recording world, many have heard his work, his craft, his mastery. The touch that he puts on recorded material that passes his hands, his eyes and his ears.

I've known Bob for a few years now and have always known him as "the mastering engineer". He was sent projects I had worked on when I was a studio assistant and later as an engineer. Many mixes left our facility to go visit with Bob wherever he was to be prepared for Vinyl and CD. Many years ago I had the pleasure of seeing what his workspace was and how he did his craft. A great experience...

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In preparing, I thought I'd dig in and find out a bit about Bob's roots and share with you what he brings to the table. Bob has a Bachelor's and a Master's of Music from Eastman School of Music in Rochester. At Eastman, he was active in their radio station and recorded many recitals and concerts in the Rochester area. From Eastman's connection to the New York recording gurus, Bob got to work along side his mentor (& ours) Phil Ramone, at the famed A & R Recording in NYC. While working at A&R Bob got his introduction to disk cutting and mastering, as a building block to being a better engineer. He obviously caught on, because he soon started building a client list, that lead him to mastering positions at Sterling Sound and at Masterdisk, in their time the leading facilities on the East coast.

During that period Bob mastered records for the Band, Led Zeppelin, Jimi Hendrix, Janis Joplin, Peter, Paul & Mary, the Police, Dire Straits, Bruce Springsteen, Nirvana, Bryan Adams, Hall and Oates, Rush, Eric Clapton..... the list goes on and on.....  
You can do your own internet searches for Bob's entire discography.

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Bob had decided he should to set up his own facility, move out of NY to Maine. In 1992, he opened Gateway Mastering Studios, a brave move, but very successful as it turns out. At the San Francisco AES, last fall, Bob won his 12<sup>th</sup> TEC Award, Gateway Mastering won it's 8<sup>th</sup> in it's 12 year history (or is it 13<sup>th</sup> by now?) Last week at the Grammy Awards ceremonies, Gateway had 28 projects nominated, 21 of them were Bob's, all substantial Pop projects: John Mayer, Sarah MacLachlan, Sheryl Crow, Brian Wilson, Roxy Music, Eric Clapton, as well as Classical and Orchestral work.  
CONGATULATIONS.....

<http://www.gatewaymastering.com>

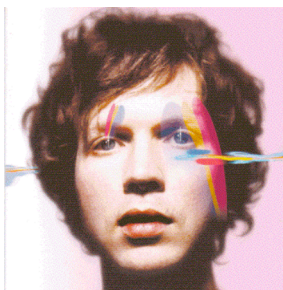
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In New York City, Bob has worked on the executive of the local AES Chapter. Bob has chaired workshops and presented tutorials at recent AES conventions, sat on discussion panels at the 2003 AES 24<sup>th</sup> international conference on Multichannel Audio in Banff.

More recently, Bob and 16 or so of his peers, audio engineers and producers, a committee within NARAS, the National Academy of Recording Arts & Sciences, who run the Grammys, authored a bold work, 68 pages of detailed consensus and coloured diagrams, a document entitled, “Recommendations for Surround Sound Production” which is now available on the grammy.com website.

Without any further processing delay, to tell us about “**Mastering for Stereo and Surround**” our speaker, the president of Gateway Mastering and DVD in Portland, Maine...

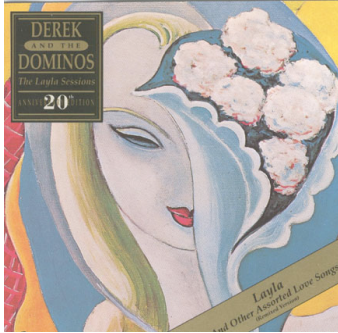
Bob Ludwig.



**Bob Ludwig’s Presentation (notes by Robert Breen, quotes are not exact):**

*The creative purpose of mastering is to maximize the inherent musical value of a given recording; to enhance the details, soundstage, dynamics and equalization.*

The presentation will focus primarily on three different examples, Eric Clapton's Derek and the Dominoes' classic album "Layla and Other Assorted Love Songs", Beck's new classic "Sea Change" and the "Black and White Night" Roy Orbison tribute DVD.



