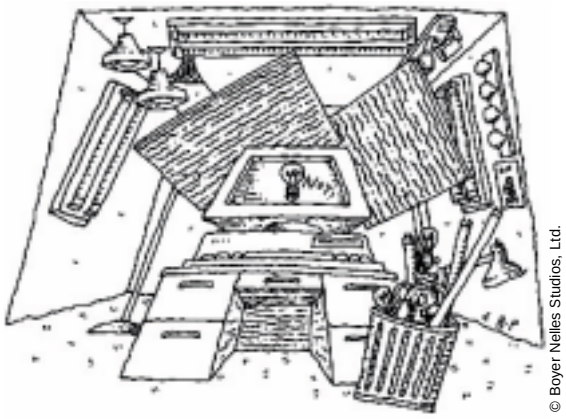
Lighting in the Workplace

New Priorities



People who work in offices receive most of the information they act on through their sense of sight. They read printed reports, handwritten memos, photocopied faxes. They analyze figures on a VDT monitor, type from reference documents, edit letters on a computer screen. They glance into the next office to determine if a colleague can be interrupted with a question, and scan the facial expressions and body language of the person across the conference table to assess the true meaning behind the words.

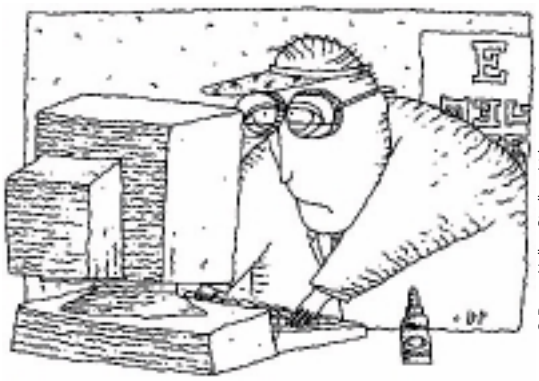
Over the course of the century, work has shifted from physical labor to tasks that place enormous demands on a person's visual systems. Over the course of the past two decades, new technologies, demographic trends, and ways of working have intensified and complicated those demands. Designing workplace lighting that meets the needs of people who work in offices today has become correspondingly urgent and complex.

Changing needs and priorities

Computers

The prevalence of computers has changed lighting design objectives more than any other factor. In the early '70s, the computer terminal-to-staff ratio in the United States was 1:30; in 1990, it was 1:5, and still going up.[1] Their presence in the office has forever banished the "brighter is better" school of lighting design. Because VDTs are self-luminous, they require little or no lighting themselves; adjacent tasks, however, must be lighted.[2] Since a VDT screen differs dramatically from paper—a screen is vertical rather than horizontal and glossy as well as luminous[3]—it requires a completely different type of lighting. Reflected glare on the screen, or different levels of illumination that cause the VDT user's eyes to continually adjust between the different brightness levels of screen and background, can result in eyestrain.[4]

Architectural lighting consultant Mitchell Kohn says that the difficulties of lighting a computerized workplace have brought lighting problems out into the open. In the past, "lighting frequently did not accommodate basic visibility needs, even for paper tasks. Today, with the introduction of the VDT into the office, bad lighting becomes even more intolerable; and even good lighting for a paper-based office can result in eyestrain and fatigue in a facility now incorporating VDT tasks."[5]



Worker health

According to a recent U.S. study, people are increasingly aware of the ill effects of bad lighting design in the workplace. Of the 1,008 employees surveyed, 47 percent felt that eyestrain was the most serious health hazard of the office environment, ranking it above poor air quality, VDT radiation, hazardous building materials, and cumulative trauma disorders as a concern. In the same study, 92 percent of the employees said they felt proper lighting was very important. [6]

A recent study of the influences of lighting on the health of office workers bears out their concern. Researchers found that the type of lighting used represented the dominant influence on health disturbances that included visual impairment, burning eyes, fatigue, and headaches. The type of equipment used on the job was another influencing factor; subjects working with machines—VDTs or typewriters, for example—were subject to more stress in all categories than people working in conventional desk-based jobs. Still, the type of lighting had a more significant effect on virtually every category of health complication studied.[7]

Aging work force

The aging of the baby-boom generation is another factor that directly affects office lighting concerns. According to the United States Bureau of Labor Statistics, the median age of the American work force will rise to 37.3 by 1995, from 34.8 in 1982.[8] The number of Americans age 65 or over is also increasing—from 12.2 percent of the population in 1987 to a projected 21.8 percent in 2030.[9] As the work force ages, lighting needs will change for this segment of employees.

