From Loudspeakers to Listeners

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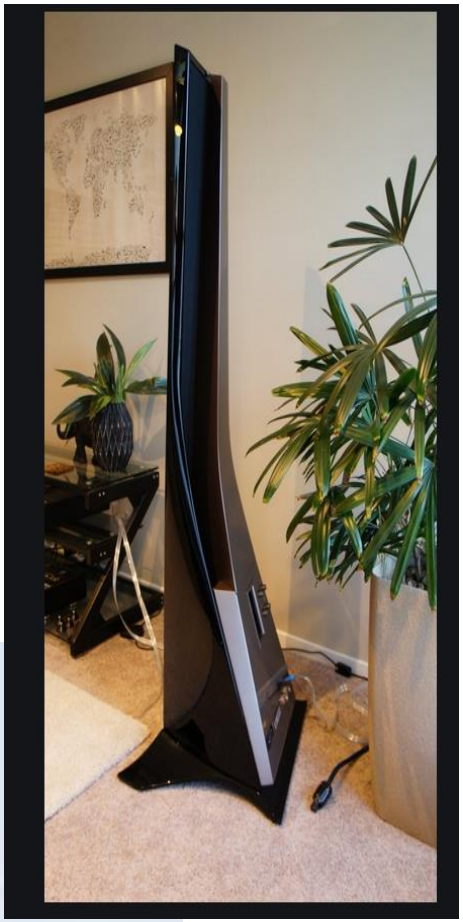
From Loudspeakers to Listeners

Tonight's topics:

1. The loudspeaker
2. Sound from loudspeakers into rooms
3. The surround sound experience
4. Putting it all together
   - Measures well, sounds bad
   - Subjective listening assessment



From Loudspeakers to Listeners

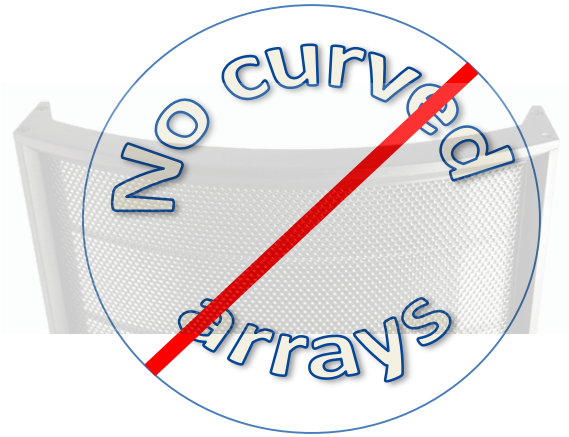
1. The loudspeaker - Electrostatic technology superior but issues...

   Film (Mylar) thickness, tension, panel width, gap separation, width to gap separation ratio, stator thickness/rigidity

   Polarisation Voltage, transformer ratio, interwinding capacitance, conductive coat

   Segmented vs. single arrays, standing waves/nodes, rear wave treatment, Diaphragm resonant frequency vs SPL, mechanical (cloth), electrical damping

   Polar pattern, directivity issues (turned to advantage – see later)



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2. Sound from loudspeakers into rooms

Dipole, bipole, monopole, concentric, non concentric

Why can a good testing speaker sound bad and a bad testing speaker sound good???

We tested many combinations of speakers for frequency response, THD, IMD, CSD, tone burst and polar response.

No Correlation to user preference

Preference was always Dipole followed by bipole and last of all the monopole

Electrostatics are natural concentric dipoles!!

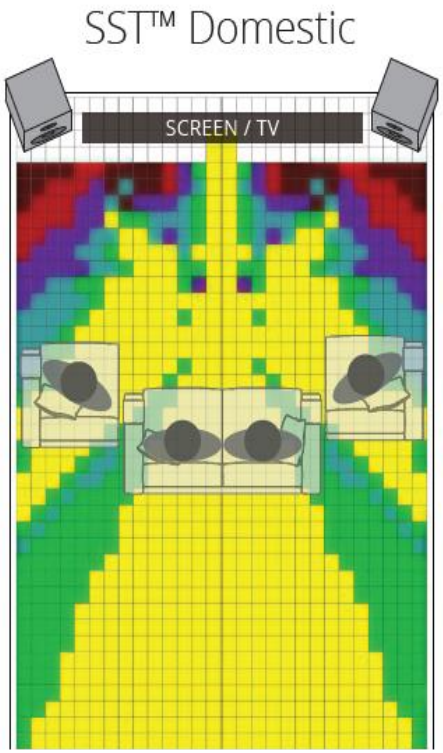
We should have known!