### “Layla”

For re-masters, Mr. Ludwig always goes back to the original master tape and asks “is it good as it can be?” Sometimes a master tape, such as the original 15ips Derek and the Dominoes master from 30 years ago is unplayable, but can be restored for a few plays – maybe more – with baking in a convection oven for 8 hours at 130 degrees Farenheit.

It is important also to go back to the original release of the album that Clapton/Derek originally approved, in this case, the vinyl. Using a Well-Tempered audiophile turntable, and a Manley “Steelhead” preamplifier, Mr. Ludwig will listen for EQ, Compression, and Varispeed from the original album.

There are 2 kind of \_” stereo master tape, as a result of the original recording machine. US and Canadian machines would have a larger 2mm guard band between the tracks.



European machines will have a \_ mil guard band, and the head will almost have a “butterfly appearance” famous from the old Studer machines.

An American recorded tape played on the European head will have too much bass, while a European recorded tape played on an American head will have too much hiss since the head gaps aren't wide enough to read all the information on the tape – so you need to start with the correct set of playback heads!

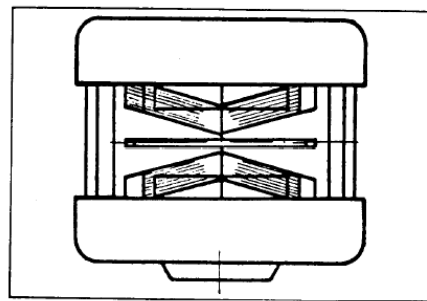


Figure 1. Butterfly Head.

Since there were no tones on the “Layla” masters, each song had to be azimuthed by ear. This was made even more difficult as none of the original alignments were dead on. Using the AudioCube VPI Azimuth plug-in in Nuendo, which auto-corrects azimuth between left and right stereo tracks, he was able to “check” the alignment done by ear, compensate on the machine mechanically, and then remove the plug-in.

Mr. Ludwig says 50-60% of the current incoming sessions have an analog component, even if it is only a “copy” from the Pro Tools session. If the session is all digital often they

will run it on and off analog tape to cure the “digititis.” Mr. Ludwig suggested it would be a great study to figure out why the human ear seems to love analog tape so much! He also added that master mixer Bob Clearmountain’s work seems to never need this treatment, as all the aspects of analog Mr. Ludwig likes seem to make it into Clearmountain’s mixes regardless of the format!

For analog playback gear, Gateway has 2 Ampex 2 track machines, 1 stock and one modified to 1” 2 track.

ATR Service Company built Class “A” tube electronics in addition to the Ampex electronics in the stock machine. There are 2 sets of playback electronics which can be patched out, listened to separately and compared to see which suits the material best.

The 1” machine has custom Tim Da Paravicini (Esoteric Audio Research) tube electronics (he started the 1” 2-track format), and all discreet Dave Petit Crane Song “Aria” electronics as well. The machine can run 1”, “\_” or “\_” tape. The “Aria” electronics were used on the Rolling Stones ABCO reissues, and though they always reference the original 45s, with the new clarity Mick Jagger accused them of “overdubbing new instruments!” Brendan O’Brien and Gloria Estefan also have 1” 2-Track machines.

Here is the complete list of tape machines from the Gateway website:

- Ampex ATR (stock with Flux heads) (balanced or unbalanced)
- Ampex ATR (transformerless)
- Ampex ATR (tubes) (balanced or unbalanced)
- Ampex ATR (Tim da Paravicini audiophile tube electronics)
- Ampex ATR (Mike Spitz ARIA audiophile tape electronics)
- Studer 820
- Studer 820 with Cello class-A solid state audiophile electronics



For equalizers, gateway has the SONTEC MES-432C Mastering EQ, the lathe EQ of choice from the late 70’s, which looks something like the similar example on the left. It features big, detented knobs for easy recall, each circuit is hand wired.

