A new acoustical design of control room for multichannel production and reproduction

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Contents **– This paper describes a new method of acoustic adaptation of control rooms with a goal to satisfy the necessary conditions for a quality control room, able to provide a better mix translation to other systems, with less need for the engineer to adapt, which is compatible for stereo as well as for surround monitoring.**

The practical examples of control rooms will be described, which are realized by using the new principles, along with the descriptions and experiences of sound engineers who have worked in them.

Keywords **— absorption, acoustical design, control room, diffuser, diffusion, Energy Time Curve, MLS, multichannel, non-environment design, RT60, stereo image, subjective impressions, surround monitoring.**

I. Introduction

Beginning of 2006. we were given an engineering task described by the client in one sole sentence: “Make us the best small control room in the given space”. The plan for it was to have both stereo and surround monitoring.

The available space was relatively small (Table 2), and narrow, with an almost square base (Table 1), and the speakers were already ordered.

During the last couple of years, small control rooms became more frequent, mainly because of the changes in sound engineers approach, and the tendency to move the workspace to living quarters.

None of the existing approaches [1] was appropriate for this specific task at hand for one or more reasons, so we were forced to abandon them.

The control room C at the Blackbird studios [2], [3], based on wideband diffusion on all of the surfaces except for the floor was the closest to the idea of how this room should be treated. But, due to the restrictions caused by the room dimensions, it was not possible to directly apply that approach.

We started researching in order to define the best possible acoustic treatment.

In general, rooms smaller than 80m^3 are not advised to be used for a control room for stereo and surround production and reproduction, so it was impossible to find and apply an existing solution, which could provide satisfactory results.

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II. Initial design conditions

The first step was to introduce certain limitations and compromises which could make possible the design of a treatment with similar/better end result compared to conventional approaches and solutions.

A. Diffusion

The basic condition which is pre-defined in the new approach to control room design (in the further text referred as “MyRoom”) is homogenous diffusion on all of the surfaces except the floor, for the frequencies above approximately 1 kHz. Reason for this is the fact that in small rooms all surfaces are too near to the listener and the diffusers must be at least three times their lowest designed wavelength away from listener [4]. It should be kept in mind that the depth of the diffuser is always at the expense of the absorption thickness, and that in that case some kind of a compromise is essential.

B. Absorption

The second condition was for MyRoom treatment to provide maximum possible absorption of frequencies below 250 Hz, homogenously on all the surfaces, except the floor. Without that condition the effect of the diffuse field would not be satisfactory, because the strong room modes would acoustically mask them.

III. Methods

Basic principle is left-right symmetry, and great care should be taken to sustain it while designing the control room. Later experience showed that the spaces with so much diffusion virtually enlarge the subjective perception of asymmetry in the monitoring; hence the extreme caution is desirable.

We analyzed many possible approaches to low frequency absorption, so we decided to use “wideband absorbing system”, similar to solution which is used in Tom Hidley/Philip Newell’s “non-environment” design [5].

We solved diffusion problem by inventing a new 1D amplitude grating diffuser which has enough air transparency not to diminish the efficiency of wideband absorbers which were placed behind them. An example is Fig. 2.

Diffuser is made of slats with openings for air flow. Slat depth is calculated by using Schroeder's formula for N=13 [6]. Only wells without fins were used, there are no solid spacers between the wells. The divider between the wells is the only air.

For implementing more than one of diffusers on surfaces, in RES Media Studio, we used a Maximum Length Sequence (MLS), a pseudorandom sequence, to determine each diffuser element orientation.

