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ACOUSTICS OF THE OPEN PLAN ENVIRONMENT

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Open Planning for Higher Education
Acoustics

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In architecture, acoustics cannot be treated in isolation from other design matters. Dr.Nuttgens has referred to thermal problems in the Polytechnic buildings. There is no mechanical ventilation and the original rooms suffered from summer overheating. Removal of internal walls has given natural cross ventilation which helps in the summer, but aggravates winter conditions. The heating system needs re-balancing for it gives excessive temperatures in winter sunshine. Allied with the increased ventilation it results in low internal relative humidity in winter. Values of 25% rh occur. With nylon carpet this causes unpleasant static discharge from fingers. No-one has complained of other discomfort because of low humidity. Evidently, in the extreme climate of a burolandschaft jungle, man as a species can adapt better than the greater green speckled nylon carpet. Which prompts the question if by fitting a good quality haircord could expensive humidity control be avoided?

Two floors were adapted to open plan, a general office and a teaching area. Reverberation time averaged over seven octaves is 0.76 S for the office, and 0.71 s in the teaching room. The sound level averaged 51 dBA during the day in both rooms. The background noise rating was N45 in the teaching area and N50 in the office. By normal acoustical tests both rooms were thus similar. However, sound is attenuated with distance more in the office than in the teaching area (Fig.1). This was thought to be due to screens and furniture in the office, for the teaching room was relatively bare.

To test this, screens were replaced at 2 m intervals down the length of the teaching room, leaving a clear sight line to the noise source. The fall in sound level with distance was measured, first with a gap between the screens of 0.6 m, and secondly with a gap of 1.2 m (Fig.2). Sound attenuation is increased by the screens particularly with the smaller gap in the line of sight.

The open plan teaching area was designed for a flexible use of space, and for a high quality of staff accommodation. Screens are placed to make booth areas large enough for teaching groups, giving both visual and aural privacy, and preventing distraction of students' attention. It is important for members of a group to hear each other speaking clearly. On the other hand, good attenuation between booths is needed. The noise source was surrounded by screens, and sound levels were measured at various distances. In a second test, both the noise source and the measurement point were surrounded by screens (Fig.3). The lower curve could be used to ascertain the spacing of classes by trading distance for sound insulation. If this is done it leads to a distance of 23 m between classes, which is a hopelessly uneconomical use of space. The establishment of fresh criteria is needed, for

example by observing class spacing in practice. To date an overall spacing of 5.8 m^2 per person has been observed, with a local concentration of 1.4 m^2 per person. An overall spacing of 4.2 m^2 per person has been aimed at.

The original screens were 1.4 m high with a gap at the bottom, and covered in furnishing fabric. With the gap closed an improved attenuation of sound was obtained. Some screens 1.7 m high with no gap at the bottom, and surfaced with hardboard were placed round the noise source. Fig.4 shows that they increase attenuation. Further tests were taken with screens surrounding both the noise source and a measurement point 11 m from the source. The attenuation in the various octave bands caused by both types of screen was measured (Fig. 5). The 1.7 m screens give increased sound attenuation in the main speech frequencies. Slightly increased attenuation is obtained by scattering odd screens between the two booths.

The hard faced 1.7 m screens have a further advantage (Fig.6). The sound pressure level within the noise source booth is higher than with the absorbent 1.4 m screens because of sound reflections. This is of advantage because it gives better aural conditions within a booth.

Conclusions

(1) In an open plan room with absorbent ceiling and floor, and walls far enough away to give little reflected sound, enhanced attenuation is obtained with randomly located screens, furniture etc. even with a clear sight line between source and listening position.
(2) In an open plan teaching situation, hard faced screens with no gap at the bottom, and about 1.7 m high, surrounding the various teaching areas, with randomly spaced intermediate screens, have given best conditions.
(3) With these conditions an overall spacing of 4.2 m^2 per person should be attainable, with a local spacing of 1.4 m^2 per person in the screened teaching areas.
(4) In teaching, there are some noisy activities which cannot be accommodated in an open plan area. They should be identified and isolated in separate rooms.

