Study case of a centre for biomedical analyses : the importance of an acoustic analysis of the current situation and definition of the targets to be achieved

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French regulations concerning the maximum noise levels in medical premises also cover the acoustic performances in existing buildings housing certain defined medical activities in which the regulations are normally applied.
Nevertheless, some cases fall either outside the list of the buildings covered, or merit special treatment.
One example is described here: it concerns a centre for biomedical analyses in a large regional teaching hospital with a technical area of several hundred square meters. This concentration of a workforce and technical equipment without any acoustic attenuation measures led to a labour dispute. This article describes the challenges encountered, the pitfalls to be avoided and any post-project and design stage measures to be implemented.

A new project that soon became the source of a labour dispute

Covering an area of around 10,000 m² on several floors, this centre groups together several laboratories that had previously been installed on different hospital sites. The floors in the new centre accommodate activities organized in disciplines and separated from one another.

On the ground floor are:

–a technical area of approximately 450 m², without any partitions or separated passages for persons, equipped with bench tops, automatic analysis equipment, centrifuges, IT stations, telephones, and so on, in which a metal tray suspended ceiling had been installed. It accommodates approximately 35 staff, technicians and managers who receive, record, sort and prepare approximately 3500 blood and urine samples a day from external services and dispatches them towards the specialized services;

–laboratory zones outside the technical area but connected to it by shared passageways.

Typologies of the different noise nuisances

Technical area: a constant hubbub

In broad outline, staff are divided into the two main sub-groups shown on the floor layout plan below, respectively called zones A and B.

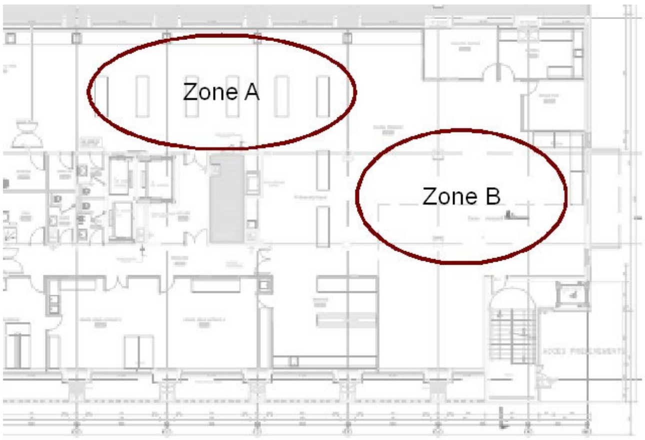

Fig.1 Main sub-groups on the technical area.

The activity of the employees themselves more than the building equipment, which generates a second order background noise, that is the source of a very high noise level due to:

–shouted requests for information on a sample;

–technical discussions concerning the interpretation of such or such an automatic analysis (the staff validate the analyses one by one);

–telephone communication of the most urgent results (for instance to a doctor waiting for results before deciding on a patient's treatment);

–training of new arrivals or night duty staff (generally the new arrivals);

–professional or personal discussions on areas that should be used for passage and are not separated from work areas, etc.

In fact, the constant LAeq levels are around 63 to 67 dB(A) (L50 from 61 to 65 dB(A)), and can reach 70 dB(A) during a few minutes whatever the position of the readings (see graph below).

This uninterrupted hubbub, at the extreme limit of the so-called "cocktail effect", results from verbal exchanges on the technical area on top of the background noise due to the building equipment.

The fact that the suspended ceiling consists of reverberating metal trays only compounds the problem.

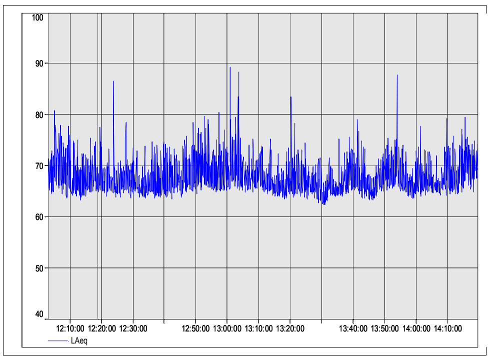

Fig.2 Sound levels measured on the technical area.

In this type of situation, there are obvious grounds for the staff to complain. Such noise levels are incompatible with the level of concentration required to work.

Hence the sudden disenchantment that arose on opening this new service, which resulted in a labour dispute and strike.

Peripheral laboratories: counting and recounting

A certain number of small laboratories line the two passages leading to the technical area. Those with controlled access are obviously closed and as a result separated from the passages. However, the laboratories without controlled access are completely open to the passages.