They also have a vintage NTP Compressor from the original Neumann lathes, hard to find, though they’re still made. Problem is the new ones feature “no distortion!”

“Layla” Stereo was mastered at 192 kHz/24 bit for SACD and DVD A formats.

For processing “Layla”, Gateway used mostly analog processors or 192 kHz plug-ins. Some of Gateway’s Digital Work Stations include Wavelab, Pro Tools HD, and Nuendo SADiE, Pyramix, Sonic Solutions HD and Sonoma.

Sonoma can now do DSD (Direct Stream Digital) up to 24 track! It features a DC Meter, LF Meter, Max Peak and HF Meters. DSD is high definition audio which samples 1 bit at 2.8MHz/second – the best digital sample rate available. It is the closest digital system to analog, though signal processing degrades it. Like analog, DSD gradually distorts and has the ability to “soft” overload – unlike all other digital systems which clip nastily at 0 dBfs. DSD will actually go +6 past digital “0”. Sony/Phillips incidentally say +3 is the ceiling - any louder and they won’t mass produce the recording. PCM and DSD just don’t mix.

Sadie/Pyramix and Sonic Solutions HD can currently work in either PCM or DSD depending on the I/O purchased.

“Layla” needed lots of vari-speeding. “Layla” itself was sped up 2.5%, while “I Looked Away” was sped up .5% and Bell Bottom Blues came up 1.3%, for example. “Layla” as you likely know, was recorded in 2 parts which were edited together. The first “classic rock” section, then the cathartic piano driven ending. These were off pitch with each other, so part 2 actually had to go up 2.6 or 2.7% to fit.

On the stereo \_” master, there were some odd phase problems in the drum set! Manley Massive Passive and GML mastering EQ was used. A common discussion these days is how compressed music has become. Apparently “Layla” was quite compressed even in its time so not much more was needed for the high resolution digital version.

For the surround mix, Mick Guzauski did 2 versions. One with a Sample Frequency converter and varisped off his rig, the other with no vari-speed, meant to be altered at Gateway. When vari-speeding digital, it is crucial to remember if the master is being vari-sped, the SLAVE WILL FOLLOW and the net result is no actual change in sampling frequency! It’s important to use a good sample rate converter so the change will translate across to the slave. The Apogee “Big Ben” Master Clock in variable mode was used for “Layla.” It is important to note that no “high end” sample rate converter will operate in real-time, and since 2.5% exceeds Pro Tools’ maximum vari-speed, the “Big Ben” was essential to fix the track.

### **“Sea Change”**

Beck’s “Sea Change” was a rare recent example of a new album being recorded and mixed entirely in Analog. As we know, the major labels are shrinking and merging and Quantegy (the last Analog tape manufacturer in the US) recently declared chapter 11. Cost is the main factor that music production is turning entirely digital.

Of course Sony and Fuji (etc.) still make DA-88 & Betacam tapes. Mike Spitz of the ATR Services, Inc. has been planning to produce “boutique” runs of analog tape for almost a year. Samples are expected in the next 3 months. Quantegy is attempting to produce a small run as well, though this may be up in the air we hear. Since big productions prefer analog tape, and NASA uses it as well, some will likely appear sooner or later.

The stock Ampex machine with its snappy midrange was originally used on this stereo mixes of this album. Later it was decided to go with the ATR “Aria” electronics, which provided a more open natural sound. Minimal EQ was used, only a maximum of a few

dB anywhere. The SPL Tube Vitalizer was used as well. Nigel Godrich did the stereo mix, though he did not want to mix it for surround.

Elliott Scheiner handled the surround mix duties, to 2" analog 8 track at 15ips with Dolby SR. One of the tracks on the machine is reserved for timecode. Queen's "The Game" was re-mixed surround to this format at 30ips. **Sea Change** is a great sounding surround disc.