As people's eyes age, the lenses grow larger and more rigid, requiring more effort of the eye muscles to focus at close range. As a result, people experience a decrease in light transmission and color identification and an increased intolerance to both direct and reflected glare.[10] As a general rule, older people require more illumination in order to perform tasks and have a harder time adjusting to varying light levels in the environment. The use of bifocals to correct for the change in near-point vision that occurs between age 45 and 55 complicates matters for people who work at computers; they experience more frequent health complications than people who wear other types of corrective lenses or none at all.[11]

All these vision changes—and their accompanying lighting needs—will be multiplied by the number of employees who will opt to work past the age of 65 as the pool of younger American workers dwindles.

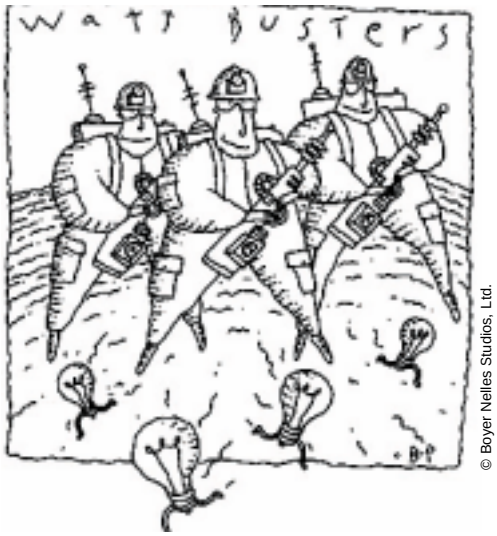
Legislative trends

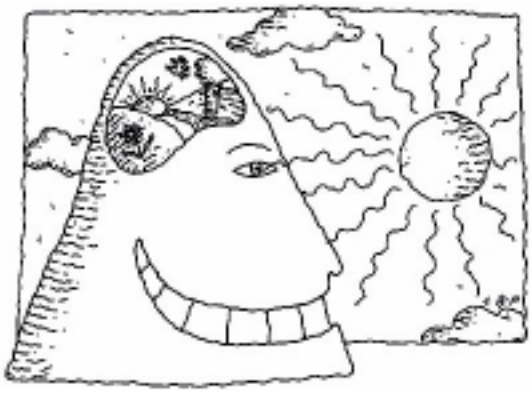
New laws to govern the application of VDTs and to alleviate a cluster of potential injuries that might result from work on keyboards and in front of screens are beginning to force lighting issues as well. The San Francisco VDT Worker Safety Ordinance attempted to "provide public- and private-sector employees who operate video display terminals within the City and County of San Francisco with a safe and healthy work environment" by setting standards for such ergonomic issues as work surface and seating adjustments, breaks from keying, and shields from radiation emissions.[12] The ordinance also set specific standards for office lighting, stating that light levels should fall within 200 to 500 lux; that task lighting must be made available on request; and that glare must be reduced through the use of window coverings, terminal positioning, anti-glare screens, and keyboard finishes that minimize light reflectance.[13]

Even though the ordinance did not stand as originally ruled (it now applies only to public-sector employees), it received attention from other city, county, and state bodies, and it has provided the momentum for a wave of similar legislation. In early 1992, proposals relating to VDT work environments and conditions were pending in states across the country, including California. There is a strong likelihood that in the near future workplace design will be not only influenced but also governed by laws like these, with lighting being one of the focal issues.