Although they generate relatively little noise themselves, they are unfortunately exposed to the ceaseless noise of passing personnel with no possibility of cutting out this noise as everything is largely open.

The typology of nuisances encountered in these laboratories can be fairly well illustrated by the testimony of a laboratory assistant who told us that when performing a cell count under the microscope, which required a high level of concentration, she regularly had to restart her count due to the noise that disturbed her concentration.

Typology of the dysfunctions

The dysfunctions were of different kinds:

–a great deal of background noise (L50 of around 65 dB(A)) on the technical area,

–in the peripheral laboratory rooms, the existence of low background noise onto which were superimposed unexpected and "external" acoustic events with high sound emergence (high signal-to-noise ratio),

–in almost all the premises, the continuity of the phenomena, staff knowing that the only way of extracting themselves from the noise was by leaving the workstation.

A certain number of authors [1] have studied the non-traumatic effects of noise and disturbance on workers. In the present case, we can identify the following probable effects:

–effect on concentration: difficulty of concentrating (high ambient noise level) and loss of concentration due to unexpected sound events (emergence) or with a negative connotation,

–stress – dissatisfaction: chronic impossibility of achieving one's own level of concentration or calm,

–tiredness: compensatory effort required for the success of one's tasks in spite of the external disturbances.

"Hell, it's the others" [2]

We were called in after the centre had been operating in these conditions for several months. We began by gathering the comments and criticism of the users before proceeding to take measurements and make our own observations.

The testimonies gathered from the users and our observations converged as to the existence of a considerable difficulty caused by persons moving in the "pseudo-passage" area (absence of partitions), and who did not observed a minimum degree of discretion to avoid disturbing nearby workstations.

Conversely, our conclusions diverged as to the impact of the noise generated by those in the "other zone" on the technical area. They were accused of causing disturbance whereas in actual fact, the noise in zone A or zone B mainly concerned the work within zone A or zone B. Staff strongly favoured installing partitions between the different sub-groups, in particular those of zone A who were facing an even more difficult working environment than those in zone B.

A computer model shows the impact of each zone on the other. It appears that the input from zone B was about 10 dB(A) less than the total noise level in zone A and vice versa, thereby confirming that the dominant noise was not that which came from the "others" but from one's own zone.

Lastly, although each sub-group was obviously at the origin of most of the noise it encountered, the declarations were much more moderate when it came to the disturbance caused by colleagues from the same sub-group. This can be interpreted as due to the fact that the intra-group relations are relatively tolerant, with self-regulation practiced in a fairly gentle manner. On the other hand, the nuisances from the outside, that is to say from the other sub-groups, take place without any real possibility of control and is thus less easily supported.

Reducing the noise

Actions to reduce the noise from the laboratory equipment were sought as a priority. Additional characterisations were envisaged, but for very little total acoustic gain.

As to oral communications, apart from the conviviality aspect, they are absolutely essential to the correct working practice.

Therefore, according to the users, they should be:

–isolated from the passages: we put forward a proposal to install separating partitions but as this called into question the original principle underlying the project, i.e. a completely opened technical area and laboratories, it was not considered suitable by management, at least initially;

–isolated from the "others" by creating separate rooms, returning therefore to the organization of the area that existed before the refitting operation. This is where our acoustic analysis contradicted the statements gathered from staff (especially those in zone A), supported by models of the impact of one zone on the other.

However, we were unable to take account of the wishes of users.

The basic precaution would have been to install a sound absorbing suspended ceiling at the outset of the project. However, this was not retained for health reasons. Even so, in our opinion other choices would have been entirely feasible, including compliance with the requirements of the Committee for the Prevention of Non-comial Infections.

Therefore, based on computer model analysis (AcousPropa® software), we put forward that the replacement of the suspended ceiling was essential:

–to improve the acoustic insulation between zones A and B by lessening the reverberation,

–this would also attenuate the ambient noise levels by users speaking more quietly, not only because there would be less "cocktail effect" conditions, but also due to the general appeasement that this new sound environment would create. In fact in our opinion the noise maps give a minimum improvement compared to the final benefit achieved, as they do not take account of the effect of users' voice level.

On the other hand, this solution would obviously have very little impact on the nuisances due to the noise from passing foot traffic.

Fig. 3, 4 and 5 are noise maps and gains in dB(A) achieved by computer modelling in certain zones using AcousPropa® software developed by Gamba Acoustique.

