

Quality Lighting Means Quality Work

Focusing on energy consumption can have unintended consequences

by John P. Bachner

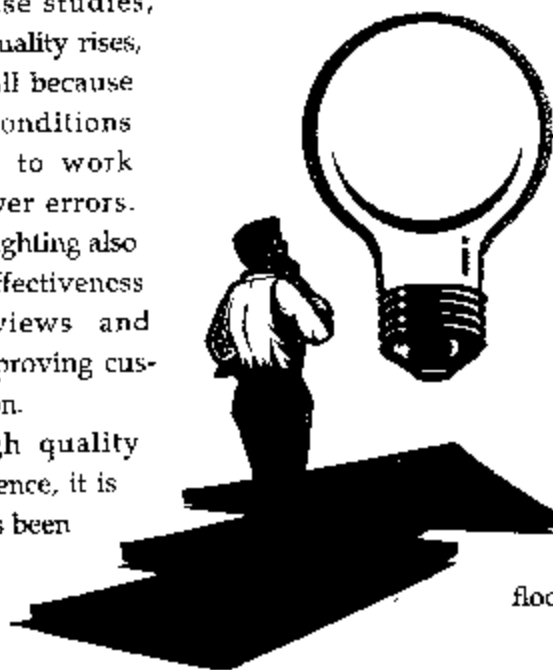
ALTHOUGH COUNTLESS THOUSANDS spend countless millions of hours attempting to improve the bottom line by improving quality, many, if not most, fail to consider lighting—an element of task performance whose optimization is essential to process quality improvement.

In fact, as demonstrated by a variety of case studies, when lighting quality rises, process costs fall because better seeing conditions enable people to work faster with fewer errors. Higher quality lighting also enhances the effectiveness of visual reviews and inspections, improving customer satisfaction.

What is high quality lighting? In essence, it is lighting that has been successfully designed for

the specific spaces, tasks and workers involved. Two factories producing identical widgets may need radically different lighting to support optimum productivity, if only because production areas are shaped differently, or workers in one plant are, on average, older than those in the other.

Of course, even if the two facilities are identical in all respects, unique lighting systems in each can both work well, given that the variety of equipment now available offers designers any number of ways to skin the same proverbial cat. In almost every case, however, flexibility is a hallmark of high quality design because it permits lighting system owners, users and managers to adjust the system when change is warranted, such as when tasks performed in the space are changed, when the work floor layout is altered and so on.



Although thousands of lighting systems are improved each year, most modifications are initiated principally to reduce lighting energy consumption and thus enhance the quality of building performance. Focusing exclusively or even principally on the energy efficiency of lighting can have costly, counterproductive results, however. It is akin to modifying an Indianapolis racing car to make it more fuel efficient. While fuel efficiency is a good thing, what about the car's acceleration, top speed and handling? After all, the purpose of a race car is to win races. If improvements are to be genuine, they must better enable the system to achieve its purpose.

Purpose of lighting

What's the purpose of lighting? That depends on where it is installed. In offices, for example, lighting is there to help people perform their visual tasks. When lighting quality is optimized, people have ideal or near ideal seeing conditions, and the lighting therefore provides maximum support for performance of visual tasks.

Substantial performance improvement is not required to attain substantial benefits, a particularly important point to recognize. Generally speaking, the cost of the energy consumed by one office worker's lighting tends to average about \$50 a year or less. If we assume that worker costs the employer \$25,000 a year (salary, Social Security, benefits), just a 1% productivity improvement has a value 10 times greater than a 50% lighting energy conservation savings.

In cases where the existing lighting is particularly inappropriate, improvements can have even more profound impacts, including faster task performance, fewer errors, less absenteeism (because workers experience fewer lighting induced problems, such as eye fatigue, headaches and neckaches), fewer accidents, less paperwork, lower insurance rates and higher staff morale, among others.

Consider the case of Pennsylvania Power & Light's N3 drafting room in Allentown, PA, where the productivity of the drafters was monitored closely. The new lighting system installed by the utility was considered carefully, principally to provide optimized seeing conditions for drafters.

About 20% of the 12,775 square foot space was reilluminated on a trial basis, and the results were extraordinary. In particular, productivity rose more than 13%, from 0.144 drawings per hour to 0.163. In fact, the productivity jump was so pronounced that the utility decided to use 7.5% as the expected productivi-

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ty increase to keep its projection conservative.

The utility also decided to disregard the value of better lighting's impact on error reduction because it is virtually impossible to predict the cost of any given error and thus the amount to be saved by preventing it. Nonetheless, management felt confident that error reduction would be another benefit to be derived from the lighting system modification.

A spokesperson for the utility was emphatic in pointing out that had the utility's interest been energy conservation alone, the lighting quality probably would not have been such an important issue. Energy conservation was hardly ignored, however. It was considered along with other factors.