Energy costs and ecological concerns

A growing concern with the environmental impacts of energy consumption combined with the '90s trend toward downsizing and trimming operating expenditures has focused new attention on the financial and ecological costs of electrical usage. It's becoming apparent that habit and outmoded standards have led to waste. For example, many existing commercial buildings have lighting loads of two to five watts per square foot, when most new building codes indicate a maximum of two watts per square foot. (Lighting technologies currently exist that can provide effective lighting with





less than one watt per square foot.[14]) Once in place, lights are left "idling"—drawing electricity when the building is unoccupied or in areas where daylight is sufficient—accounting for 40 to 80 percent of all commercial lighting costs.[15]

Coupled with budget concerns are the ecological considerations of energy depletion. The Green Lights Program, founded by the Environmental Protection Agency (EPA), reports that lighting consumes 25 percent of the country's electricity. Simply by employing efficient lighting and avoiding idling, a 10 percent reduction could be achieved, reducing emissions of carbon dioxide, sulfur dioxide, and nitrogen oxides in energy production by four to seven percent and saving corporations approximately $16 billion in operating expenses.[16]

Productivity

Lighting can enhance or deter every task accomplished in the office. Investments in effective lighting can improve productivity by helping people work safely and comfortably, reducing errors and absenteeism that may result from visual strain or fatigue. Glare on a computer screen may cause a misreading that will certainly lead to lost time, and possibly to lost business. Improved lighting helps minimize errors and enhance quality control; even a small investment in better lighting can save hundreds of thousands of dollars a year.[17]

Factors in office lighting

There is a complex mix of elements to balance in designing lighting for the office workplace. First consider the four different types of lighting used to illuminate the office environment today:

- **Daylight,** which is brought into the building by windows, skylights, and glass doors.
- **General lighting systems,** which offer ambient light by either direct (ceiling-mounted) or indirect (ceiling- or furniture-mounted) methods.
- **Task lighting,** which lights a smaller area within a work space.
- **Accent and display lighting,** used to add visual interest, brighten dark areas, and define space.

Daylight

Daylight is highly variable, its angle and brightness changing with the position of the sun over the course of the day and the year and with fluctuations in the weather. Natural light, because it is horizontal as well as vertical, helps define the contours and textures of surfaces. Some lighting experts argue that these qualities are essential to a sense of well-being and that lack of variation in lighting results in sensory deprivation, leading to "boredom, fatigue, lack of concentration, and even a reduction of intellectual capacity."[18]

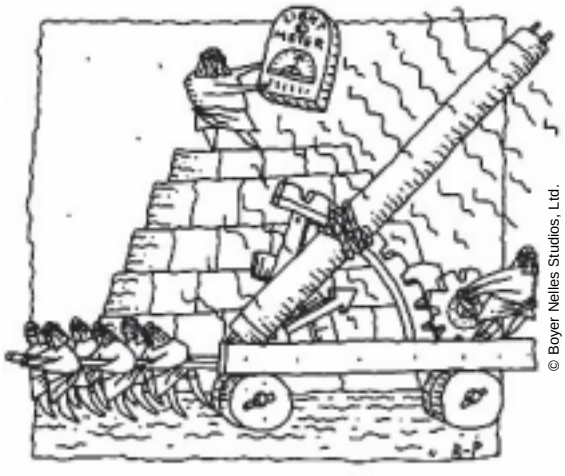
In addition to the stimulating effects of varying the visual environment, the changing quality of daylight has proven effects on human performance, triggering and reinforcing the body's natural biological rhythms. Recent research indicates that daylight entering through the eye controls or affects many of the complex endocrine processes that take place in the human body.[19]

Natural light can quickly become too much of a good thing, however, with brightness levels that far exceed current recommendations—particularly for VDT environments.

General or ambient lighting

Lighting in the office has for many years meant uniform lighting for all areas, which generally meant direct overhead lighting designed to illuminate the desktop. While this worked fairly well when office people were primarily focused on paper-based tasks and energy was cheap, light from overhead fixtures tends to be reflected off the computer screen into a modern-day office worker's eyes.

General lighting today is designed to overcome screen reflection with various louvers on luminaires that shield workers from direct down-lighting.[20] Another solution, indirect ambient lighting that bounces light from the ceiling back down to the work areas below, reduces the amount of energy needed to create the perception of a brightly lit office. While indirect lighting can reduce "image glare" from VDT screens, it can create "uniform glare" if the light is at too high a luminance level and "area glare," which reduces task contrast and makes eyestrain more likely.[21] Indirect ambient lighting also washes out the overall look of an office by taking away all contrasts and shadows; this can be discomfiting, however, because people depend on a certain amount of contrast for visual clarity and stimulation.