The electronics on the 2" 8-track feature very fine 1/10dB step metering. For best azimuth adjusting, all channels are summed in "sum" mode.

For surround mastering EQ, Gateway has Millenia Media EQs, which have a "sweet" top end and can be run either tube or solid state. They also have 6 channels of GML EQ, which are very transparent. The signal doesn't sound much different whether they're in or out when set to unity. There are also 6 channels of Manley "Massive Passive" EQs which sound very cool but are deliberately *not* transparent.

Mr. Ludwig's protégée, Adam Ayan, works the 2<sup>nd</sup> mastering room at Gateway. It is the same room as Mr. Ludwig's, except a little smaller though with identical room ratios. Surround setups at Gateway used to take 3-4 hours longer than regular setups, so the rooms were rebuilt. There have been 150 surround projects mastered at Gateway since.

For Digital EQ, Gateway uses Massenburg Design Works' Digital Mastering EQ, which works at 96 kHz and up and down samples. The 5.1 version has linkable channels. They also use the Daniel Weiss Linear-Phase EQ, a 24/96 DSP EQ which is unique and good sounding.

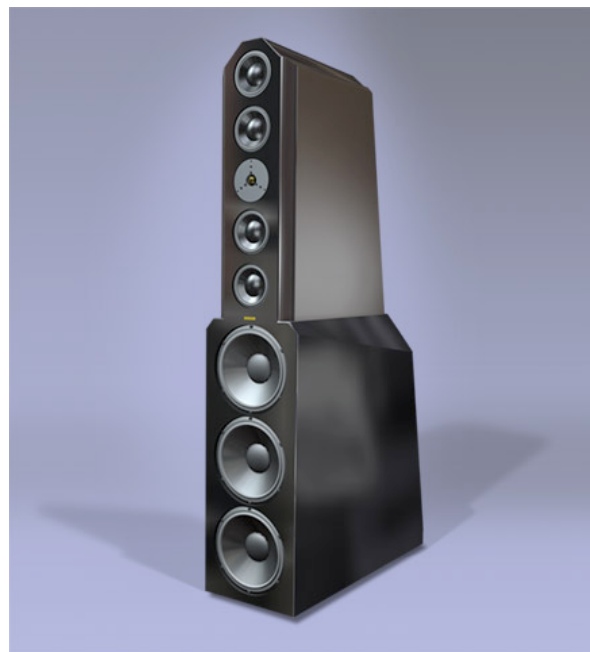
## Speakers

At Gateway, Mr. Ludwig uses speakers Serial #s 1 & 2 made by Bill Eggleston of Memphis, though apparently he is no longer with the company:

<http://www.egglestonworks.com/>

The speakers are made of granite and weigh 358 kg (790 Lbs.) each! They feature drivers by Dynaudio which reproduce frequencies down to 13 Hz, Modified Morels, and Esotar HF Drivers. There are 23 drivers in each speaker, 2/3 of them hidden, which equalize the pressure inside and outside of the box. He uses an M&K subwoofer for .1 only.

For compression in 5.1, Gateway has the Millenia Media Twin Com, which can run in tube or solid state mode, all channels linkable. There is also the SSL XL Logic



compressor for “that” rock sound in surround.

For metering, there are Mytek meters, that work up to 96 kHz. A SFC converter can be used to downsample for metering 192 kHz on them as well.

Gateway opened in January 1993 using Transparent Audio cable. When the studio was re-modeled 2 summers ago, Ludwig again chose “Transparent Audio Cable”, OPUS MM Speaker and interconnect networked cables which impedance match all the cabling and sounds very musical. For digital we upgraded to the Reference Digital Link This was a big part of the remodeling budget. Extra wires were laid in case surround formats expand beyond 5.1.

Completing the wiring scheme was a 256x256 Z-Sys digital router. Brian Lee wrote the software code to make this digital patchbay flexible enough to re-patch the entire room for surround instantly, and the clocking always works.

