

LIGHTING AND HUMAN PERFORMANCE: A SUMMARY REPORT

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INTRODUCTION

Personnel responsible for the acquisition of commercial, industrial, and institutional lighting systems may be making some seriously erroneous decisions, according to a new study just published by the National Electrical Manufacturers Association (NEMA) and the Lighting Research Institute (LRI).

Researched and written by some of the world's leading independent lighting authorities, the study comprises the most comprehensive critical analysis of the relationship between lighting and human performance ever compiled. Titled *Lighting and Human Performance: A Review*, the study provides dramatic scientific evidence of lighting's ability to affect how people work, how it can influence attention spans and mental fatigue, and how it can have profound physiological and psychological impacts. According to Frederick E. Nicholson, a NEMA spokesman, "This compilation of research -- authenticated case studies and thoroughly documented laboratory experiments -- brings into sharp focus how much we actually have learned over the years. It also points out how much further we have to go, to gather more data so we can somehow quantify these effects, to enhance our design capabilities."

Although more research is being called for, that which already exists -- and which is covered in the new study -- points out that lighting's ability to influence on-the-job performance is a major determinant of the cost of getting things done. As Nicholson commented, "Untold amounts of money are lost because people do not have the proper lighting for their work. Any number of tasks are taking longer than they should, and wholly avoidable errors are being made. When lighting is selected because of its price or because of its impact on energy consumption, important human factors can be ignored. In fact, high-quality lighting that can elevate human productivity while minimizing energy consumption has been available for many years. The premium that may have to be paid for this type of quality can in some cases be paid back in a matter of weeks." Nicholson calculated that the total cost of operating and maintaining the lighting needed by a group of 100 clerical workers would probably amount to some \$5,000 per year or less. If the productivity of the same people could be elevated by just one percent, the value of the productivity improvement would be close to \$30,000.

HIGHLIGHTS FROM THE REVIEW

The following are selected case studies that demonstrate the relationship between lighting and human performance.

CASE STUDIES AND LABORATORY EXPERIMENTS SHOW LIGHTING'S EFFECT ON PRODUCTIVITY

Several case studies reported in the review lend support to the idea that changing the lighting in a workplace can have a significant impact on employee productivity. A four-year study of workers who stamped out leather shapes for handbags showed that increasing illuminance from 32 footcandles (32 fc) to 93 fc resulted in an average performance improvement of 7.6 percent (Stenzel 1962b). In another study, workers who checked original copy against a computer printout showed a dramatic 30 percent reduction in work output when illuminance was reduced from 93 fc to 46 fc (*Electrical World* 1975).

Further evidence that lighting affects performance was obtained through a number of strictly controlled laboratory studies. Research by Bennett *et al.* (1977) showed the effect of illuminance on output for a number of practical tasks such as probing needles, map reading, micrometer reading, measuring the diameter of bolts with calipers, and thread counting. All of the results showed that, as illuminance was increased, less time was needed to carry out each task. Smith and Rea (1978, 1979, and 1987) conducted a series of simulated task studies involving proofreading, number comparison, and check verification using a performance measure involving both speed and accuracy. Their results also showed that performance improved significantly with increasing illuminance.

DISEASED MEAT PASSES INSPECTION UNDER IMPROPER LIGHTING

The study describes an experiment by Collins and Worthey (1985) in which 18 poultry and 16 meat inspectors observed five different poultry and meat tissue samples under each of five different light sources. The researchers found that inspectors passed a greater number of unacceptable meat samples and rejected more acceptable samples under lighting with poorer color-rendering properties. This and similar studies relating to color vision show that the type of lighting used can have a significant impact on the performance of jobs which require accurate color discrimination.

BETTER LIGHTING HELPS COMPENSATE FOR AGING EYES

Several studies designed to examine the relationship between lighting, age, and performance point to the conclusion that older people benefit more from higher illuminances than younger people. As people age, their pupils become smaller and their lenses scatter more light, making it more difficult to perform visual tasks. In experiments by Muck and Bodmann (1961) and Smith and Rea (1978, 1979) involving visual search and proofreading, older subjects performed far worse than younger subjects at low illuminances. As illuminance was increased, both groups' performance improved, but the performance of the older subjects gradually approached that of the younger subjects. In view of the U.S. population's aging trend, this evidence would

suggest that arbitrary reductions in lighting levels can have a seriously detrimental impact on performance.

STUDIES SHOW THAT LIGHTING CAN ATTRACT AND DIRECT

Display lighting has long been used in retail settings to draw attention to certain items. Now research evidence supports the idea that lighting can influence behavior by directing people along a certain path or attracting them to an object. Research by Taylor and Sucov (1974) explored the effect of lighting on people's choice of passageway at an exhibition. They found that more people chose the lighter passageway. In a different experiment, Flynn *et al.* (1973) recorded how customers selected their seating at a coffee bar. When one half of the coffee bar was lit by wall washing, people chose to sit in the darker part of the room, facing the lit walls. When the location of the wall lighting was changed, customers still sat in the darker part (although it was in a different place) and looked toward the lit wall. Research remains to be done which can suggest how lighting should be used to direct people to be more productive.

LOW LIGHTING LEVELS CAN CAUSE DEPRESSION

The amount of light entering the eye has been proven to influence food and water consumption, body temperature, ovulation, and hormone secretion (Hollwich 1979). Hormonal changes due to lighting are thought to influence the occurrence of seasonally affective disorder (SAD), a form of depression experienced mostly by people who live in areas where the day/night cycle varies significantly from summer to winter. During winter, these people become lethargic and easily fatigued, they sleep excessively and they overeat. These symptoms disappear in the summer when the days are longer. Some researchers suspect that SAD may be experienced by everyone to a greater or lesser degree. Research by Rosenthal *et al.* (1984) showed that SAD sufferers responded favorably to treatment with electric light at an illuminance of 232 fc. If lighting affects a person's hormone balance, it almost surely also affects his or her performance.

FOR ASSISTANCE

Research evidence is accumulating to support what many companies have discovered through experience: Lighting affects human performance. For many years, the National Lighting Bureau has been collecting case histories of lighting installations which have resulted in increased worker performance, fewer errors, and other profit-increasing benefits. The Bureau has also published numerous guides for those who own, use, or otherwise rely on lighting to help them maximize productivity and minimize costs. All Bureau publications are written in nontechnical terms and are fully illustrated. They are also low in cost. Request a free, illustrated catalog of NLB publications by writing directly to the Bureau. *Lighting and Human Performance: A Review* may also be ordered through the Bureau at a cost of \$75 per copy.



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