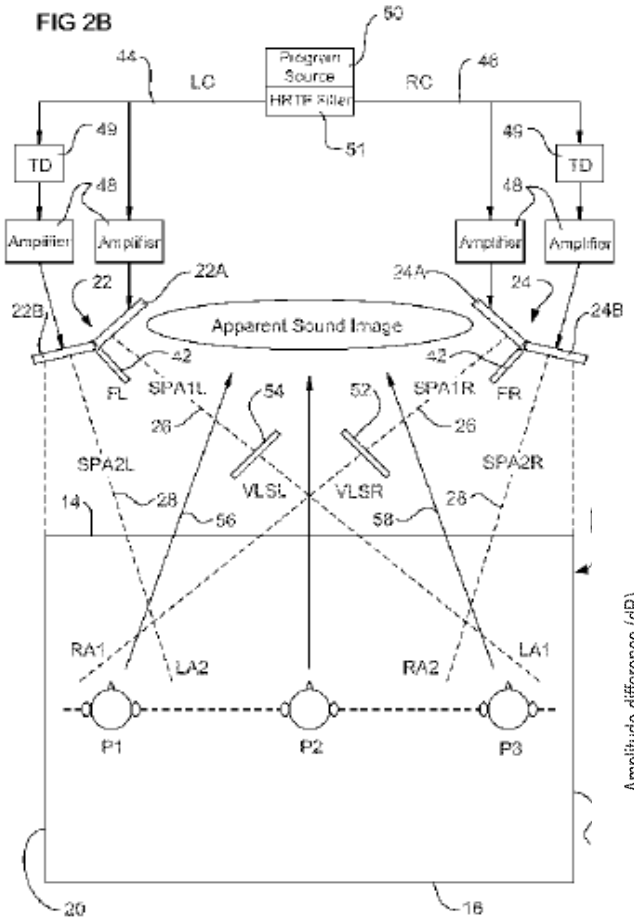
From Loudspeakers to Listeners

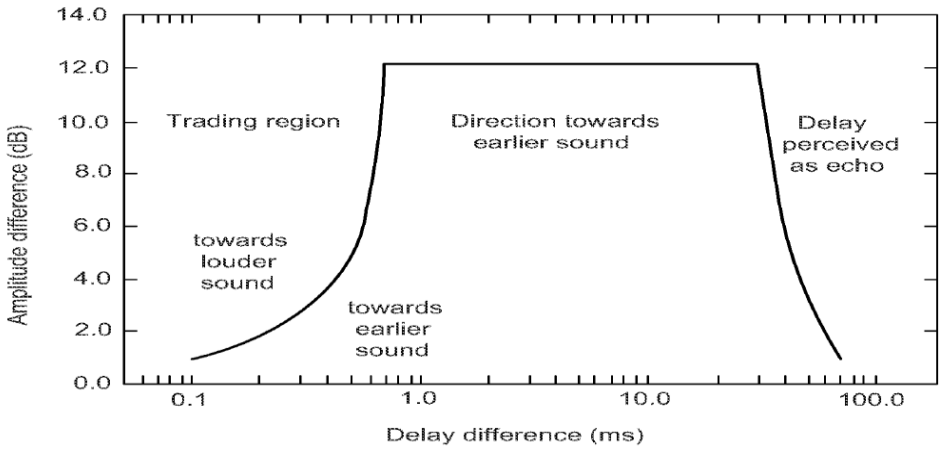
3. Sound through the air to the listener

Sound stage, central imaging, sweet spot enlargement

"Total Perspective™"







From Loudspeakers to Listeners

Listener preference with Sweet Spot Technology

Differences

Subjects were asked if they could discern a difference between Stereo and TSS, results are as follows:

In central seated position:

Yes: 6

No: 5

In left seated position:

Yes: 11

No: 0

SST vs Stereo Preferences

Subjects were asked if they had a preference for either system. The results were as follows:

In central seated position:

Stereo:	**4**
SST:	**2**
No preference:	**5**

In left seated position:

Stereo:	**0**
SST:	**10**
No preference:	**1**

4 From stereo to Surround

- Since the 70's surround sound has had quite a convoluted journey. The failure of it to be adopted in the 70's was due to the following reasons:

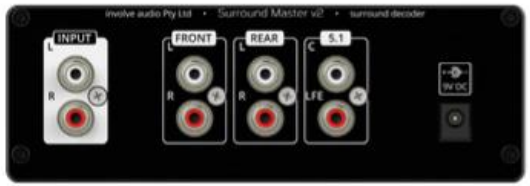
1. There was only one central position for the image to be consistent
2. Too many conflicting non compatible formats that confused the market
3. Most formats were only partially stereo compatible many exhibited a compression of the stereo image
4. The matrix based systems had poor separation and most of the ones that had additional "logic" had issues of pumping and smearing of the sound. Often with sounds popping up in strange places
5. One system SQ had good stereo compatibility but poor results on surround
6. Discrete based systems such as CD4 was very critical on the cartridge, wore the record early and often had popping and screeching sounds, in addition to requiring double the bandwidth for transmission.

- Come 1980 it was a dead duck and most people returned to plain Stereo. Simultaneously, Dolby was falling into a hole with the death of the cassette medium and they had to find another stream of revenue. The one thing Dolby had created during the glory days of the cassette was the brand logo recognition that unified a standard independently across all brands – really the first "Intel Inside"!

Redevelop and add psychoacoustics to the SQ system

$$L_t = L_f + .414R_f + jL_b + jO.414R_b$$
$$R_t = R_f + .414L_f - jR_b - j.414L_b$$

Surround Master V2 front panel



Surround Master V2 rear panel

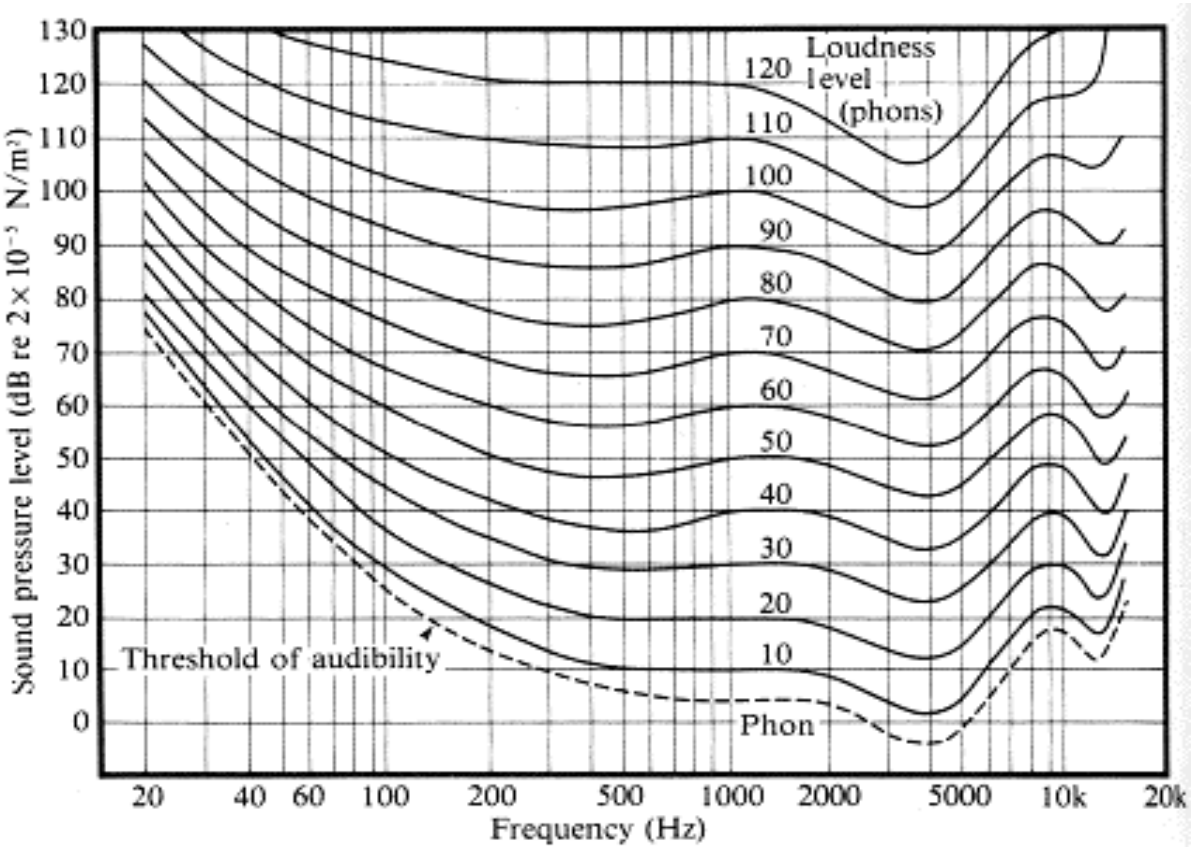
The birth of the Involve surround decode system