Gateway also uses the Weiss DS1-MK2 de-esser/compressor/Limiter, the first digital de-esser. Neumann made the best mastering de-esser and this unit uses the Neumann design as the starting point (read: shamelessly copied, then improved).

On the questions of plug-ins vs. outboard gear, all are different and should be considered individually. A good sounding digital EQ is tough to do though Massenburg, Sony Oxford and Waves among others can do a good job. Extra DSP chips in stand alone dedicated units really help get the job done, and as any Pro Tools user can attest, the plug-in versions that do sound good are DSP hogs.

The new Nine Inch Nails album was done for surround in 192 kHz, which immediately drops the track count in Pro Tools. Numerous groups of 6 tracks were needed for crossfades, and the system is heavily taxed with even minimum plug-ins used.

For track configurations, with 6 channel surround, there are 640 possibilities! The standard has become the ITU/SMPTE layout:

1 = L, 2 = R, 3 = C, 4 = LFE, 5= L Surround, 6 = R Surround

While the Pro Tools “5.1” track display currently defaults to L, C, R, LS, RS, LFE, this can be fixed in the I/O configurations. Gateway went 5.1 in 1997, and DTS format was the first to utilize the technology in commercially issued material. The DTS track lay-out was L/R, LS/RS, C, LFE.

5.1 converters have their own special set of challenges. Sample Frequency Conversion, Time Code, and Latency must be addressed. Stereo sample rate converter units are not acceptable for surround as they have an SFC Algorithm that re-integrates every few seconds to keep the boxes locked. This is insufficient as the soundstage shifts constantly with even the most minute variance in sync. The boxes need to “talk” to each other at all times.

Down and up sampling is another matter as well. Mr. Ludwig favours an 88.2 kHz sampling frequency when CD is the final product simply because it happily divides down 2:1 for 44.1 kHz.

96K – 44.1 kHz on the other hand is a complicated ratio of 320:147 and it sounds a bit worse. It has been discovered that the least damage occurs when you downsample to the closest frequency and then again sample frequency convert. For example, 192 kHz – 48 kHz is a simple 4:1 conversion. 48 kHz – 44.1 kHz then is the lesser of two evils going the rest of the way.

Gateway uses a dCS or dB Technology (now Lavry Engineering) converter designed by Dan Lavery for these kinds of transfers. The dCS 974 Stereo SFC and Format converter does the job well. One is master, two are slaves. The boxes offer different filter options, from “textbook” until there is gradually more and more aliasing. This creates a dramatic difference in the musicality and transient of the converters in appropriate applications.

Latency is always a problem when locking sound to picture. Even within a digital console, plug-ins add a delay. Nuendo has long had automatic latency compensation. In Pro Tools HD the latency must be adjusted by hand (and is well worth the trouble) or the newest release can now automatically do it.

For DVD video, there is always a question of what and how much to send to the subwoofer. Frequency-wise, Dolby Digital and DTS, restrict the bandwidth to <120 Hz. In DVD-A and SACD, the specification is 6.0 therefore no LFE bandwidth consideration. In Mr. Ludwig’s opinion, the sub is always a problem as the setups can vary so wildly from installation to installation – even in theatres which are supposedly “regulated.” Many film mixers don’t even use the LFE. He believes a full range ceiling speaker sounds much cooler and regrets it not being in the specification instead of the LFE for music.

When using an LFE, Mr. Ludwig recommends “Less is More.” If your client expects the subwoofer to do something and one must create it where none existed, use as little as possible.

The TC Electronic System 6000 offers a 4<sup>th</sup> order High Cut filter which can be used to tailor a sub track, but beware latency again. Filter Pre and end ringing plus delay can put the low end totally out of phase – which in his room is quite audible due to the extensive ray analysis that went into designing his room. Out-of-phase bass will actually disappear acoustically.

*AT THIS POINT I’D LIKE TO PAUSE AND SAY, ON BEHALF OF EVERYONE I THINK,*

**WOW!!!**

*AND GOOD TO KNOW IT’S POSSIBLE.*

The other 5 tracks need, therefore, to be delayed to match.

