Lighting the Office Workplace and Corridor

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This article builds on a recently completed pilot study of daylighting potentials in eight office wokplaces that include desktop computer (VDU) screens in Stockholm. The intention was to identify potentials for improving lighting of VDU tasks while reducing electric lighting and cooling loads. The focus concerned wintertime conditions when daylight is most critical to occupant needs and yet most limited and difficult to control. The results suggested not only daylighting potentials within the office workplaces, but also in the common office corridor.

Introduction

Decisions concerning the control of artificial lighting in private office workplaces are typically made upon arrival and not adjusted or turned off until final departure. This is a conclusion from a study of daylighting potentials in private office workplaces that include desktop computer (VDU) tasks (Sweitzer, 1990). This finding suggests two possibilities in order to better exploit the use of daylight in office buildings.

The first, dimming of fluorescent lighting in office workplaces in response to available daylight, has been studied for a range of hot and cold climates, window-to-wall ratios, and glazing types (Johnson et al 1983; Selkowitz et al 1983; Sweitzer et al 1987). A second alternative includes daylighting of adjacent corridors as well and, integrated dimming of both corridor and office lighting in response to available daylight.

This second alternative has not been simulated or assessed in practice although currently available means to admit daylight into interior corridors (via light pipes, prismatic panels, and electrochromic glazings) have been explored (Sweitzer, 1991). In addition, there is an existing computer program that can be used to visualize the effects of and provide luminance information for these advanced technologies.

Concept

The approach to and departure from the office workplace is typically via an adjacent corridor. The distribution of luminances in the corridor therefore can affect visual adapation that may be critical to the switching of lighting in offices, especially upon initial arrival. If the luminances in the corridor and office are similar, little if any additional adaptation in the office should be required. If there are significant differences in the luminances, however, visual adaptation can require considerable time, depending upon whether the change is from lighter or from darker as well as upon the magnitude of the differences.

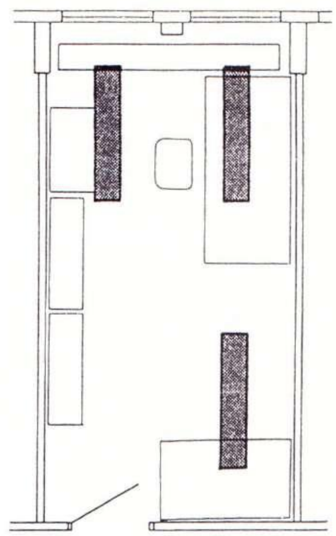
While adaptation when changing from dark to light luminances requires only a few seconds, adaptation to change from light to dark is a substantially slower process. This might well be the case, for example, upon initial (morning) arrival to private offices during winter periods. The most common response to this situation is to switch on at least room lighting, in part because the switch is usually located just inside the office door.

In response to these limitations, the following lighting control concept, that includes both automatic dimming and manually adjustable task lighting, is proposed:

* Provide sensor-controlled dimming of room lighting (in response to available daylight) in offices and corridors;
* Provide on/off switching of office room lighting at the conventional location, just inside the door;
* Provide manual on/off switching and adjustment of task lighting only at task position(s);
* Provide a motion or temperature sensor control to automatically turn off the task lighting when the occupant is absent;
* Provide for automatic balancing of (paper, for example) task and VDU screen luminances (Sweitzer, 1989) according to preset personal preferences or criteria in response to available daylight and room lighting.

The aim of these controls is to optimize the use of available daylight for offices and corridors while providing incentives for personally controlled office task lighting. The location of controls for task lighting is intended to allow time, however short, for adaptation to room conditions. Improved visual comfort for office occupants as well as lowered demand for electric lighting are the intended results.

Case Study



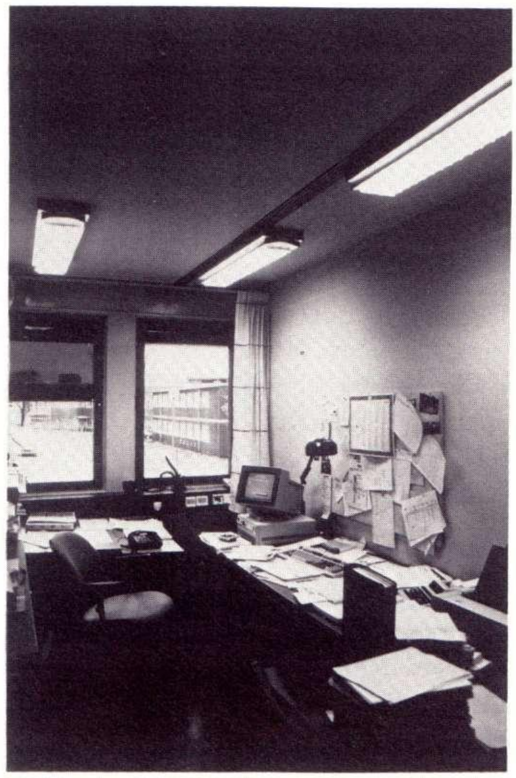


Figure 1. Representative office plan (not to scale)

Figure 2. Interior view of south-facing office

The referenced study of daylighting potentials in VDU office workplaces in Sweden included eight similarly-sized and -furnished private office workplaces (see Figures 1 and 2), all along a single double-loaded corridor in an early 60s office building.