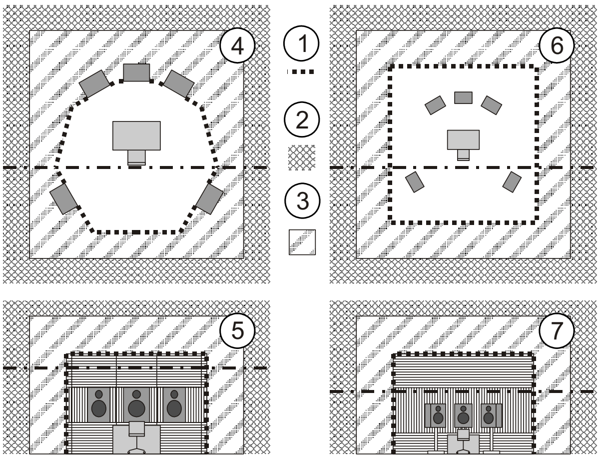

Fig. 1. – Some possible ways of MyRoom design: 1. air-transparent diffuse surface, 2. stiff wall, 3. low frequency absorption, 4. horizontal cross-section of room with soffit monitors, 5. vertical c.s. of room with soffit monitors, 6. horizontal c.s. of room with free-standing monitors, 7. vertical c.s. of room with free-standing monitors.

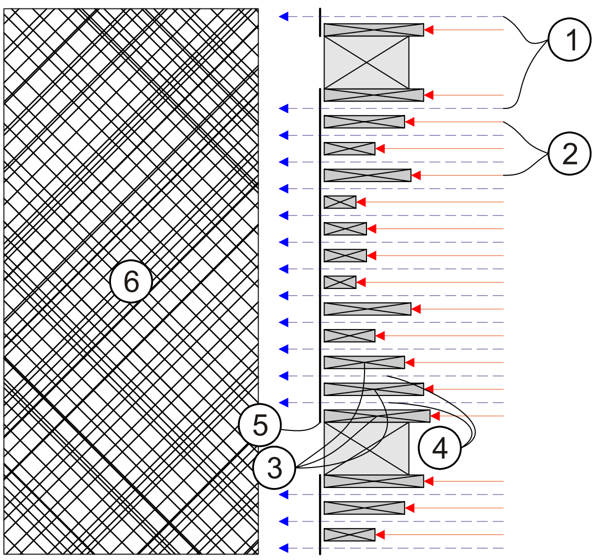

Fig. 2. – Side wall applied MyRoom treatment principle, horizontal cross-section, (top view): 1. air waves which passes through (blue/absorbed/diffused), 2. Air waves which cannot pass through (red/reflected/diffused), 3. Diffuser slats, 4. "Through hole" wells, 5. air transparent fabric, 6. Wideband absorber.

MyRoom principles were employed in two studios, one having surround 5.1 free-standing speakers (RES Media Studio: Fig. 3, Fig. 4, Fig. 5, Fig. 6.), and the other with stereo soffit mounted monitoring (Pressed Lizard Studio: Fig. 7.).

Fig. 1. shows possible ways of construction. The possibilities are virtually unlimited, but it should be taken care to maintain best possible low frequency absorption and the largest possible number of air-transparent diffusers, constructed as previously described.

Fig. 2. shows horizontal cross section of treatment. Air transparent diffusors are mounted on wooden studs. Behind diffusors is wideband absorber appropriate for specific room and specific position. Back of diffusers is covered with air transparent fabric.

IV. Measurement Results

For the calculation of recommended RT60, it is necessary to define the volume of the space [7], [8] and [9]. Having in mind predominantly reflective character of all the surfaces in a room treated by the MyRoom principles, we decided that the volume of the room is what's left after the treatment elements are applied.

The basic room dimensions are described in the Table 1.

Table 1: Room dimensions before treatment.

Name	Width	Length	Height
RES Media	3.25m	7.05m	3.32m

The volume of the room is much reduced by the low frequency acoustic treatment. The volumes are shown in Table 2.

Table 2: Room volume.

Name	Basic	Spent on treatment	Tm(s)
RES Media	76m^3	37.23m^3 - 49%	0.183

Recommended value for RT60, *Tm*, is calculated from:

$$Tm = 0.25\text{s} \cdot \sqrt[3]{\frac{V}{100\text{m}^3}} \qquad (1)$$

V is the leftover volume of the room in m³.

RT60 measurement results are shown in Fig. 3.