- The one that really stood out from the pack was QS in that it was completely free of directional bias (such as SQ) and in the surround / HiFi world probably had the best reputation for the best end surround reproduction. Like all systems it did have its problems and they were:

1. The technology of the day (mid 70's) needed to be updated and the tolerances of the mathematics needed to enter the digital realm to reduce cumulative errors.
2. The system needed to be multi band to eliminate as far as possible cross band dominance.
3. The system when encoded into the stereo container badly compressed the stereo left/ right image to a 8 dB band.
4. Lower frequencies needed appropriate weighting is any comparisons of levels and calculations to allow for human hearing, in essence allowance for the Fletcher Munson curve. See below
5. Any comparisons in calculations needed to be based on logarithmic scaling to match human hearing
6. More sensitive and precise phase detectors needed to be developed
7. A more advanced sound "packet" envelope shaping system had to be developed based on dual slope attack and decay time constants in tri bands to match typical packets of sound found in audio e.g. a guitar string or a drum. This is then used to "steer" the sound to its end location whilst leaving the listener blissfully unaware of any switching or manipulation.

Phychoacoustic factors

Other factors of human hearing perception were also modeled into our pre conditioning software/ circuitry such as the HAAS precedence curve. As we have been evolved to directionalise on the first sound arrival enabling on the fly directional calculation as most music is transitory by nature.



5 Involve Encode- variable parameter multiband matrix

- One of the biggest issues with the old QS system was material encoded in QS sounded image compressed and was not quite as good as the original stereo. In reality the system could produce 8 dB separation only. It would sound a bit better than this as the “leakage” content was encoded with a 90 degree phase shift.
- Our investigation into a better surround encode system started with the question of …..What is the minimum separation required that the listener cannot discern from digital 100 dB separation???
- These days with the advent of CD’s and digital we are all used to 100 dB separation but what is the minimum. Back in the days of vinyl record dominance 20 dB was the expectation but I remember some very good cartridges such as the “Empire” only had 12 dB

Minimum detectable stereo separation

- Again, as is our practice we created a channel leakage jig where we could vary the cross channel leakage and we used a test audience of 10 victims. The test was simple in that we just ask the listener when they could perceive a reduction of image or quality of sound.
- The end result surprised us all 12 db! It's the same number that appears in the HAAS curve and I have noticed in many other areas of audio. I suspect it is somehow bult into our human perception.
- We then adjusted the standard QS matrix equation
- Substituting 0.25 instead of the 0.414 and decoded this reduced leakage encode into our Surround Master decoder and obtained the following separation result:

outputs

I \ O	Left Rear	Left Front	Right Front	Right Rear
Left Rear	0	-43.1	-43.1	-48.0
Left Front	-12.0	-1.0	-23.1	-26.0
Right Front	-28.0	-23.1	-1.0	-12.0
Right Rear	-38.4	-34.0	-40.0	0

INPUTS

AVERAGE SEPARATION -30.9 dB

In the worst case the decoded surround maintained 12 dB separation!

This represents the worst case on fixed tone

Subjective preferences - QS matrix sound example

For music- non fixed tone

Involve intelligent decoding – optimised separation equals vinyl stereo

outputs

I \ O	Left Rear	Left Front	Right Front	Right Rear
Left Rear	0	-35.4	-36.5	-40
Left Front	-37.7	0	-43.1	-35.4
Right Front	-34.0	-38.4	0	-36.5
Right Rear	-37.7	-34.0	-38.0	0

INPUTS

AVERAGE SEPARATION -37.2 dB

Involve encode/ decode vs Discrete 5.1

Listener preference

Involve	**5**
No preference	**4**
Discrete	**2**

Our Panels

5 mm thick

Y4 Surround system with SST

10 channel

120 W class D per channel

8 electrostatic transformers

Full Involve decode

Blue tooth, Optical, RCA. 3.5mm and NFC