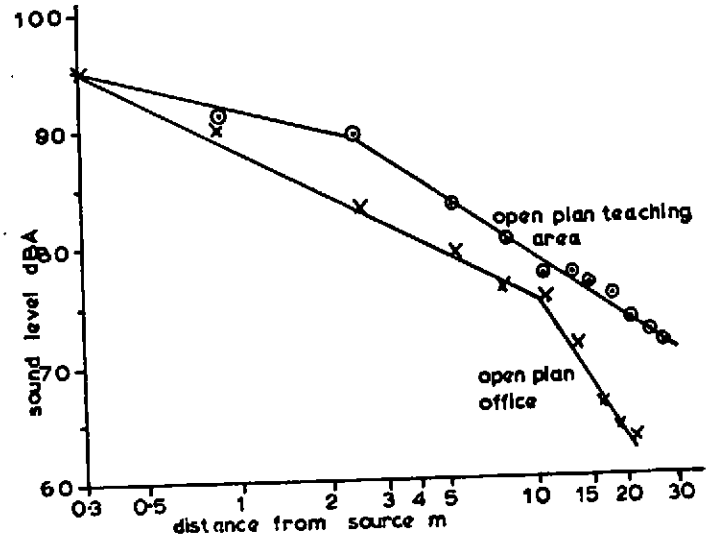

Fig. 6 Attenuation of sound with distance.