The study in each office included observations, an interview with the occupant, a self-reporting questionnaire, luminance measurements, and photographs.

The observations focused on how each office occupant used their windows and electric lights throughout the (overcast winter) study day.

Each interview meanwhile included questions concerning occupant attitudes and the planning and control of – as well as ideas to improve – the physical conditions, especially lighting, in each workplace. The questionnaire was used to better define VDU use, visual comfort, and mood. Luminance measurements were made in the field of view of (VDU) operator positions as were photographs. Overall room photographs were also documented (figure 2).

The study concluded that office worker knowledge of lighting VDU tasks in the offices studied is neither being exploited to improve visual comfort nor to reduce electricity use. It further concluded that there are apparently satisfied users for a wide range of connected lighting power densities, ranging from 3.2 W/m^2 to 31.3 W/m^2 versus the installed range of 31.3 W/m^2 to 56.2 W/m^2. The second major finding was that no light switching was noted in any of the offices during the study day; that is, the electric lighting selected upon arrival was not altered.

Both of these findings suggest that dimming of electric room, and perhaps task lighting, could be used to save electricity without compromising visual comfort. In addition, given access to daylight, corridor lighting could also be dimmed, thereby limiting visual adaptation between the spaces and therefore, reducing demand for electric lighting upon initial arrival.

Visualization

How might this and other alternate lighting scenarios be assessed during the design stage? Specifically, how might the potential effects of adaptation on room lighting be visualized, by both designers and users? Could a tool that combines both visual qualities and luminance information be useful in estimating electricity use?

A computer tool that provides both visual images and luminance information, RADIANCE, now exisits. It is a ray tracing package that can take a scene description with a light source, including sky, building, rooms, and furniture and produce spectral radiance values which can be collected in a color image. As a lighting design tool, this represents a signifcant advance in the state of the art.

For the office and corridor case studied, these capabilities might be further extended. Realistic scenes might be rendered that account for different levels of visual adaptation. In this way, a luminance map of each workplace could be documented and updated as appropriate. Based on such maps, different lighting scenarios could be constructed and, according to specified lighting criteria, electricity savings estimated.

Summary

The integration of day- and electric lighting in a specific office and corridor adjacency has been explored. Sensor-controlled dimming of office (room) lighting in response to available daylight is proposed for both spaces. This would limit, presumably, the need for visual adaptation and, therefore, switching on of room lighting upon initial arrival. Control of task lighting is proposed at the task location only. It is hypothesized that this control concept can be used to further limit demand for electric lighting without compromising visual comfort, based on the findings of a previous study.

A design tool, RADIANCE, that provides visual images as well as numerical (luminance) quantities might be used to assess alternate lighting schemes, including those where temporal aspects such as visual adaptation might be critical. With this information, the lighting of office workplaces could be made more personal and energy efficient.

References

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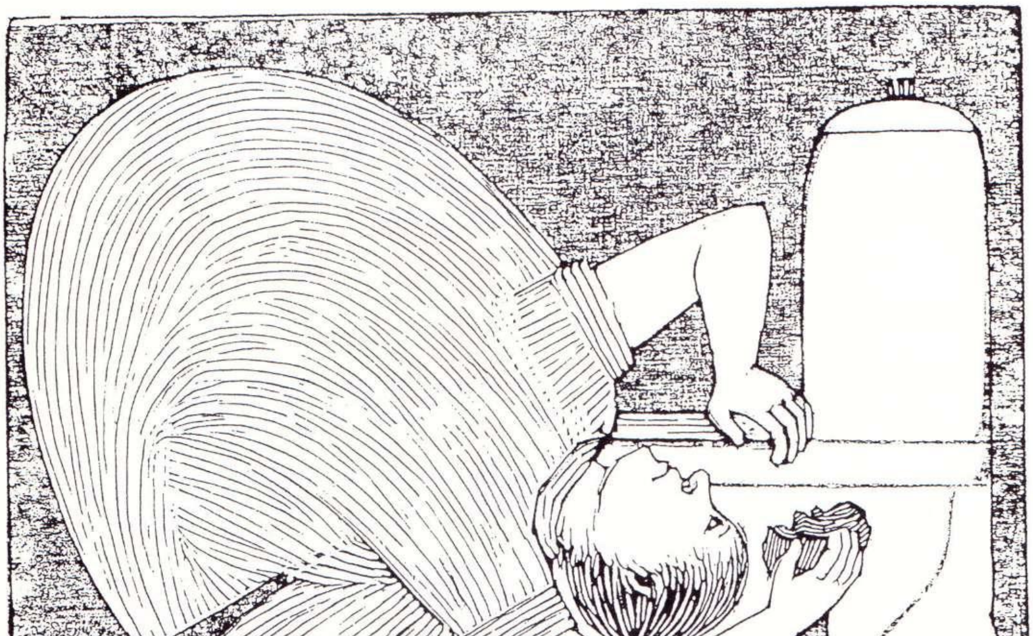

"Det omöjligas konst". Träsnitt av Ulla Wennberg.