ACOUSTICS 2012

Acoustic of open spaces - Overview of standardization work

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NF S 31-199 uses the concepts of discretion. The underlying idea is that ensuring good intelligibility in the scope of communication (the workstation) will reduce the disturbance to distant workstations. Indeed, there is a contradiction inherent in open office areas: voice, useful to transfer knowledge and expertise in the room, turns out to be a disturbance few moments later, a few meters away. The complexity of the acoustics of open spaces brought the commission AFNOR S30 D in 2007 to initiate the drafting of a new document, complementary to NF S31-080. The working hypothesis of the commission is that it is possible to solve the contradiction of open spaces, and to create a sound environment that is conducive to work. The document NF S31-199 was given a preliminary title: Acoustics – Open offices: programming, design and usage.
The central themes are that communication and concentration have declined from a model space analysis distinguished in three zones, each corresponding to different acoustic issues: the workstation, the team and the department. The paper proposes the state already in a number of strategies, including the provision of workstations with issues and interactions between employees, reducing the ambient noise level or the mastery of sound propagation in space. This presentation proposes to make an inventory of the progress of the drafting work for four sub-categories of open space, ranging from call centers to open space to the public.

1 Introduction

In France the use of open plan solutions has increased dramatically over the past decade. Open plan solutions are often based on the belief that, within a department, openness between workplaces stimulates communication and the sharing of information. In addition such solutions provide considerable flexibility, resulting in easier adaptation to reorganisation; this is especially valuable in project oriented businesses. Another belief is that investments can be reduced by accommodating a larger number of the employees and by spending less on the construction of workplaces, in comparison with the construction of more traditional private, closed offices. Open plan solutions, however make high demands on the acoustic environment if an acceptable level of acoustic comfort is to be achieved. There is a paradox, on one hand you need good enough speech intelligibility to allow personal discussion and phone calls and, on the other hand, you need a reasonable level of privacy. If two people, each at their own workplace, can clearly hear each other's conversation, they may feel disturbed and uncomfortable.
Many people in open plan environments complain about disturbance and annoyance due to poor acoustics. A number of studies [1] show that people working in open offices can experience stress, frustration and even physiological effects (strains, heart rate, etc). Some researchers even suggest that, if negative stress is to be avoided, our brains need periods of rest from annoying sounds during the course of a workday. Other researchers [2] show that, if there is a lack of privacy, it is possible that more complex work, needing higher concentration, will be performed less effectively, with more errors occurring.

2 Starting point NF S 31-080

2.1 The purpose

Until 2006, there were not any French normative references concerned with comfort and acoustic environment in work areas. This standard establishes a link between acoustic quality measurements and the acoustic performance levels to be achieved by the implementation of building systems. These performance levels are expressed through standardized and traditional acoustic criteria applicable to buildings. This standard establishes a baseline enabling technical dialogue and formal commitment among the various players intervening in the design and realization of an office or associated area project. It has been designed to assist with the drawing up of specifications and with the design, realization and acceptance of works. It applies to new premises, refurbishments and changes in the allotted purpose of areas.

For all type of office rooms , this standard defines and classifies the sound environment according to three levels of performance:

- "Standard" level: corresponds to what the regulations specify and, in the absence of legal texts, to the minimum functional level, that does not guarantee any acoustical comfort.
- "Efficient" level: corresponds to acoustic performance levels that go beyond the "standard" level. This level ensures a level of sound comfort that is compatible with good working conditions.
- "Highly efficient" level: corresponds to maximum acoustic performance levels made possible by the action on the set of construction elements making up the works (design, architecture, materials, etc.). This level targets the perception of useful noise and the non-perception of unnecessary noise: there is thus a qualitative notion that is specific to the use and activity to be carried out in the room.

2.2 Limitations for Open Offices

Even if NF S 31-080 addresses the issues of noise comfort, particularly through the concepts of "discretion" and "confidentiality". The approach chosen for the open spaces was "to ensure no discomfort between positions close but also to ensure comfort for short conversations." The underlying idea is that good intelligibility in communication perimeter (near the station) induces less discomfort to more distant positions. The acoustic criterias chosen are reverberation and special decay. After a few years of implementation many acoustic measurements were just using reverberation as the main parameter for the implementation of building systems.
Front of the number of activities going on within open offices S30 D commission decided to work on a new approach in order to better correlate the subjective experience.
This new standard is an opportunity to deepen this discussion by addressing the whole of what makes an open space, including additional facilities such as furniture, screens, privacy screens, etc...

3 NF S 31-199 - Open offices : programming, design and usage

The ambition of this standard is to provide principles, descriptors and measurement methods to characterize the acoustics, which are easy to implement and correlate well to the subjective perception of sound [3]. The hope is that this standard may constitute a basis for reflection and dialogue between different actors involved in creating office space in France. In particular, it will allow the project management to refine the drafting of specifications and help project management in its choice of objectives and resources related to architecture and space planning of open offices. Open offices must now adapt to most types of activities that often have very different characteristics. Depending on the type of activity, the acoustic challenges may be very different (number of sound sources, the level of these sources, etc...) and acoustic issues will be varied with the needs of intelligibility or otherwise discretion at the station or between workstations.
The standard defines the following four different types of open space encompassing the majority of existing activities and in which the reader should find then applying the associated acoustic: Call centers, Marketing, Administration and reception areas of public bodies.