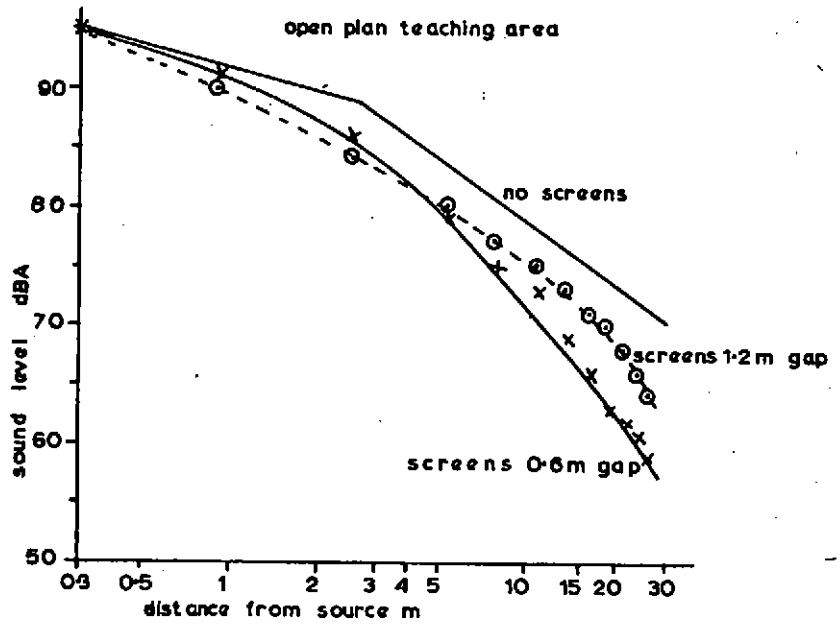

Fig. 2. Effect of Screens on sound attenuation

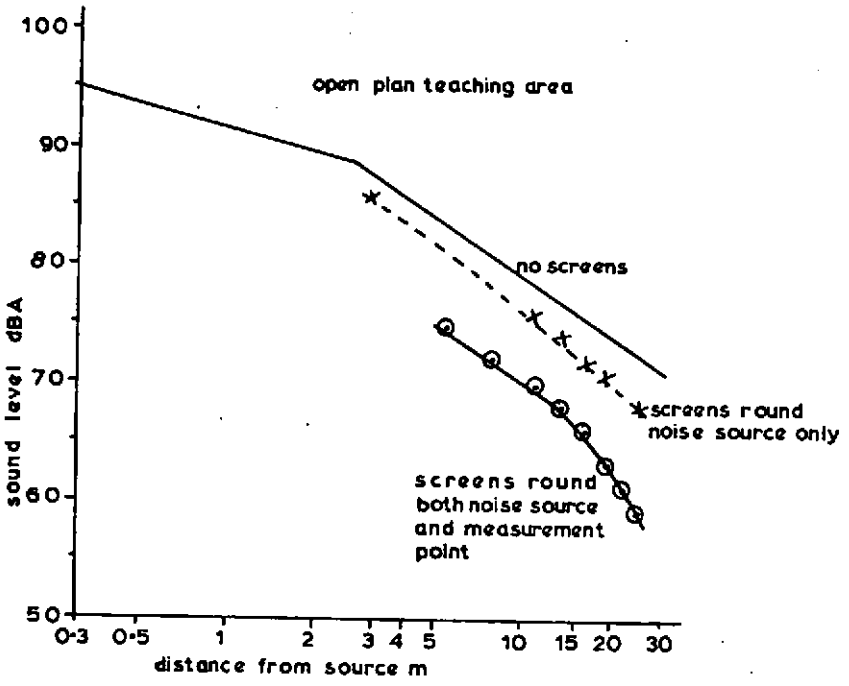

Fig. 3 Effect of screened areas

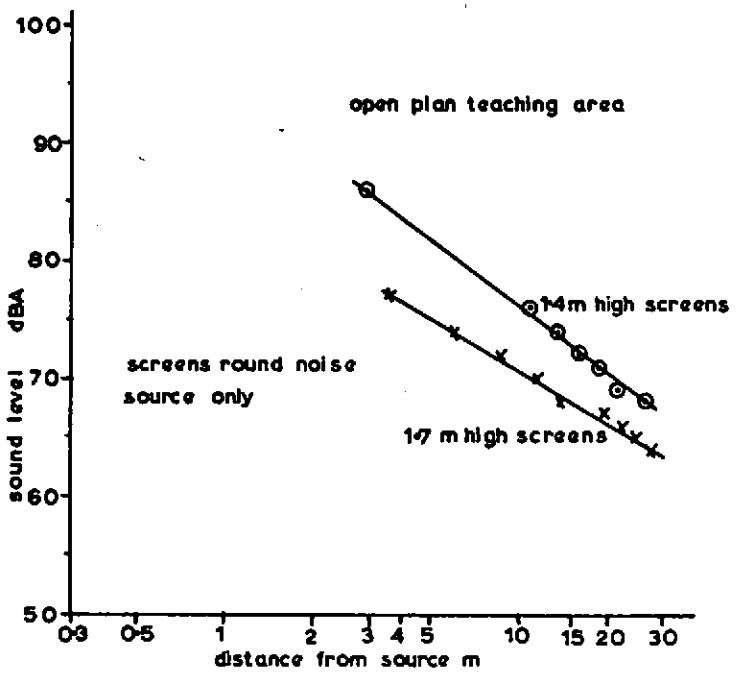

Fig. 4 Effect of taller screens

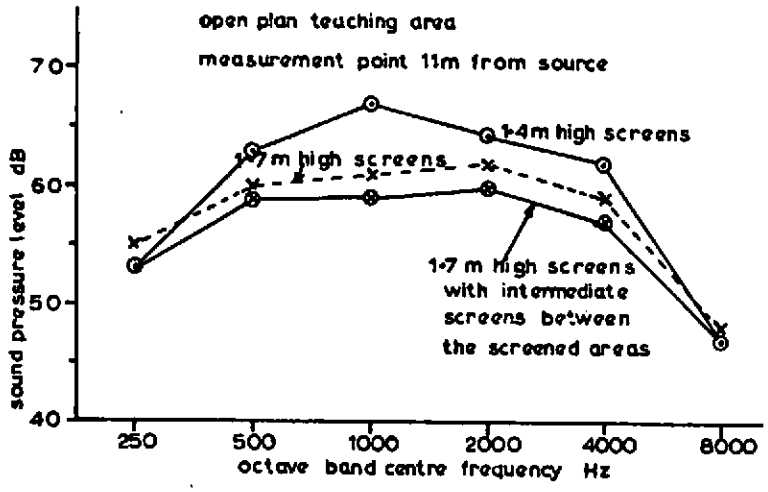

Fig. 5 Attenuation in the octave bands with different screens

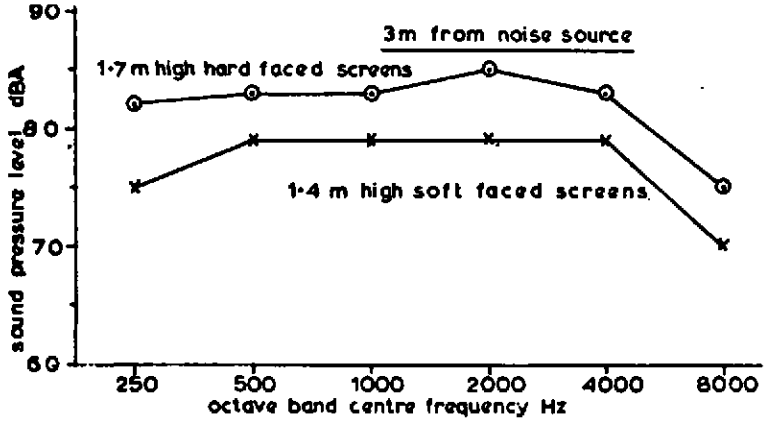

Fig. 6 Sound pressure levels inside hard faced screened booths