CASE STUDY ABOUT SPEECH PRIVACY OF INTEGRATED FURNITURE IN AN OPEN-PLAN OFFICE

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1. INTRODUCTION

In the case of a retrofitting project for large open-plan offices, it was appropriate to test a prototype of integrated furniture before completing specifications for different floors. As acoustical environment was initially good in the building, it was requested to assure that the new ceiling and the new system of office furniture could offer similar performances regarding speech privacy or even better results (especially for a call center). Four modular workstations have been placed in a large room to accomplish various acoustic measurements. Speech privacy has been compared between 17 configurations of the same prototype, which included the type of acoustical tiles for the ceiling, the material and the height of screens, or by adding acoustic baffles, localized absorption, and sliding doors.

2. TESTING METHOD

The experimental procedure was based on the evaluation of speech privacy, as it stays one of the most important criteria of acoustical comfort for occupants of the building. Even if that issue is well documented, the reach of good acoustical performance in a working environment always requires some efforts. This project aimed to help owners to take decisions about renewing completely interior arrangements. Consequently, the procedure had to be relatively simple and fast to run on site, as the specification process should not be delayed by the acoustical expertise.

2.1 Studied parameters

Few parameters can quantify speech privacy considering the level of transmission from a sound source. These include the Articulation Index (AI), the Speech Intelligibility Index (SII) and the Speech Transmission Index (STI). On a 0 to 1 scale, those values must be minimized to reduce the understanding of messages, resulting in a better privacy. SII of 0.2 under is generally considered good for open-plan spaces.

2.2 Sample of office arrangement

In order to test general ergonomics and performances of proposed integrated furniture, a prototype of 4 workstations has been built. As figure 1 shows, three workstations followed the same arrangement, but unit n°3 differed because of its counter for service.

2.3 Experimental procedure

The National Research Council of Canada developed a testing software especially for diagnose problems in open-plan offices [2]. SPMSoft uses impulse responses from a sweep signal and background noise measurement to make a calculation of privacy parameters. Up to 12 propagation paths were tested using a loudspeaker and a microphone located approximately where occupants should sit (1.15 m from floor).

2.4 Studied adjustments of the prototype

The conception team established some variables before considering acoustics. For example, each workstation should size 2.14 by 2.60 m, when the height of partitions could be chosen between 1.68 and 2.06 m. The pattern of the suspended ceiling had to follow windows' position, but acoustic tiles could be changed. It was also deter-mined that integrated furniture would be chosen for it flexibility and durability. However, finishes could be adjusted, knowing that absorbing panels could replace glazed parts. In addition to those variables, other acoustical treatments have been tested. That includes the addition of sliding doors, localized absorption or acoustical baffles under the ceiling.

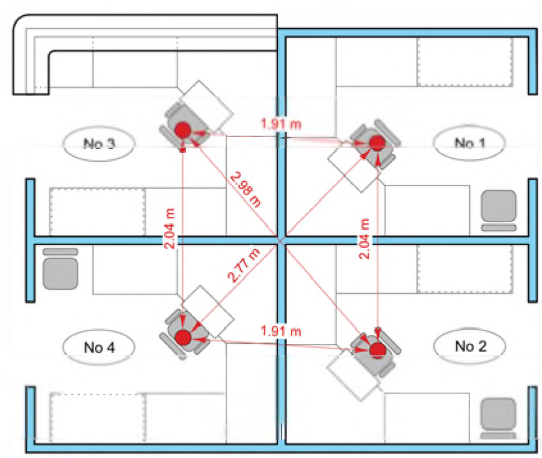

Fig. 1. Layout of integrated furniture constituting the sample of four workstations, with direct propagation paths.

Table 1. Summary of averaged results for speech privacy improvements compared to the reference case, with multiple adjustments of the same prototype.

