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Telephone booths for confidential calls in office spaces

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ABSTRACT

The task was to create telephone booths for confidential calls. A logistics company with more than 300 employees at the headquarter needed areas where the employees can telephone without the colleagues maybe listening. It seems to be a simple task for an acoustic engineer to define the requirements in absorption and sound insulation. However a box only designed under acoustical aspects might not suit the needs of the users. Hence an architect, a psychoacoustician and an engineer jointly worked together in designing a prototype. The users were interviewed inside of the booth, and the design was discussed and agreed with these local experts. Important changes were made, and as a result the resulting booths are well accepted and commonly used.

Keywords: Work interference and efficiency, Insulation, Absorption I-INCE Classification of Subjects Number(s): 63.5

1. INTRODUCTION

Telephone booths for confidential calls had to be developed. The project architect, a psychoacoustician and an engineer jointly worked together in linking all significant needs. The booths should be installed at the headquarter of the costumer in Berlin, a consultant company for logistics services. A principle of the company is that there are no closed doors. “Transparency and openness prevail in our daily communication with each other. All ‘4flowers’ communicate as equals and treat each other with respect.” [1]

Hence the more than 300 employees at the headquarters in Berlin work in offices with 5 to 8 persons working in each room. To reflect the openness, nearly every office has a door or a wall out of glass. You can look in- and outside, but you are not able to understand the conversations behind. And the glass door gives visual control about what happens on the other side in both directions.

This works well between the offices. But open plan offices might sometimes be not well suited for confidential calls and for focusing on difficult tasks. The idea was to design booths for one to two employees. They should guarantee

- separation from man-made noise and
- visual openness.

This paper mainly will focus on the acoustics. The acoustic engineer who promoted high insulation and lots of absorption inside the cabin and in the surrounding halls to damp sound next to where it is generated. The architect was interested in open doors and a pleasant design. The psychoacoustician involved the employees as experts that will give the orientation for decisions. Hence a preferably realistic prototype was build. The sound insulation and absorption were measured and experts were interviewed inside the prototype.

2. BACKGROUND

During the planning process it soon became apparent that the insulation standards for offices for confidential use (e.g. [2]) cannot be achieved. A setting according to these standards (room-in-room solution, sound insulating doors) would not fulfill the other requirements as usability and convenience. Hence a compromise design was made and was realized as a prototype.

While there is no quantity to measure confidentiality, there is one standard for speech intelligibility. In Figure 1 the level of intelligibility, where half of the text can be understood, is drawn.

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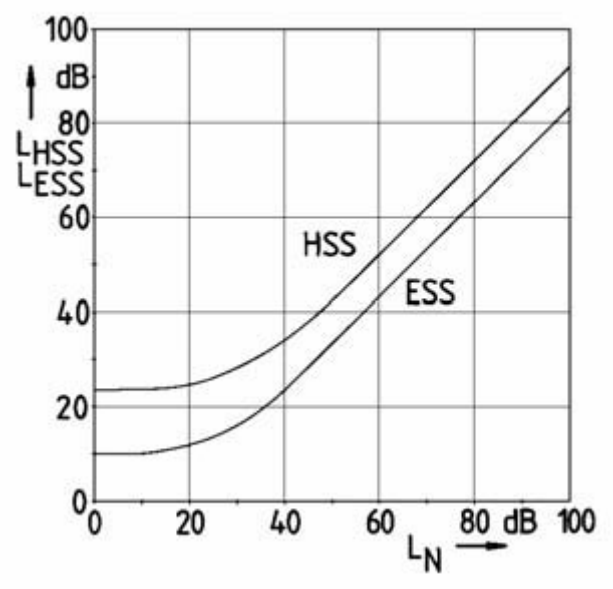

Figure 1 – Detection level L_{ESS} and intelligibility level L_{HSS} of continuously spoken text related to the background noise level L_N (white noise) [3]

Depending on the signal to noise ratio (SNR) the speech intelligibility can be categorised as follows:

Table 1 – Speech intelligibility and signal to noise ratio [4]

Signal to noise ratio	-10dB	-5dB	0dB	5dB	10dB
Speech intelligibility	poor	little	fair	good	excellent

The transmission of sound through doors and walls affects the frequency spectrum of the signals. If the doors are closed, mid and high frequencies are more insulated than low frequencies. The intelligibility of the muffled signal is even lower than expected by the SNR (Table 1). If the doors are open, the frequency spectrum of the signals does not change significantly. A good non-intelligibility can only be achieved with artificial noise resulting in an adequate SNR.

