events in a multi-purpose hall, the change of exhibitions in a museum or even the way a standard office space can be transformed into a conference room.

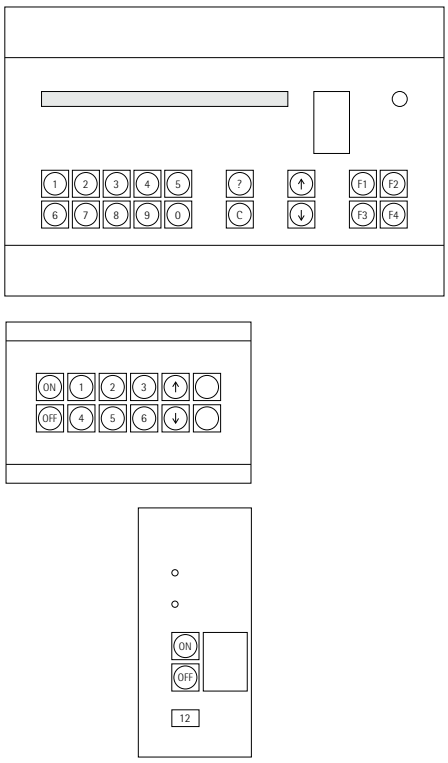
To meet such changing requirements a lighting installation has to be able to be dimmed and switched in a variety of ways to create different light scenes. The prerequisite is that luminaires or groups of luminaires can be switched separately and their brightness controlled, so that the illuminance level and lighting quality in specific areas of the space can be adjusted to particular situations. The result is an optimum pattern of switched luminaires and brightness levels, a light scene that complies with the use of the room or creates specific ambient conditions. If large numbers of luminaires are to be controlled accurately, it is a good idea to store the light scenes electronically so that any scene may be called up as required.

The main task of a lighting control system is to store a series of light scenes – each comprising the switching and dimming status required for the various circuits – and to call them up when required. Using a programmed lighting control system it is, however, possible to create more complex processes than a simple change of scenes. A change of scene can be programmed to be effected instantaneously or in the form of a seamless transition, for example. It is also possible to raise or lower the overall brightness level of a light scene without re-programming.

The transition from one scene to another can be effected manually using a preset panel. It is also possible to have a change of scenes controlled automatically. In this case the lighting control is usually dependent on the amount of daylight available or what day of the week it is and what time of day/night.

Due to the miniaturisation of electronic components lighting control systems are so compact that some of them can be installed in existing distribution boxes or fuse boxes, although large-scale systems will require their own cabinet. Lighting control systems consist of a central control unit for digital storage and control, a series of load modules (dimmers or relays), which are each allocated to a circuit, and one or more preset panels. Depending on the application, other modules for time or daylight-related control and for the lighting control in a number of different spaces are required. Via special switching arrangements or by incorporating lighting control systems into building management programmes lighting control systems can also control and supervise other technical equipment besides the lighting (e.g. sun-blinds or projection screens).

Example of a pre-programmable lighting control system: preset panel (centre) for 6 scenes with On/Off switches for controlling the brightness of the overall installation. Central control unit with LCD display (above). Circuit module (below) with programmed address and On/Off switches for testing purposes.



2.4.7.1 Lighting control systems for theatrical effects

Unlike stage lighting whose task it is to create illusions, architectural lighting concentrates on human visual requirements and on defining our real surroundings. In spite of this basic difference some stage lighting methods have been adopted in the field of architectural lighting. Lighting concepts that comprise theatrical effects are becoming increasingly popular. These include stark contrasts between light and dark, the application of coloured light – using spotlights and colour filters, contour lighting using coloured neon tubes – and gobo projections.

Besides creating specific effects on stage it is the way that stage lighting changes that plays a decisive role; a change of scenes in this case no longer serves as a method for adjusting to existing requirements, but becomes a design element in its own right. Changes in the lighting are not merely related to switching groups of lights on and off and changing the level of brightness; they also include distribution characteristics, beam direction and colour.

Stage lighting control systems therefore have to meet considerably more stringent requirements than conventional lighting control systems. With the increasing trend to apply theatrical lighting effects in architectural spaces architectural lighting designers now require lighting control systems that are not only able to switch and dim fixtures, but are also able to change their position, colour and distribution characteristics.

Light Qualities and features

Up to now visual perception and the production or generation of light have been treated as two separate topics. We will now consider the area where light and perception meet – and describe the qualities and features of light. The intention is to show how specific qualities of light create different perceptual conditions and thereby influence and control human perception. Illuminance plays as great a part as light distribution, beam direction, the colour quality of a lighting installation or glare limitation.

A comprehensive set of regulations exist for workplaces which define the optimum lighting conditions for specific visual tasks to ensure that visual tasks can be performed correctly and without causing fatigue. The standards only relate to establishing good working practice regarding working conditions. Broader concepts are required to take into consideration the architectural and psychological requirements of the visual environment.

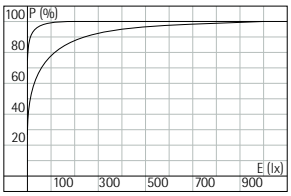
2.5.1 Quantity of light

The basis for any lighting installation is the quantity of light available for a specific visual task in a given situation. Every-one knows that light is a prerequisite for visual perception. Up to around a hundred years ago we were dependent on the amount of light available through constantly changing daylight conditions or weak artificial light sources, such as candles or oil lamps. Only with the development of gas light and electric light did it become possible to produce sufficient amounts of light and thus to actively control lighting conditions.

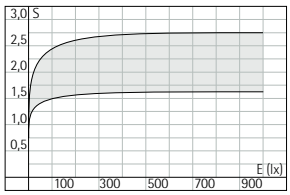
There then followed the evaluation of the amount of light that was appropriate in each situation, establishing the upper and lower illuminance and luminance limits in specific situations. Much investigation went into lighting conditions in the working environment to establish illuminance levels for optimum visual performance. By visual performance we mean the ability to perceive and identify objects or details, i.e. visual tasks with given contrast between the object viewed and the surrounding area.

Visual performance generally improves when the illuminance level is increased. This effect improves more slowly from 1000 lux upwards, however, and decreases rapidly at extremely high illuminance levels due to glare effects.

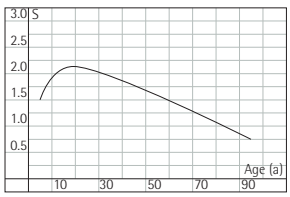
In the case of simple visual tasks adequate visual performance can be attained at low illuminance levels, whereas complex visual tasks require high illuminance levels. 20 lux is the threshold value at which a person's facial features can be recognised. At least 200 lux is required for continuous work, whereas complicated



Influence of illuminance E on the relative visual performance P for simple (upper curve) and complicated visual tasks (lower curve).



Influence of illuminance E on the visual acuity S of normal-sighted observers.



Visual acuity S in relation to age (average values).