No	Description	Ceiling tiles	Type of panels	Height of screens (m)	SII	AI	STI
1	**Reference case**	**product A[1]**	**Glazing at 8%**	**1.68**	**0.48**	**0.41**	**0.45**
2	Without computer screens	product A[1]	Glazing at 8%	1.68	-0.06	-0.08	-0.04
3	Add of localized absorbing material	product A[1]	Absorbing at 100%	1.68	-0.02	-0.02	+0.01
4	Add of absorbing baffles under ceiling	product A[1]	Absorbing at 100%	1.68	-0.06	-0.05	-0.05
5	Raise of division's height	product A[1]	Glazing at 26%	2.06	+0.04	+0.02	+0.05
6	Change between glazing and absorption	product A[1]	Absorbing at 100%	2.06	-0.06	-0.06	-0.05
7	Add of absorbing baffles under ceiling	product A[1]	Absorbing at 100%	2.06	-0.12	-0.13	-0.11
8	Add of sliding doors	product A[1]	Glazing at 26%	2.06	-0.12 [3]	-0.12 [3]	-0.11 [3]
9	Add of doors, absorption, and baffles	product A[1]	Absorbing at 100%	2.06	-0.19 [3]	-0.19 [3]	-0.20 [3]
10	Change of ceiling tiles	product B[2]	Glazing at 8%	1.68	-0.15	-0.15	-0.14
11	Change for thumbtack panels	product B[2]	Absorbing at 100%	1.68	-0.11	-0.11	-0.10
12	Change for highly absorbing panels	product B[2]	High absorbing on 32%	1.68	-0.15	-0.15	-0.14
13	Raise of division's height	product B[2]	Glazing at 26%	2.06	-0.14	-0.15	-0.14
14	Add of structure's hider	product B[2]	Glazing at 26%	2.06	-0.14	-0.14	-0.12
15	Change between glazing and absorption	product B[2]	Absorbing at 100%	2.06	-0.20	-0.20	-0.18
16	Change for thumbtack panels	product B[2]	Absorbing at 100%	2.06	-0.17	-0.17	-0.15
17	Change for highly absorbing panels	product B[2]	High absorbing on 37%	2.06	-0.21	-0.22	-0.19

Notes : 1 -High density fiberglass tiles (rated NRC-0.90) 2 - High density fiberglass tiles (rated NRC-0.85) 3 - Comparative measurement with or without the sliding door

3. RESULTS

Multiple experiments has been achieved with the prototype of office furniture. The table 1 summarizes most interesting results considering averages of each parameter for tested propagation paths. To show privacy improvement, values are compared with the first case, which is the reference proposed by project's designers. With a SII of 0.48, corrections had to be made to respect comfort specifications.

The first noticeable observation is the general effect of ceiling tiles. Even if the NRC value published by the manufacturer is lower for the second product, the perceived absorption seemed higher, as the average privacy was increased of almost 30%. Another important aspect is the height of each screen, which is normally beneficial to performances when raised. However, this assumption depends highly on the choice of material used in their construction. With the first tested case of high divisions, case n°5, the addition of modular panels at the top of partitions surprisingly reduces privacy between workstations. The choice of glazed parts, to allow natural light diffusion in the building, explains this situation, because divisions become partially sound reflectors. The substitution of those panels for standard absorbing surfaces can reduce intelligibility, but the better results are obtained with high absorption materials that are thicker.

Those results concern directly the system of integrated furniture. Other modifications represent optional elements that might be useful for particular areas with high level of privacy needed, in a call center for example. One good way to cut sound propagation between workstations is to add sliding door to screens, so each space could be closed according to occupant's wish (cases n°8 and 9). If the height of division cannot be raised because of air distribution or sprinklers' operation, then acoustic baffles become an interesting solution. Absorbing panels of only 0.20 m high suspended beneath ceiling system are enough to make a substantial difference. Finally, experiment n°2 demonstrates the significant role of computer screens in the propagation of sound as for direct reflection of user's voice.

4. DISCUSSION

As expected, results show that the choice of materials for the ceiling and divisions has the greater impact on speech privacy. The height of screens is also an important variable, but the addition of absorbing baffles can reduce that need.

The intent of this case study was to quantify acoustical performances of office furniture. Several tests made on a demonstrator of widespread commercial products has been profitable to justify owners' choices before implementation on a large scale. This practical example was constrained to comparison of most feasible modifications to interior arrangements, and few aspects were fixed in advance, as the orientation of workstations. However, it reveals the importance of collaboration between conceivers, designers and architects to assure the final efficiency of the environment procured in an open-plan office.

REFERENCES

[1] Asselineau, M. et al. (2009) *Looking at speech privacy in buildings : a few considerations*, Inter-Noise 09 Proceedings, 6p.

[2] Bradley, J.S., Gover, B.N. (2008) *Development and Evaluation of Speech Privacy Measurement Software: SPMSoft*, IRC Research Report, IRC RR-262, 45p.

[3] Bradley, J.S., Gover, B.N. (2008) *Open-Plan Office Speech Privacy Case Studies*, IRC Research Report, IRC RR-262, 35p.