For the evaluation of the prototype employees, management, architects and the acoustic consultants were involved. The respective analysis by the psychoacoustician provided the following factors as relevant for the acceptance of the booth:

- acoustic (insulation, absorption),
- lighting,
- temperature,
- ventilation,
- haptics,
- safety,
- confidentiality/intimacy,
- colors,
- variability of use.

3. PROTOTYPE

3.1 Description

One booth as a prototype close to the planned final design was set up at the company. The walls were built as double layered gypsum walls with a sound reduction index without flanking transmission of $R_{w,R}$ = 64dB, mainly covered with porous absorbers. The ceiling and the back wall were realized

with perforated gypsum walls. The booths were fully equipped with a desk, chairs, a screen and a telephone. The outer wall is illuminated. The booths were arranged shifted, which was called the "ZIGZAG" design, to increase the insulation if the doors are open (see Figure 3).

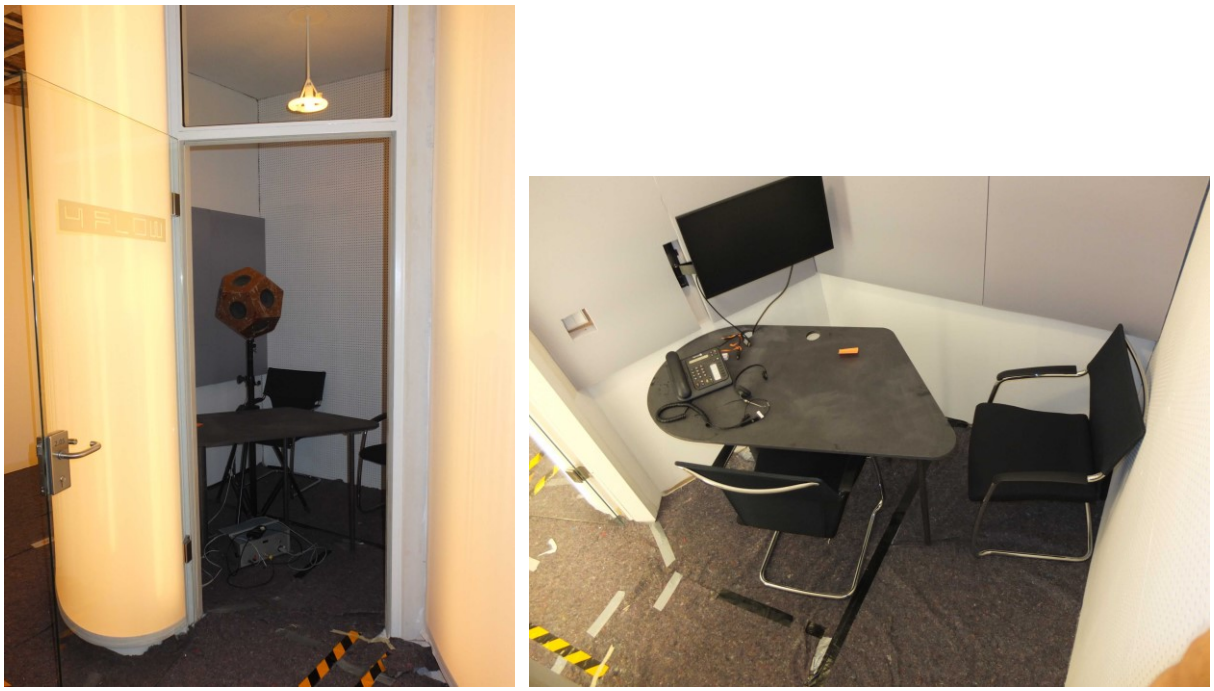

Figure 2 – Pictures of the prototype

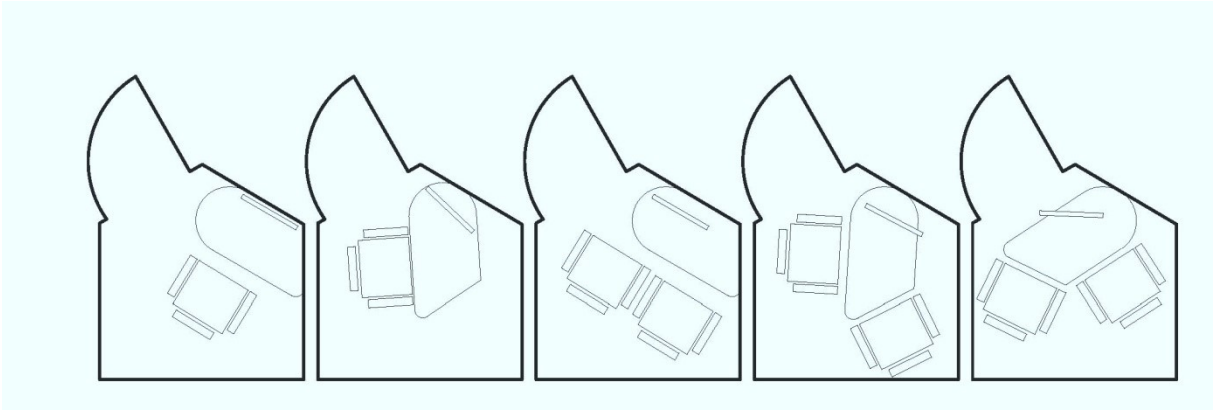

Figure 3 – Sketch of the booths and the movable desks arranged in various layouts [5]

3.2 Acoustic Measurements

The sound insulation was tested in measuring the level differences between the inside of the booth and the outside. To achieve general results

- a dodekaeder loudspeaker with omnidirectional radiation,
- a microphone with omnidirectional directivity and
- a standardized test signal (pink noise) with a constant frequency spectrum

were used. The level differences were measured in both directions and the results are shown here:

a) door open, with visual contact: about 10 dB
b) door open, without visual contact: about 15 to 20 dB
c) door closed, with visual contact: about 30 dB
d) door closed, without visual contact: about 40 dB

With closed doors the booths sufficiently reduce the level of words spoken in usual manner. An acceptable non-intelligibility is given, if the unwanted listener does not concentrate on the talk. Through the glass door control is given in whether somebody stands next to the door. With open doors no adequate reduction could be achieved. Generally loud talks might be intelligible even with closed doors. However this is not expected in consulting.

To reduce the sound level by absorbing sound close to the sources most of the surfaces inside the booth were covered with absorbers. This resulted in a reverberation time of about 0.1 s to 0.2 s above 250 Hz. In a room with such an unusual low reverberation time people sometimes feel uncomfortable. To avoid this, the absorbers at the rear wall could be removed without increasing the level inside the booth, as one sits generally with the back to the rear wall and speaks to the front.

