



AN ERGONOMIC PRIMER ON OFFICE LIGHTING

Light is something we generally take for granted. For most of us, the majority of our waking hours are during the day and daylight has a significant effect on how we see. Daylight also has a large impact on how much and what type of supplementary lighting we need.

A little more than a century ago, we were an agrarian society. The majority of us worked outdoors in the daytime, so lighting wasn't a problem. At night, those who couldn't afford artificial lighting, (at one time even candles were expensive), probably just went to bed. With the industrial revolution came a mass exodus to the apparent comfort and security of the city and the promise of easy money in its factories. But with this rose a new concern: the need for adequate illumination in the form of artificial lighting. The invention of the fluorescent light was still decades away, and gas lamps and even incandescent lights were both inefficient and expensive. Lighting's connection with safety was most likely critical at this stage, as quite often lives depended on it. As time went on, and with the advent of fluorescent lighting and in particular its high efficiency and economy, conditions in factories and other industrial settings improved a great deal.

In the last couple of decades society again appears to have shifted occupational direction slightly. This time, away from factory/manufacturing jobs and into office and service industry positions. One other critical factor has been added – the widespread, almost requisite use of computers or visual display terminals (VDTs). This has changed the work surface in an office from a horizontal one to that of both a horizontal and vertical one. New lighting factors have come into play for the first time: VDT glare, veiling reflections, and cut-off angles from overhead lights. As we are all aware, the commonplace usage of computers has brought with it a host of new problems; things like *carpal tunnel syndrome*, neck strain, back strain, headaches, eye fatigue and lost productivity. Office ergonomics is now one of the hottest topics in the field of Safety and Health. And lighting is considered by many ergonomists to be one of the top three office ergonomics concerns.

Lighting and Ergonomics

One of the basic problems we, as safety professionals, see in an office environment is that employees tend to accept what they are given. Their workstation may be initially set up by a systems person who knows relatively little about ergonomics. The new employee sits down at their workstation, often not really understanding why the equipment is arranged and adjusted the way it is, but taking for granted that it's that way for a reason nonetheless. This often results in the new employee immediately forming some bad habits – in an effort to see around the glare on their screen, they may crane their neck or contort their body into various awkward postures. Down the road, such habits can lead to potential work-related musculoskeletal disorders (WMSDs). Of course, pro-active employers offer ergonomic training for VDT users and perhaps a cursory ergonomic assessment, but few of these really take note of the lighting conditions this new employee is being forced to adapt to.

The setup and design of an office's lighting system has a direct bearing on the ergonomic design of that office. Some typical symptoms, directly attributable to poor lighting:

- Headaches, indigestion, nausea, blurred or double vision, flickering sensations, itching and burning eyes, tension, and vision fatigue.

Most office lighting problems are due to one or more of the following:

- Flicker and hum of old electro-magnetic ballasts

- Glare on **VDT** monitor screen
- Generally overlit office
- Excessive background light (*luminance ratio*)
- General fatigue from staring at the monitor screen

Each of these potential problems has specific solutions, some of them quite simple and economical.

Ballast Flicker and Hum

Ballasts are an essential component of any fluorescent lighting system, providing a controlled current to the fluorescent tubes. However, about 25% of the population is sensitive to ballast flicker and hum and actually can become physically ill from too much exposure to it. An easy solution is to upgrade ballasts. In recent years, a new solid-state electronic ballast has become available to the American market. This ballast is lightweight, generates very little heat, and operates at about 25,000Hz (cycles per second), rather than the standard 60Hz used by the old systems. This last detail, high frequency operation, effectively eliminates all flicker and hum. When switching to these ballasts, it is also necessary to change to T-8 fluorescent tubes, which are available in a full-spectrum type – providing excellent, daylight-like color rendering. It is also wise in an office setting to install ballasts which are dimmable. This provides the user some additional control in adjusting the amount of light needed. The real beauty of these electronic ballasts is their long life and energy savings – they provide a 30% reduction in energy consumption. This, coupled with rebate programs being offered by most utilities, makes upgrading all ballasts a very logical move.

A final couple of points about the old electro-magnetic ballasts:

- During the final 30% of their lifespan they consume the same amount of energy, while producing far lower light levels - not an efficient use of power.
- Any ballast manufactured prior to 1978 contains *PCB's* – a hazardous material, known to leak out of older units.