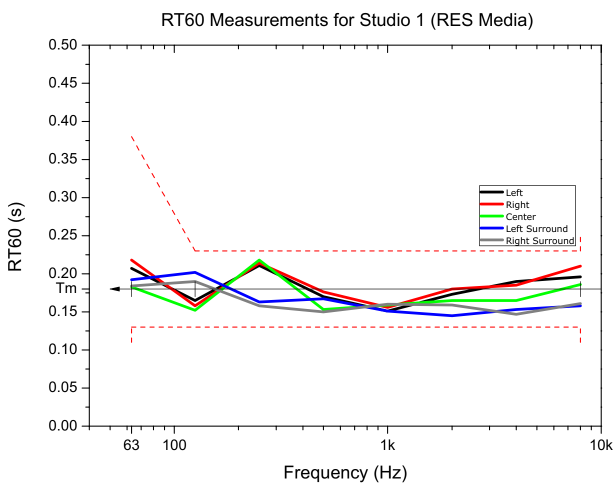

Fig. 3. - RT60 Frequency dependence for the control room in the RES Media Studio, with AES limitations [9]. Graph shows the response of all five speakers.

Energy Time Curve (Fig. 4.) for RES Media Studio measurements show that the response is similar to Massenburg's Blackbird Studio C Control Room [3], with the difference where decay starts from around 20dB and not from 30dB as is the case there. The difference of 10dB can be explained by the different level of absorption and the fact that in our case the diffusers are closer to the listening spot, since the room base is smaller.

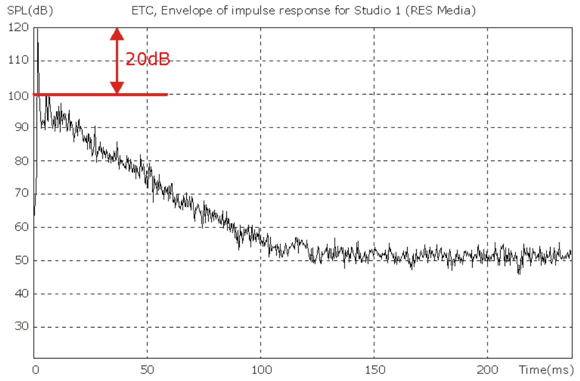

Fig. 4. – Envelope of impulse response for RES Media Studio. Similarities with Blackbird Studio C are obvious, only attenuation of first reflections isn't 30dB.

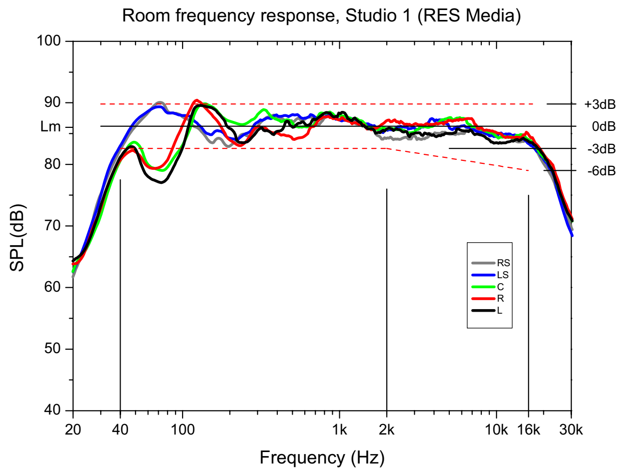

Fig. 5. – Acoustical frequency response of the surround control room in the RES Media Studio along with the limits defined in AES recommendations [9]. Graph shows the response of all five speakers.

Frequency response measurements are derived from impulse response measured by the MLS method (Fig. 5.).

V. Subjective Impressions

Subjective impressions are much better than expected. The impressions are as follows:

1. Reproduction is much more realistic and closer to the natural source compared to the conventional acoustical design.
2. Rooms treated in this way cause similar impressions, no matter the difference in size and shape (they 'sound' similar).
3. The detail in reproduction, previously not heard in other designs.
4. A sense of extremely flat frequency response of the room.
5. Feeling that the low frequency is evenly distributed throughout the room, not depending on the listening position.
6. Wider, deeper, and more detailed stereo image.
7. A large level of detail at low SPL.
8. Excellent mix translation.
9. The rooms, even with all the absorption, sound very natural and live.
10. The time of adjusting to the room is very short, and is mostly to the much higher level of detail.
11. The listeners perceive the space as being acoustically larger than it physically is.
12. Users, who are capable of recognizing the specific sound of a sole diffuser in some control room, do not distinguish that sound in this room, even with so many of them, just the elevated level of detail in the material being listened to.
13. The sense of the listener that the "walls" are much more neutral and "quiet" than in a traditionally designed room. Walls are virtually "disappearing"?

