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IMPROVING SPEECH PRIVACY IN AN OPEN PLAN OFFICE

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1. INTRODUCTION

The adoption of open-plan for office design is becoming more and more prevalent because open plan offices provide flexibility in the design of an office's layout and re-arranging workstations to accommodate organizational changes. Open plan offices allow the use of simple and efficient air-conditioning systems to serve all workstations. Without the full-height walls, adjacent workstations can share light, resulting in less energy to be required for lighting. On the other hand, some major concerns regarding open-plan offices are control of noise level from office activities, control of business machine noise from adjacent areas, and speech privacy between adjacent workstations. The first one can be addressed by having a proper layout to cater for the operational behaviour of a company. The second concern becomes less serious as companies use computers to replace noisy office machines such as manual typewriters, electronic typewriters, dot-matrix line printers and telex machines. Those machines were very popular in 70's and 80's. Among these three concerns, speech privacy is the most difficult one to address as people have to communicate with their colleagues and clients and a person's ability to reconstruct the information content of a sentence based on comparatively little information is surprisingly high.

In this paper, we focus our attention on the speech privacy between two adjacent workstations in a typical open plan office. Some screen configurations were tested and the resulting speech privacy would be assessed using the articulation index (AI).

2. SPEECH PRIVACY IN AN OPEN-PLAN OFFICE

The speech privacy depends on signal-to-noise ratio between the intruding speech level (signal) and the steady background noise. The intruding speech level is largely determined by the voice effort of a sound source/speaker and the sound reduction between workstations. The background noise is commonly produced by the ventilation and air-conditioning systems, office activities, or electronic masking sound systems.

In an open-plan office, the path for speech intrusion is direct, or interrupted by partial-height acoustic screens. Possible sound paths between two workstations separated by a screen in the office include sound energy transmitted directly through the screen, diffraction over and around the screen, and reflection from the ceiling, the floor, adjacent screens and the walls.

Some researchers [1,2] investigated the effect of sound diffraction and reflection on sound transmission and attenuation in laboratory environment. Maekawa [1] measured sound diffraction over a thin rigid screen in a laboratory using pulsed tones of sufficiently short duration. He proved the sound diffraction to be a function of the Fresnel's number. Moreland in 1988 [2] showed that an acoustic screen must function as a barrier to block sound propagation from the source to the receiver in order to provide good speech privacy between adjacent workstations. He stated the blocking effect to be the primary function of the screen. The other dominant factors which may affect the speech privacy are diffraction over the screen, and reflection from the ceiling, the floor (if there is a gap between the screen and the floor) and other vertical surfaces. Pirn [3] and Warnock [4] studied acoustical variables in open-plan offices such as speech effort, source orientation, background noise, source-to-receiver distance, barrier attenuation (if present and flanked), etc. They produced plots and tables showing the articulation index against those variables. These publications are extremely useful for interior designers to design an open plan office with good acoustics. However, when the improvement of speech privacy is of concern, none of these publications can provide a simple guide on how to modify the office's layout.

3. AI MEASUREMENTS

The measurements described here were performed in a typical open plan office after working hours in order to eliminate unwanted noise from human activities. Office furnishings were in place and the air-conditioning system was operated to simulate the normal office environment. A standard test procedure, ASTM E1130 - Standard Test Method for Objective Measurement of Speech Privacy in Open Offices Using Articulation Index, was followed to evaluate the degree of speech privacy for various screen configurations. In the office, the source workstation and the receiver workstation were separated by two acoustic screens of 1 m width. It should be noted that in Asian countries it is quite common to use two/three short screens to build a long partial-height barrier. To perform objective measurements of speech privacy, a sound source (SP) was located 1.2 m above the floor and 1.3 m from the screen. It was activated by a B&K Sound Analyzer Model No.2144. The analyzer was also used to measure two sound signals from B&K Model No.4165 Microphones with pre-amplifiers. Microphone No.1 was positioned in the source workstation at 0.9 m from the source. Microphone No.2 was positioned in line with the source and 1.3 m from the screen in the receiver workstation. The office arrangement is shown in Fig.1. This setting was used as the basic configuration (Configuration No.1 in Fig.2) throughout the measurements.