Task lighting

This has become increasingly important as a way to separately illuminate non-computer tasks as general lighting levels are dimmed to reduce glare. Adjustable task lighting also gives the user some control over intensity and direction of light, with both practical and psychological benefits. A recent study found that the mere availability of a desk lamp of any quality was enough to create a more favorable impression of the work environment's artificial lighting.[22]

Accent and display lighting

These two types of lighting are used to mark out territories, draw attention to particular areas, set moods in meetings and presentations, and focus attention on others or oneself.[23] Lighting has the power to influence feelings of well-being, to provide visual cues—such as about whether a space is public or private—and to affect depth perception, visual clarity, and a person's general sense of orientation within an interior environment.

Developing the right mix of lighting types for a given office environment depends upon the type of work that is performed there, the interior layout, workstation configurations, window size and location, and computer screen characteristics.[24] There are no absolutes when it comes to lighting recommendations. But research does indicate some general directions to take into consideration when lighting comes under review.

Keep it low

General, overhead lighting cannot provide the major source of light for offices, especially now that computers are the focus of many people's jobs. General light needs to be lower than task light, and complementary to it. Twenty-five to fifty foot-candles, supplemented by task lighting of an additional 25 to 75 foot-candles, is now thought to be the extent to which direct or indirect general lighting should be used.[25] More is a waste of energy and, frequently, a drain on health and productivity.

Make it specific

Additional and appropriate lighting should accompany each individual task in a work area. Tasks need to be identified carefully and lighting chosen for each based on the task itself, its size, its importance, the duration of time it needs to be performed, its priority in relation to other tasks, general lighting in the area, and the physical condition, age, and expectations of the person performing the task.[26] Because these factors will vary dramatically from task to task and person to person, the task lighting solutions chosen should also be varied, specifically applied, and under user control.

Consider the special needs of VDT workers

The kind of task light typically used today is the linear fluorescent luminaire, mounted under panel-hung storage components or overhead storage units. Although this light can provide broad, even light, it is not a good choice for the lighting of tasks that are adjacent to computers. Depending on its location, the light can produce veiling reflections on computer screens or can overlight VDT backgrounds. An unshielded fluorescent strip is particularly inappropriate; diffusing materials may soften its light, but glare problems are not usually diminished.[27]

The best task light is one that gives the user control over position and intensity so that it can be located to minimize glare and altered to match the worker's changing needs over the course of the day.[28]

Accept no substitutes

One kind of light can't double for another. Daylight is important and should be part of a carefully planned lighting design, but it is too intense for many tasks, and especially for computer work. Task lights alone can't provide all the light for a facility, but general lighting is never appropriate for individual tasks. Accent lighting must not be confused with task lighting and needs to be used with extreme care in VDT work areas because it can interfere with the balance of light for the screen and tasks. Lighting for psychological impact alone can undermine the specific work done in people's offices.

Inappropriate lighting can have a negative effect on more than just people's vision: If people try to change their posture to avoid glare on a VDT screen, for example, they may be setting themselves up for repetitive-strain injuries. Dealing with lighting challenges can circumvent such problems. Let the individual control it whenever possible. The simple act of turning on a light at the beginning of a

workday and turning it off at the end is a gesture that carries a symbolic importance. It also underscores the fact that lighting carries with it a whole galaxy of meanings beyond function. Because good lighting is important to people, they want to participate in its control. When individuals are in charge of lighting, for example, they can close shades when daylight obscures their VDT screens. They can turn up lamps if they need more light to read by. They can turn off their lights when they leave for meetings, saving both energy and money. Involving people in the lighting design process is important because only they know how to evaluate what good light means to them. Allowing them a measure of control once the lighting is in place can have positive returns in morale and productivity.

Glossary

Foot-candle A basic measure used to indicate level of illumination.

Illumination The measure of light falling on a surface. The unit of measure is the lux or foot-candle.

Lens A glass or plastic shield that covers the bottom of a luminaire to control the direction and brightness of the light it emits.

Louver A series of baffles arranged in a geometric pattern to shield a light source from view at certain angles.

Luminaire A lighting fixture, or housing, with a lamp.

Luminance The measure of brightness of a surface, a function of the light that is reflected or emitted from the surfaces of walls, furniture, and other objects.

Lux A basic measure used to indicate level of illumination.

Veiling reflection A reflection of a light source that obscures task details by reducing the contrast between them and their background. Also known as reflected glare.

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28 Sundstrom, pp. 104–105.