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# THE DESIGN OF CEILINGS IN BUROLANDSCHAFT OFFICES.

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The design of a ceiling in spaces of normal plan dimensions and ceiling heights is not usually so important a design problem as that of the walls, windows or floor. The human eye tends to scan the visual field on a horizontal plane some 1.65 m above floor level and the tendency is to observe the vertical surfaces of the enclosure and the floor, rather than to notice the ceiling. Although most ceilings contain, or have attached to them, light fittings, only a minority include air handling devices. In addition the range of design possibilities and the materials that can be used within normal cost limits are relatively limited. The flat smooth plaster finish is the cheapest and the use of ceiling tiles or timber boarding is limited to those spaces that require some acoustic absorbent.

In reality most ceilings can be said to happen, rather than to be positively designed to be either a major factor in the visual scene or to provide a positive environmental function. A choice is made of the flat ceiling material, a uniform pattern of light fittings is incorporated and maybe another pattern of air diffusers, extract louvres, fire detectors or sprinkler heads, all features which tend to complicate the ceiling appearance, but which can be organised to produce a geometrically acceptable uniform pattern.

This normal situation has to be compared with the design problems associated with the Burolandschaft situation. In a Burolandschaft space the actual properties of the enclosure are very different from normal rooms. Due to the large plan area and the obscuring of the floor by the screens, furniture and other fittings, the ceiling becomes the major factor in the visual scene. The vertical surfaces, by comparison, become a minor visual factor for the majority of the occupants of the space. Due to the long distance view available, the ceiling is visible to all at normal viewing angles.

While in the traditional architectural design process the proportions of the enclosure, that is the width to length to height, would be related, so that the larger the plan area the greater would be the height, in the Burolandschaft situation this is not economically possible; therefore a visually acceptable space has to be achieved which has a large plan area, but a normal economic ceiling height. This presents a unique problem. It must be realised that the ceiling of any space reflects the plan in an unobstructed way, so that the actual plan proportions can only be assessed by observing the ceiling dimensions. One visual factor in Burolandschaft ceiling design is therefore to attempt to design the ceiling so that the large plan area is not accentuated but apparently diminished.

A second visual factor is that, due to the large area of ceiling surface, it is seen at a much lower angle of view than normal, so that the angle of incidence to the surface becomes very small. In this situation the microtexture of the ceiling surface becomes an important factor. Ceiling finishes which appear matt at normal ceiling viewing angles can appear to be semi-gloss or even glossy when observed at longer viewing distances. For example, metal perforated ceiling tiles, which appear to be matt when viewed at angles of $30^{\circ}$ can appear glossy at angles of $10^{\circ}$. This can produce unsatisfactory visual situations, as they can reflect the movement of people in other parts of the office, which would otherwise remain unseen, and cause distraction due to peripheral vision effects. While all light neutral ceiling finishes tend to appear coloured, due to the reflection of light off the horizontal surfaces within the interior, a ceiling finish that appears glossy at low angles of viewing tends to be strongly coloured due to its surfaces acting as a mirror to the external colour outside the building being reflected through the glazing. In some situations where the Burolandschaft office is surrounded by grass and has a high proportion of glazing in the walls, the ceiling will always appear to be a strong green colour, regardless of its actual colour.

These visual problems would suggest that there would be advantages if the ceiling of a Burolandschaft office was not flat. If therefore it is to be three dimensional, what form should it take? The opposite of flat is an egg crate louvre ceiling, in which no horizontal surfaces are visible. In this situation, however, the scale of the pattern becomes important. From a proportional aspect the louvre pattern should be large, as the larger the pattern, the smaller will the plan area be assessed. This, however, presents cost problems in relation to the generation of excessive surface areas of materials, as well as the increase in the actual depth of ceiling void necessary to cut off the view of the horizontal plane above, which would indicate the actual height of the space. One possible solution to this problem is the use of the 'Vee' form ceiling section, which avoids the development of a horizontal plane and, depending on the area of the space, can be designed to provide a visual cut off to the peak of the Vee at normal viewing angles. The Vee form has the advantage that it still retains the space between the V to carry the building services without any increase in actual floor to floor height.

In the design of a flat ceiling the overall floor to structural soffit height is determined not only by the floor to ceiling height, but also by the height of the ceiling void required to incorporate building services, particularly ductwork. Often this ceiling space contains additional height, due to the fact that the space for services must allow for any obstructions caused by downstand beams. With the design of a Vee form ceiling it is possible to avoid this situation, as the plan of the ceiling can be integrated with the structure, so that, while visually the ceiling appears to be higher, it still retains its ability to accommodate the services required.