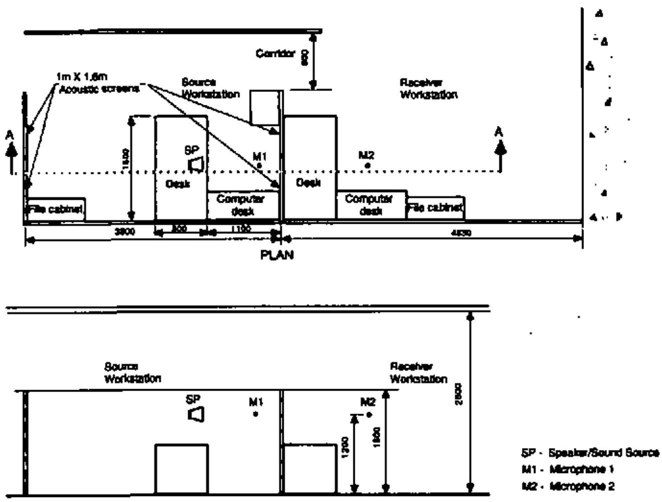

Fig.1 Office Layout

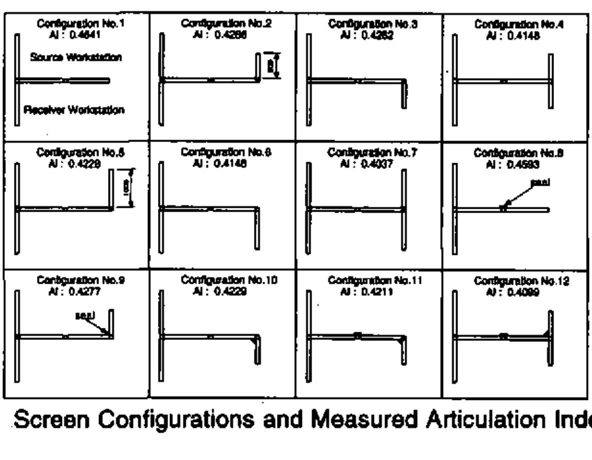

Fig.2 Screen Configurations and Measured Articulation Indexes

Fig.2 shows the 12 screen configurations and their corresponding AI values. The variations were sealing up the 0.1 mm gap between two acoustic screens separating the source and the receiver, and adding short or long side screen(s) in the source workstation or/and in the receiver workstation. It should be noted that at Articulation Index values above 0.40 they can be classified as poor speech privacy and substantial distraction.

Comparing the AI values for Configuration Nos. 1-7, one can observe the AI value for Configuration No.7 to be the lowest (thus the best) as two long side screens plus two acoustic screens acting as two enclosures to protect the receiver from the sound emitted from the source. However, if one screen was used, Configuration Nos. 1-3, 5 and 6 show placing the side screen in the receiver workstation to be better than placing the side screen in the source workstation. Configuration No.4 (two short screens) has the same AI value as Configuration No.6 (one long screen in the receiver workstation).

Table 2 shows the effect of gap(s) present or sealed at different location(s) of the screens on the articulation index. It shows that a good improvement can be achieved by sealing the gap in the middle of the acoustic screens separating the source and the receiver.

Configuration Nos.	Difference in AI	No. of locations sealed
1 & 8	0.0048	1
2 & 9	0.0009	1
3 & 10	0.0033	1
3 & 11	0.0051	2
4 & 12	0.0049	2

Table 2 The Effect of Gap(s) Present or Sealed on the AI values

4. CONCLUDING REMARKS

A number of screen configurations were tested in a typical open plan office. The measured AI values indicate the most effective (and economical if the cost of materials is considered) screen modification to enhance speech privacy to be sealing the gap between the existing screens and adding one long screen in the receiver workstation.

5. REFERENCES

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