VI. Discussion

RT60 measurements in the RES Media Studio proved that the results are well compliant to the Audio Engineering Society (AES) recommendation [9] as shown in Fig. 3.

The deviation of frequency response from the AES [9] recommended criteria can be seen in certain frequency ranges below 100 Hz for front speakers (Fig. 5.) are a consequence of the lack of space and the possibility to optimally position all five surround speakers in such a space. Also, Studio has a starting problem of one of its cross sections being almost square-shaped.

Room is also very long, and this helps for low frequency absorbing because there was more space for bigger absorbers. Reason for this is fact that low frequencies below 150Hz aren't directional in room.

The subject questioned agreed that the diffusers, which are not in the places of the first reflections, contribute to more detailed and focused image during work.

VII. Summary

The goal of this paper is to show the new approach at the design of a control room, whose main principle is homogenous treatment of all the surfaces, as a main prerequisite for surround monitoring compatibility. Practical example was shown as an evaluation of design usability with the basic measurements.

The principle of having all of the surfaces, except the floor, air transparent and diffusive, and good low frequency absorption is definitely the right approach for the rooms in which surround monitoring is expected.

MyRoom principle can be a better alternative to conventional design for the rooms of volume of 30m3 and more...

There is no limit in size; we see no reason as to why the suggested MyRoom approach would be incompatible with larger rooms (100m3 and more). We can expect that the described design principles will perform even better in larger rooms.

We also concluded that diffuse early reflections in control rooms are extremely important for quality and more precise (hence more objective) assessment of sound image, and thus faster decision making during the production. This assumes a hypothesis that the presence of diffuse room reflections above 1 kHz causes better mix translation, even during the trial attempts, and also causes less work fatigue and more relaxed approach to work. Also, the already mentioned phenomenon of the diffusers causing a psychoacoustics feeling of a larger space than it in reality is helps to reduce the feeling of discomfort caused by smaller spaces.

By applying MyRoom design to two completely different small rooms, we resulted with impressive stereo monitoring.

We believe that by using any of the traditional designs, we'd not be able to achieve such stereo imaging, detail level and mix translation with rooms with such small volumes.

Fig. 6. – RES Media Studio, designed by MyRoom principles. Side diffusers are air transparent, order N=13. Behind front speakers is fractal diffuser of order N=7 and M=7, it is air transparent too.

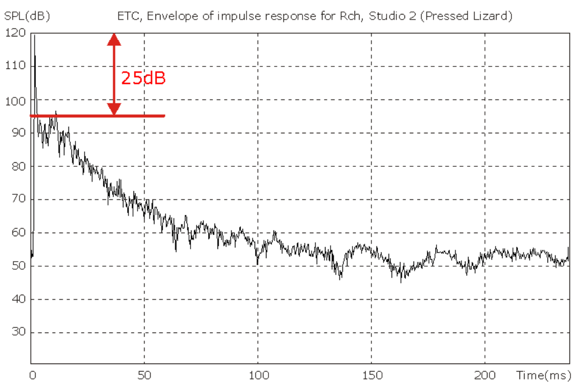

Fig. 7. – Pressed Lizard Control Room with stereo monitoring. Envelope of impulse response.

We can expect that the design principles which showed results complying in measurement very satisfactory with recommended objective criteria, although not being large enough according to current standards, will perform even better in larger rooms.

The new design, described in this paper, we called "MyRoom principle", by the expected scenario that it's a small volume room, most probably a home studio located in an apartment/house in which the owner resides. Technical names for this design could also be Non-Coherent (N-C) acoustic design, or Early Reflections Delay Encryption (ERDE) design...

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