For further monitoring in an uncontrolled environment, a severely bass-managed system in the lounge is wired to the control room, in this case a BOSE Lifestyle system.



Bob suggests, when mixing or mastering in 5.1, always start with the LFE OFF, get the bass right on the L&R – the stereo is still the foundation of a good 5.1 system – then add LFE later to just fill out the lowest octave remembering that “less is more.”

Mr. Ludwig’s analog 5.1 and stereo mastering console is a new SPL Surround MMC 1 console, with a 5.1 correlation meter. He highly recommends not mixing with the vocal just in the centre. While the center speaker gives a great deal of extra presence. If a good phantom image is achieved with the left and right speakers and the center tucked in at -6dB in the effect is much more natural.

Hi Definition TV requires that the LFE is mixed into the stereo for a 5.1 down-mix. When mastering, Bob always encodes the signal in Dolby Digital and feeds it out to the BOSE system, which decodes it like a home video. Often one can hear the encoding artifacts (An aside about the BOSE system – it employs “range compression” in its nighttime setting, which really pumps. You can turn it off, but the system defaults to “on”. Dolby can make suggestions, but apparently can’t force them not to do this. Also, on the 0 gain setting, L&R Bleed into the center channel, though there are 3 discreet channels at +2. Hmmm).

DSD is a heavily noise-shaped signal, which peaks around 60 kHz.

Mr. Ludwig told us, as a practice, that an incoming master that already sounds good in digital will stay that way, otherwise an analog transfer or working in the analog domain usually helps. The sound quality of most album masters these days are worse than ever due to non-professional engineers and basement studios. It’s a problem. When asked what sort of problems he meant, Mr. Ludwig replied, “well, intelligibility in the vocal is a problem, usually engineers don’t spend enough time riding it to make sure it is correct. And the low end, because the rooms usually aren’t correct so there can be way too much or too little, and the top... um, in short, the treble, the middle, and the bass are the problem!”

For “Black and White Night” the film was recorded in 30fps as this is the frame rate for black and white television. The in-house black burst generator would only reference to NTSC or PAL so an old PCM 1630 was used to generate 30fps, resolving the machine to a Lynx. The final black & white video master, when it came in, was in fact done at 29.97 for the DV-CAM, though the actual film editing was done at 24 fps pulldown or 23.7 fps! The sync for audio and video was a nightmare!

The SPL console is an 8 channel unit, an “exercise in how audiophile you can make sound.” It features 124V power rails and has tons of headroom! It also features an 8 channel attenuation pot that perfectly matches all 8 channels, and 3 dim settings to avoid using a volume pot as much as possible! The routing is done with no patch cables that can degrade your sound, rather all high quality relays, which can also degrade your sound! Hopefully less so. SPL also makes a Stereo Motorized analog EQ, with total recall, but no VCAs – all motorized pots.

Some of his favourite converters are Apogee, dCS and Microsoft (Pacific Microsonics), which all sample at 192 kHz and sound great.

Some rules of thumb again then – while the stock 192 converters on Pro Tools HD are good bang for the buck they are definitely designed to make the HD system more affordable. The analog-to-digital conversion is the most critical conversion, any jitter at this stage can never be removed. Buy the best converters you can.

***Use your ears and do what sounds best!***

## QUESTIONS AND ANSWERS

From the question and answer portion of the presentation, here are a few random examples and I'm paraphrasing, but the essential details are there:

**Q: “Who inspired you???”**

A: Two clients at Phil Ramone's A&R Studios... June Klagis from Command Records who did early stereo experiments. It was said she could “hear the grass grow” and was inspiringly picky! The other was Leiber and Stoller, the songwriting team responsible for “Hound Dog.” Etc. They used great mixers, but always complained they never made a mix they liked because they were so detail oriented and it was never quite good enough! The Mutt Langes of their day! Ludwig also singled out Mike Shipley and Bob Clearmountain's work for praise. He added he tends to work harder on material he hates because he wants to make sure the client gets value for their money and doesn't feel short changed.