Glare on Monitor Screens

Glare on the VDT screen can cause many of the symptoms noted earlier. Perhaps worse than this, however, since people typically try to adapt themselves to a bad lighting situation rather than look for solutions, are the awkward body positions that often ensue, sometimes resulting in the development of work-related musculoskeletal disorders (WMSDs)

Glare is caused by the following:

- Reflections caused by window light
- Reflected light from a glossy wall surface
- Poorly located task light
- Reflected light from a standard *downlighting system*

Solutions to these problems are not complex, but can potentially be expensive:

- Window light can easily be controlled with blinds and other window coverings. VDT screens should always be located at right angles to the window.
- The problem of glossy wall surfaces can be frequently eliminated by painting walls and ceilings with a flat paint, producing a matte finish.
- Various task lights can be added for non-computer tasks but it is important to arrange these lights so that they produce no glare on the VDT screen, or are left off when using the computer. Naturally, a lighting engineer should be consulted regarding any systems modifications.
- For today's modern office, the ideal solution to problems caused by outdated downlighting systems is a complete conversion to an *indirect or uplighting system*. This type of system directs all light to the ceiling, whose light-colored, matte-finished surface is then evenly washed in light. The resulting reflection – known as the *cloudy day effect* – is both shadowless and glare-free, providing the ideal environment for the VDT user. These systems also provide energy savings

over the older type, offering a payback to any investment. A major study conducted by Alan Hedge, PhD of Cornell University which concluded in 1991, revealed a far greater level of visual fatigue and other negative symptoms for computer workers using a standard downlighting system, while another group in the study given a lensed indirect lighting system had far less complaints. Additionally, a large percentage of the downlighting group appeared to lose fifteen minutes or more of productivity each day. The end result was that workers using the older downlighting-style systems were more likely to develop an injury or illness over time and lose significant productivity each day, while workers using an indirect-style system would be more productive and would suffer less negative health effects. This study is considered the most definitive examination of the effects of office lighting on computer users to date.

Glare Guards

The ever-popular glare guards for VDT screens should be looked on in the same way we view the use of back belts to prevent back injuries. These devices are merely a band-aid fix, which in turn is probably masking a larger problem. Glare guards, while effective in reducing or even eliminating the glare on VDT screens, also reduce the intensity of light being emitted from the screen as well as distort the character images being viewed. Both of these latter factors can contribute to vision fatigue.

Overlit Office

Most offices are garishly overlit for computer work. In general, this can result in glare on the VDT screen as well as potential symptoms similar to those mentioned earlier as being caused by older style ballasts. For computer use, only about 30-50 foot-candles of light is needed, whereas most modern offices typically use 100 or more foot-candles. This also wastes quite a significant amount of electricity. Here are a few simple recommendations to help improve conditions in an overlit office:

- Turn off some of the overhead lights
- Put all overhead lights on dimmer switches, controllable by individual users, which will also result in decreased energy consumption.
- Convert to an *indirect lighting system*

Excessive Background Light

Especially when using VDT monitors, an important factor to consider is the *luminance ratio* of potential background light. The VDT screen is itself a light source, emitting a given number of foot-candles of light – usually less than 10 fc. It is important that the background surrounding the screen not exceed a ratio of 10 to 1 with the screen. What happens when you place the VDT monitor near a bright background source, such as an uncovered window, is this: your eyes, though focused on the screen, continually try to readjust to the different light levels emitted by the screen and the brighter (or darker) background source. This causes visual and sometimes general fatigue in the user.

Fatigue From Staring at the Screen

Visual fatigue from staring has less to do with office lighting and is more an outcome of poor work habits. VDT users should be aware that they don't blink nearly as often when watching TV or looking at a VDT screen – in fact people have a tendency to stare in these situations. A couple of simple tips can help to counteract this tendency:

- When using a computer, consciously blink more often. This helps to lubricate the eyes.
- Every fifteen minutes, pause to look out a window at a pleasant landscape, or across the office at a picture on the wall. This need not occupy you for more than a few seconds. The point is to change your focus of vision from the fixed distance of your monitor and source document. The eyes need the stimulation of change of focus to stay refreshed and fight fatigue.

Hot Tip

For an inexpensive, quick fix in an office with lighting problems – consider purchasing a couple of torchiere floor lamps and a task light. This works primarily in an enclosed or small office. Torchiere lamps provide uplighting, and are now available in a compact fluorescent-style lamp, dimmable from the equivalent of 0-300 watts – actual energy consumption being a maximum of 55 watts. The task light will ensure that there is plenty of light for source documents. This setup is not exactly state of the art, but can be done quite inexpensively while providing good VDT lighting and a friendlier, comfortable atmosphere.

Conclusion

With the growing number of office ergonomic-related injuries these days, it would pay to put some attention into lighting considerations, both as possible causal factors and as an examination of what is appropriate for each individual space. Nearly as important, should be the concern of lost productivity and down-time, due to the effects of glare and other poor lighting issues. Lastly, in this era of rising energy costs coupled with uncertain supply, businesses should be examining every angle toward cutting their consumption of electricity – especially when there is an added benefit of reducing worker fatigue and other symptoms, and improving their overall productivity. In taking a good look around your workplace, you might be surprised by what you see.

To access additional sources of information on lighting, or to refer to an appropriate expert, check the yellow pages of your local phone book under *Lighting Consultants*. A national organization called the *Illuminating Engineering Society* is the ultimate authority on lighting issues and standards.

Copyright © 2000-2010 State Compensation Insurance Fund