They show an acoustic gain over the initial situation that may reach ten or so dB(A) in certain areas, but only 2 to 5 dB(A) around the more agitated areas (cf. Fig. 5).

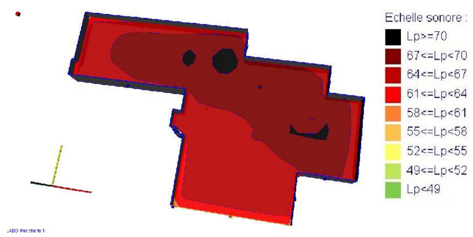

Fig.3 initial situation.

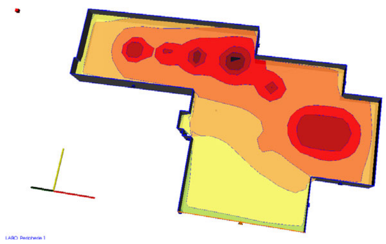

Fig.4 situation predicted after replacing the suspended ceiling

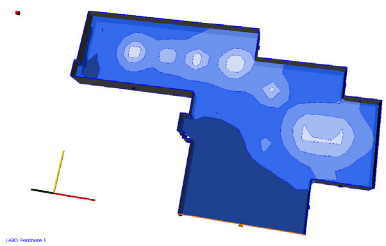

Fig.5 gain predicted after replacing the suspended ceiling

If we observe the influence of one zone on another (fig. 6, 7 and 8), we note a gain of 10 dB(A), this is achieved by replacing the suspended ceiling, which brings a gain on one zone to approximately twenty or so dB(A) below the total ambient noise level. In these conditions, even if no partitioning occurs, propagation will be such that the impact of one zone on the other will be negligible.

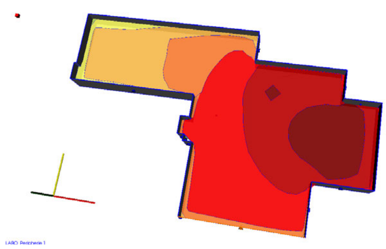

Fig.6 impact of zone B on zone A in the initial configuration.

Fig.7 predicted impact of zone B on zone A after replacing the suspended ceiling.

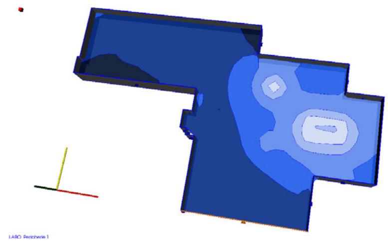

Fig.8 predicted gain after replacing the suspended ceiling.

Replacing the ceiling was an essential pre-condition to improving the acoustic situation.

But we soon discovered during the diagnosis that, although obvious, the acoustic problem was not the only dysfunction faced by users. Several other catalysts contributed to their discomfort: the sporadic arrival of sample batches (slack periods followed by periods of very intense work), tiredness and frustration concerning the absence of rest areas for them to withdraw from the noisy environment, stress due to the need to avoid errors (professional liability concerning health and even the life of patients) while working to very short time scales all in a tense environment created since the centre began work.

In addition, changing work practices, having been replaced by new working conditions considered to be very bad, undoubtedly created the shock that stigmatised the situation, making it more delicate to manage.

Conclusion

Finally, several aspects are undoubtedly to be regretted:

–insufficient preliminary analysis of users' needs, the organization, work and staff flows (absence of an ergonomist for example when developing the project),

–the absence of a questioning approach regarding the acoustic aspect (if an acoustic expert had been present early on, the sources of acoustic dysfunction would probably have affected a certain number of organizational and layout choices and one might wonder whether the situation would have been quite the same if the suspended ceiling had been noise absorbent from the outset).

The analysis of the work and the gathering of users' needs (occasionally contradictory and out of phase with the reality of the acoustic expert's measurements and observations) formed the necessary foundation for defining the cause in the first stage and then putting forward effective technical solutions which received the backing of the persons involved.

Good practices require that this preliminary analysis is initiated upstream of the project at the programming stage. Clients initially, followed by project managers should be aware of the stakes involved.

References

[1]R. FLORU, JC CNOCKAERT, bibliographic study "effets non traumatiques du bruit sur la santé, la sécurité et

l'efficacité de l'homme au travail", INRS, Cahier de notes documentaires n°154, 1er trimestre 1994

[2]J.P. SARTRE, "Huis clos", Ed. Gallimard, (1944)