He also suggested we should see the DVD documentary, *Tom Dowd & the Language of Music* immediately!

**Q: Are records too compressed?**

A: A&R people & artists often hear louder stuff as better, though it contributes (he believes) to fewer sales and ear fatigue! It makes for less compelling records which are fatiguing to listen to repeatedly. It's a serious problem. “Thank goodness the Beatles didn't have look-ahead digital compressors!” He's pleased that when he sends the band **Tool** 3 references (one with low compression, one with normal, and one with what he called “competitive” compression) the band will always take the one with the least compression as they *like* their music to actually be dynamic.



It's important to remember radio stations add their own compression. Digital satellite stations, though advertised as CD Quality, are NOT, and seriously manipulate already-too-loud recordings. Clipped records react to this the worst. Hopefully records with a 3dB dynamic range are falling out of favour with bands and labels.

**Q: What is the solution to the problem of listeners buying MP3 or AAC more than high resolution digital?**

A: Educating the listener. NARAS P&E Wing is toying with the idea of sending out mobiles with good 5.1 systems to let people hear what good sound really is and hopefully get them excited about it again. Truth is, people want CONTENT, and CONTENT drives people's purchases. While Bob will stand to listen to 33Kbit BBC Radio 3 Classical recordings streamed in the internet because he loves the instructive programs, he would prefer the experience to be much better quality. Hopefully the NARAS mobiles would help people realize that high resolution audio in fact offers greater and more thrilling emotional content.

The Grammys were broadcast in surround the past 2 years and Mr. Ludwig found it odd that this was hardly mentioned in favour of other topics. He believes if surround sound is done right there's nothing quite like it and stereo becomes a letdown!

**Q: What is the best philosophy for placing the instruments in a surround mix?**

A: Depends on your age... older and younger listeners prefer different. There are two philosophies, "best seat in the house" or "in the middle of the band." This is a Mixer/Producer & Artist call and Mastering Engineers don't mix!!!

**Q: What can an inexperienced mixer do better?**

A: Inexperienced mixers do not spend enough time on the vocal! For the mastering engineer, sometimes it takes many edits of isolated sections to make it right after the fact. On small low resolution monitors where the bass is highly unpredictable, bass is also a problem.

**Q: What's the ideal Sample Rate?**

A: For Mr. Ludwig, 176.4 is ideal for CD projects because it divides down to 44.1 well! It's always better to mix at a higher resolution and downsample later. The crucial detail is working 24-bit, which offers the biggest improvement over 16-bit.

**Q: Which is better, SACD or DVD-A?**

A: Either as long as they make up their minds! With the best converters they're very close.

**Q: What about dual discs?**

A: This is a great way to get high resolution audio to the masses – selling a CD with another high resolution layer, but selling it out in the CD bins. Problem is the disc is

slightly too fat for a Red Book CD and may have trouble in certain players. Beveling the edges helps somewhat, but it shortens the disc length to 63 minutes. Beck's new CD is a dual disc. Again what the consumer will buy is always CONTENT DRIVEN.

**Q: Will there be more channels in the future?**

A: I hope not for a while, the consumer is too confused now (as are professionals!) We've run cables for 10.2 at Gateway just in case, and have a ceiling speaker as well.

**Q: So what's the ultimate surround format?**

A: The ceiling makes a much bigger difference than a LFE... a 7.1 system with a ceiling and a center speaker in the back perhaps. For classical music the rear surrounds at 110 degrees sound good, for pop, maybe 125 – 135 degrees (at least for a Mark Knopfler record. In New York City apartments with the TV on one wall and the sofa on the other, all the rears are at 90 degrees anyway! Fortunately it all sounds pretty good.

**Q: What about M/S EQ?**

A: It works well on some old records or stereo 3 track – it's often used but generally is only appropriate less than 10% of the time.

**Thank you Bob Ludwig!!!!**