A NEW CONCEPT OF CONTROL ROOM ACOUSTICS

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What follows is a short talk about studio acoustics. It is not needed to have any technical knowledge to read it: actually all applied acoustics lags well behind any other branch of physics and engineering as far as ability to define and measure the involved parameters is concerned, not to speak about even the possibility of reproducing the same parceptual conditions with some confidence on the results.
This means there is still much of an art in audio consultancy, and the debate and contributions are open nearly to everyone involved in the field.
Theories which relate human aural perception to practical configuration of room suffer greatly from the lack of measuring opportunities, due to both the extreme complexity and cost of equipment to be used for even basic reliefs and the relatively poor number of defined and measurable parameters.
Reverberation time, for example, is obviously useful as a diagnostic tool for gross acoustic anomalies, and often used for specifications by acoustic designers, mostly being a readily affordable measure to take with common available equipment. The resolution of reverb time measurements is much impaired by restrictions and averagings taken at the moment of relieving, so that

repeated measurements in the same room may easily give widely different results.
Correlation measurements and Time versus Energy curves are both of fresh introduction and not at all widespread: experimental data are rather episodical and any theory based from them lacks of cross-checkings between a sufficient number of experimenters. Many audio consultants, expecially in USA, are anyway beginning to take confidence with these new techniques: LEDE control rooms are indeed a step forward with respect to older cut and try methods of designing acoustics, but there are many assumptions in their basic concept that deserve a deeper insight.

LEDE control room design, which postulates the subdivision of the room into two halves, one being heavily absorbent to sound, while the other (at the back of console and listeners) being much more alive, strongly implies one radical departure from anything looking (and sounding) like an ordinary living room. This is a rather overlooked point, yet the strive for standardization on control room acoustics has now become a subject worth of maximum attention, since problems on practically any other step of the audio recording process are vanishing day after day. Digital recording techniques get now rid of dependance on tape selection or biasing, head wear and speed variation. New microphones and loudspeakers have response and dynamics to allow for conservative operation, like already from earlier with the electronics, so distortion problems are much harmless.
Yet the interaction of monitoring loudspeakers and control room acoustics can introduce severe departures

from linearity,and each of them has a definite and well related counterpart in the finished musical recordings made available to the public.

Replaying equipment too,shows nonlinearities of various kinds, but what can be common between movie sound and domestic hi-fi, or car stereo and disco sound, or radio and TV broadcast?
So it is much better for control room acoustics to stay above parts and commercial fashions, also in view of the conspicuous financial investment normally involved in studio set-ups.
LEDE control room designe confirms this accepted departure but it still remains plenty of room for objections on the ground of feasibility of a true aural standardization on this line of design phylosophy.

Like any traditional acoustical treatment, LEDE designed rooms still depend on a marked degree for their "sound" on the physical dimensions and proportions of the ambients. This is because low frequency energy control is effected by means of wideband absorbents.
Wideband low frequency absorbers, either "traps" or any kind of resonating panels, must have large physical dimensions to guarantee the correct amount of absorption at the lower end of recorded frequency range: this is without any doubt a very difficult requirement to be satisfied without side effects.
Human hearing extract the information of "space" mostly from lateral reflections, arriving with different delays and spectra at the two ears: so it is important to keep

some degree of wideband reflectiveness on side walls of control rooms; the floor is obviously difficult to be made absorbent at low frequencies, and any kind of "bass traps" may create rather unpredictable behaviour of monitoring speakers if kept too near them: how much room surface is being left for low frequency absorption now?
Insufficient absorbent area causes both diffraction and long reverberation time, with the subsequent high energy content of first and second order reflections.
Either reflection or diffracted waves add in phase or not with the direct field produced by the monitors, and being only some percent weaker than direct field, there can be severe peaks or cancellations, all clearly audible.
This is a very down to earth explanation of the strong uneveness of response, expecially at low frequencies, displayed by both traditional and more advanced control rooms, together with a lack of correct balance between lateral and vertical reflections, thus accentuating the sensation of being in an enclosed space of unique and fatiguing "sound".

Now let we resume and go one step forward.
In a most advanced control room the reverberated field must be kept at a level of low potential interference with the direct field from the monitors, giving peaks and dips in the response eventually limited to subliminal entities. Optimal reverb times seem to range between 0.2 and 0.3 seconds for average sized rooms.
Reverberation must be due mostly to lateral reflections, and give coherent cues on a wide range of frequencies for the sensing of ambience without hearing fatigue.

No vibrating panel structure can be absorbent to frequencies as low as 30 or 40 Hz., enough to give the requested reverberation times without occupying most of the lateral surface and thus impairing lateral reflections more than necessary .

Only cavity resonators can absorb substantial energy even down to 30 Hz or lower, while having proportions and surface finish tu guarantee diffusion at mid frequencies and reflection of higher harmonics.
The very small bandwidth of such resonators was a great obstacle against their widespread use for the great number of different types and sizes required and the lenghty calculations involved in the design.
Computer speed and a number of measurements on actual units, plus natural cross-check between the two, now allows to use cavity resonators as radical means to overcome the "personality" of even very small rooms, making them free of standing low frequency waves, peaks and dips in response and lack of sensation of space.

Most important is the linearity of absorbption coefficient over wildly different sound pressure levels, on orders of magnitude better than conventional ill-fixed structures: there is practically no distortion limit dictated by the structure of the room.

Another huge step ahead of common practice is that cavity resonators respond with the same spectrum of absorbption to both continuous and transient signals: this is not at all true, for example, for the common layers of rock wool, that easily begin to vobrate in unison with the sound source after some cycles of excitation, thus losing much of their absorbption properties (or showing too much of them on short transient signals).

Cavity resonators may be flexible as far as replacement or corrections are concerned, enabling alterations for fulfilling differing requirements to be made with a minimum of redesign and time expenditure.

Studio remake may require extremely short times, and this brings together sensible economical savings.

Combining cavity resonators with foam prisms and balancing the relative surfaces after measurements take with gating techniques is in our opinion the most interesting and straightforward method of obtaining a true "standard" room, regardless of dimensions and geometry, together with a perfect spectral balance.

One more suphistication on design phylosophy gives the final touch of finesse to an already revolutionary configuration.

Assuming to design a loudspeaker system with cylindrical wavefront (at low and mid frequencies at least), this could greatly relax the design of floor and ceiling structures, being not involved in first order reflections.

Further, the same brilliant results of LEDE control rooms as far as reduction of coloration from early reflections, or possibly better, may be easily obtained by placing the two line sources in the front corners of the room: no first order reflections may then come from the two lateral walls adiacent the corner, and the very first energy to strike back to the listeners ears from rear or controlateral walls arrives with such a delay to be completely masked by Haas Effect.