4. FINAL DESIGN

Based on the evaluation and following detailed proposals by the users several changes were made. The final design can be seen in Figure 4.

Figure 4 – Final design of the telephone booths [5].

An amorphous illumination was chosen which is coupled to the inner lighting. Therefore it can easily be seen from the outside whether a booth is occupied or not. The sound insulation is adequate for confidential calls, and the room acoustic supports the users in feeling comfortable and safe. The desk and the monitor are variable. Each user can set up his or her preferred arrangement. An air conditioning provides fresh air if the door is closed for a long time and if the booth is used by two persons.

5. CONCLUSIONS

The booths are frequently used by the employees. The concept of openness and confidentiality led to a pleasant design without loss of functionality. The result was achieved through collaboration by the customer, the architect, the psychoacoustician and the acoustic engineer. The writer of this document is the acoustic technician. He learned to question rules and given standards and to be open-minded for different approaches. The demands of a costumer are sometimes not only driven by acoustics but by a

bunch of different aspects. And the architect is right when he or she notes that “perfect acoustic is sometimes not only a question of limits”.

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REFERENCES

1. Working at 4flow. [cited 2016 May 16]; Available from: http://www.4flow.de/en/careers/working-at-4flow.html.
2. Schallschutz im Hochbau. Hinweise für Planung und Ausführung. Vorschläge für einen erhöhten Schallschutz. Empfehlungen für den Schallschutz im eigenen Wohn- und Arbeitsbereich. DIN 4109 Beiblatt 2. November 1989.
3. Lazarus H, Sust C.A, Steckel R, Kulka M, Kurtz P. Akustische Grundlagen sprachlicher Kommunikation. Berlin, Heidelberg: Springer Verlag; 2007.
4. Ergonomics - Assessment of speech communication. ISO 9921: 2003.
5. Moers A., Quiet please! Prototype for an acoustically optimized Workplace. DETAIL Zeitschrift für Architektur + Baudetail. 2015; 2: 64-66.
6. Schulte-Fortkamp B., Psychoacoustic Comfort of Office Spaces. DETAIL Zeitschrift für Architektur + Baudetail. 2015; 2: 66-69.
7. Rohrmann B. Verbal qualifiers for rating scales: Sociolinguistic considerations and psychometric data. Project Report. University of Melbourne/Australia. January 2007. Available at http://www.rohrmannresearch.net/pdfs/rohrmann-vqs-report.pdf