3.1 Call centers

Call centers are open office spaces where various activities (commercial, technical assistance, information, surveys, relief ...) are produced mainly by telephone. They often have the name of Customer Relations Centre (CRC), call centers, contact centers, etc . Noise sources are numerous and generate a significant ambient noise level, which can affect the vocal effort of each employee (Lombard effect).
Verbal communications between employees are frequent between calls after difficult calls or during quiet periods. Conversations with the supervisor line manager and colleagues take place at the workstation (short conversations) or in premises adjacent to the open space (long conversations, training, etc.).
The general acoustic environment should allow the production of intellectual work which requires a level of medium to high concentration. It must limit fatigue, ensuring operator comfort knowing that the voice level is higher than the ambient noise level.

3.2 Marketing

This type of space is designed for collaborative work, mostly in teams and project groups. The open space contains individual tasks requiring limited concentration. This type of space is made for advertising agencies. marketing, consulting firms, etc ...).
The activity is differentiated and collaborative. Between employees, communication is primarily verbal, incidentally on the phone. The number of simultaneous sources may be relatively large and especially the vocal behavior will be fluctuating: lively atmosphere, a lot of interaction. Good intelligibility is required between jobs within the team. Good Intelligibility over the phone is also required. There is also a need for discretion.

3.3 Administration

This type of space is arranged to work mostly individual, including an ad hoc collaboration and limited. It is intended to accommodate business-type administration, accounting, human resources, purchasing, etc. The concentration of employees is supported. Their activity is undifferentiated within a team, and is not collaborative. Staff are typically grouped in teams [1-8 people], which can occasionally communicate. Therefore, verbal communications are relatively limited (sporadically, colleagues or the phone). Normally, the vocal behavior of some simultaneous speakers is characterized by regular exchanges and content, with a low level of voice (calm), no with little interaction. Therefore, the ambient noise level is low during periods of relatively large (several tens of seconds to several minutes), resulting in strong emergence that can be disruptive of their degree of origin. The discomfort due to emergence is low and dependent on their origin. In general, in the case of the same service, disturbance due to emergence is more accepted than in the case of cohabiting different services. There are few sound sources simultaneously, but given the number on the board, this may represent a significant proportion.
This results in a need for intelligibility at the workstation, but also a need for discretion between positions, especially when different services are located on the same plateau.Public

3.4 Public

This type of space may correspond to reception areas of public bodies, insurance, banks, etc ...
It is organized for meetings and must allow for many interactions between staff and clients.
The space is designed for providing hospitality to the public and to facilitate individual work.
The public can be received in "windows"-like spaces or be seated in "office"-like spaces if the interview requires a greater period of time.
Between two appointments, staff may have to perform data entry tasks and report writing requiring a relatively strong concentration. In most cases, the activity is not collaborative between staff and the exchanges are mainly face to face with the customer. Exchanges are often directly related to privacy and it is therefore necessary to ensure good privacy. Noise sources which are mainly spoken exchanges are numerous and simultaneous. Levels of voice in this type of space may vary greatly depending on the trade and activity more or less contained therein (eg rush hour).
The ambient noise level is relatively high. Emergences are regular and sometimes very pronounced. The degree of disturbance of emergences is strong.

4 Inputs Nice Reports

In a Nordic cooperation project the acoustical conditions in open-plan offices was investigated [4]. Measurements have been carried out in five open plan offices accompanied with an inquiry gathering the subjective judgments by the staff. A program for the acoustical measurements was designed specifying how to perform the measurements and which type of parameters to

measure. The acoustical parameters included in the measurements are Reverberation time T_{20}, Early Decay Time (EDT), Clarity (C50), Speech transmission index (STI), Speech intelligibility index (SII), Privacy Index (PI), Rate of spatial decay of sound pressure levels per distance doubling (DL_2), Excess of sound pressure level with respect to a reference curve (DL_f), background noise levels in occupied and unoccupied offices. In two of the offices a refurbishment program was carried out. Measurements as well as questionnaire were accomplished after refurbishment. Ordinary room acoustic parameters like reverberation time are not sufficient for a relevant characterization of the acoustic environment in open-plan spaces. The influence of the interior design on sound propagation over distance is a crucial factor for the overall impression of the acoustic environment and its suitability as an efficient work place. Measures related to sound propagation like DL_2 and DL_f are therefore appropriate for open-plan spaces. In two open-plan offices a refurbishment program has been performed. It has been shown that DL_2 and DL_f are sensitive for the acoustic treatments carried out and also reflect the improvement of the subjective judgment concerning the acoustic environment in general.

5 Inspiration 3382 – 3

ISO 3382-3 specifies methods for the measurement of room acoustic properties in open-plan offices with furnishing [5]. It describes measurement procedures, the apparatus needed, the coverage required, and the method for evaluating the data and presenting the test report.

In this international standard, the sound power spectrum of normal speech is used. The octave band values represent normal effort unisex speech (average of female and male speech). The determination of $D_{2.S}$ (an application of DL_2 defined in ISO 14257, but using the spectrum of normal speech and A-weighting over the whole frequency range) is made from the results at measurement positions at distances within the range 2 m to 16 m from the sound source. A logarithmic distance axis and linear regression is used. The standard also defines sound pressure level at 4 m ($L_{pA,S,4m}$) which is determined via linear regression from the line, and a distraction distance (r_D), defined as the distance where the speech transmission index (STI) is equal to 0.5. Recommendations of levels are given in the annex of the standard as follows: $D_{2.S} \geq 7$, $L_{pA,S,4m} \leq 48$ dB, and $r_D \leq 5$ m.

5 Conclusion

In view of the complexity of open offices acoustics, the S30 D commission proposed a model space analysis distinguished in three zones, each corresponding to different acoustic issues: the workstation, the team and the department.

References

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[4] E. Nilsson, B. Hellström : Room Acoustic design in Open-plan offices; *Eronoise 2009 , Edinburg, Scotland*

[5] ISO 3382-3 Acoustique – Mesurage des parameters acoustiques des salles – Espaces ouverts