The next major factor is the design of the ceiling in relation to the system of artificial illumination.

In so large a ceiling area a considerable number of light sources have to be incorporated. In the flat ceiling these fittings tend to produce a strong geometric pattern. With high levels of artificial lighting of 750 lux and above, it has been common practice to use recessed fittings with translucent diffusers. No recessed fitting installation can illuminate the ceiling directly, but only by reflection from the horizontal surfaces below, the colour of which also determines its colour appearance. The ceiling therefore has always a considerably lower brightness than the surface of the diffusers, so accentuating the light fitting pattern and in some examples this becomes the centre of attention in the visual field. Attempts have been made to overcome this problem by the use of surface mounted fittings which also directly illuminate the ceiling itself. Often, however, the plastic diffusers create bright edges to the fittings which in themselves also become the centre of attention. In addition, the lighting of a ceiling by a surface mounted fitting, due to the low angle of incidence, reveals all the three dimensional defects in the flat ceiling. One method of reducing the visual impact of the light fitting pattern is to use fittings with low brightness louvres. Such fittings can, if carefully chosen, have a surface brightness similar to that of the ceiling itself, so considerably reducing the visual impact of the fitting pattern, but at a very high capital cost, due not only to the increased number of fittings required, but also to the high cost per fitting.

The function of a light fitting is not only to control the distribution of the light output of the source, but also to avoid glare due to the high brightness of the source itself. It is suggested that if the three dimensional ceiling is carefully designed it can take on the function of the light fitting to control the distribution of the light output and screen the light source. In this case the light fitting itself can be a basic type such as a batten fitting, which can considerably reduce the capital cost of the lighting installation and the cost saved used to produce the three dimensional ceiling which obviously generates a greater surface area than its flat equivalent. The three dimensional ceiling can therefore function also as the light fitting.

The second function of the ceiling is to incorporate the input and extract system for the air conditioning plant. One of the most important factors in the design of an air conditioning system for a large open space is to achieve a satisfactory pattern of air movement and distribution. This is determined to the maximum extent by the design and location of the air inlets. With a flat ceiling air inlets can be located where required, but in practice the grid pattern of their location has to mesh with the grid pattern of the light fittings if the visual appearance of the ceiling is to be acceptable, or else air handling fittings can be used. However, it is unusual if the location of light fittings is also satisfactory in relation to the air distribution pattern. This is also the case in the three dimensional ceiling, where it is essential that in the development of the ceiling form the air conditioning engineer is consulted concerning the type of air diffusers to be used and their spacing or location required for air movement purposes. In the three dimensional ceiling it is usually possible to incorporate the air inlets at the base of the V section, with the supply ducts within the V and to extract the air alongside the light units located in the top of the V section.

The third function of the ceiling in a Burolandschaft office is that of acoustic control. Observations made in a number of such offices suggest that the main acoustic defect is that of an excess of acoustic absorbent. In normal sized rooms or offices the maximum area which can provide acoustic absorbent is the floor and ceiling, while the walls and windows tend to act as acoustic reflectors. In the Burolandschaft office, however, the floor and ceiling area together constitute a much larger proportion of the enclosure, and with the addition of sound absorbent screens, tend to increase the acoustic absorbency to a level not far removed from an anechoic chamber. In this situation the background noise level becomes unacceptably low and acoustic privacy is lost.

With a three dimensional ceiling generating a greater surface area this problem can be accentuated if the whole of the ceiling is constructed of a highly absorbent surface. It is suggested, however, that as there are no horizontal surfaces present it may be possible to utilise relatively poor acoustic absorbent materials due to the fact that the Vee form will produce a situation where all sound reaching the ceiling will have to be reflected twice before being reflected back to the speaker. A full size experiment is to be undertaken to determine if in fact hard surfaces can be used for a Vee form ceiling. The advantage would be that the background noise level could be higher due to the reduction in the area of sound absorbent and so achieve a more acceptable level of acoustic privacy.

To date there are only a few examples of three dimensional ceilings in Burolandschaft offices. Some of these have been of high capital cost because all of their environmental functions have not been incorporated in their design. It is suggested that if a multi-disciplinary design team is employed on the ceiling design a three dimensional ceiling could be designed, such that its overall cost would be no more than a flat ceiling with a similar environmental performance, but with considerable visual advantages.