As it so happens, the utility was able to slash its overall lighting operation and maintenance (O&M) costs by a substantial 73%, a reduction projected to save \$6,194 per year. Based on those O&M savings alone, the investment in new lighting would have achieved simple payback in just under eight years. By contrast, the 7.5 % productivity boost was projected to have a value of \$235,290 per year, thus shortening simple payback to 73 days. These results instantly explain why organizations should consider quality—making the light right for the space, workers, and tasks involved—in addition to energy conservation and why lighting should never be evaluated in terms of energy consumption alone.

Other case studies

The Pennsylvania Power & Light case is one of many identified and documented by the National Lighting Bureau (NLB). The NLB (see sidebar, "The National Lighting Bureau") developed and trademarked the phrase "High-Benefit Lighting" several years ago to connote lighting designed first and foremost to optimize people's performance of the tasks lighting was installed to support.

Other NLB cases are equally instructive. At Control Data's Sunnyvale, CA, facility, for example, new lighting paid for itself in just 23 days. There, lighting O&M costs were cut 60%, saving the company \$7,290 a year to achieve a simple payback in just over two years considering O&M reductions only.

Because Control Data relied on High-Benefit Lighting, however, it was able to reduce input errors and thus achieve downtime savings worth \$200,000 a year. It also improved productivity for an additional annual savings of \$28,000 a year. As a consequence of the latter two benefits, actual payback was achieved in less than a month.

Similar results were reported at the San Diego Federal Building and Courthouse, where new lighting

The National Lighting Bureau

A not-for-profit lighting information source established in 1976, the National Lighting Bureau is sponsored by professional societies, trade associations, credentialing organizations, manufacturers, utilities and agencies of the federal government. Its mission is to help private, public and institutional sector managers make informed decisions about lighting.

The bureau's philosophy is that while lighting energy efficiency is absolutely essential, the purpose of lighting is not to consume as little energy as possible, but rather to provide optimal seeing conditions for the people who perform the tasks for which lighting is needed.

Several years ago the bureau developed and trademarked the term High-Benefit Lighting to con-

note lighting systems that are designed to optimize task performance while consuming the least amount of energy practically possible.

More specific information is available at the bureau's Web site (www.nlb.org), which includes a variety of site and function specific guidance, case histories and articles. The Web site also provides a directory of NLB publications, including the third edition of its lighting management primer, *Getting the Most for Your Lighting Dollar*.

The bureau is not alone in its efforts to provide more lighting education and, for that reason, its site also comprises hot links to a variety of other information sources. These include, among others, its sponsors, many of

which can provide literature and references regarding organizations and individuals who offer system evaluation and design assistance, some for no charge, some for a fee. (Free assistance is commonly provided by manufacturers, contractors and others as part of an overall service or sale.)

The bureau cautions, however, that the stakes involved are many times more than the cost of energy, making thoughtful consultant selection essential.

To contact NLB staff directly or obtain a hard copy of its publications directory or High-Benefit Lighting brochure, contact National Lighting Bureau Communications Office, 8811 Colesville Road, Suite G106, Silver Spring, MD 20910; 301-587-9572, (fax) 301-589-2017 or info@nlb.org.

reduced the annual cost of electricity for lighting by \$229,020. Because the reduction in power use decreased the building's cooling load, air-conditioning costs also fell, saving an additional \$50,625 a year.

While such savings are impressive, achieving them was only one of several objectives set by the General Services Administration (GSA), which manages the San Diego facility and is a sponsor of NLB. GSA understands High-Benefit Lighting and, in this case, achieved it to a significant degree. Thanks to better lighting in various spaces, workers were able to improve their productivity from 3 to 15%, saving \$1.3 million annually.

In addition, parking lot accidents were cut by 50%, and security violations were reduced by 20%. The latter two reductions also saved money because they resulted in less time being spent on cleanup, investigations and paperwork, and less money being spent on repairs and replacements. Given the full range of benefits, the \$1.04 million that the GSA invested in high quality, High-Benefit Lighting paid for itself in less than eight months.

High-Benefit Lighting in industrial situations has

achieved similar results. In the case of Metal Industries of Elizabethville, PA, new lighting in the company's 100,000 square foot plant resulted in a 5% productivity boost and 25% reject rate reduction, as well as in 15% fewer accidents, less absenteeism (due principally to fewer accidents) and lower insurance costs.

The value of the benefits amounted to \$1,931,000 a year, a particularly large amount, because the previous lighting was so inadequate, not providing enough light in many areas. While the new lighting was far more efficient than the system it replaced, it consumed more energy in aggregate, thus reducing the overall annual benefit to a net \$1,911,140. Still, Metal Industries recovered its initial investment of \$8,050 in 1.5 days, recording a simple return on investment of 23,741% a year.

Six-step process

Other cases show similar results in improved outdoor safety and security, athletic performance, retail sales, multifamily housing rental attraction and retention, and so on. But questions remain. How can a manager become part of the NLB case history database? How does he or she achieve such significant benefits?

The answers are surprisingly simple and form a six-step process:

1. Educate yourself about electric illumination.
2. Select a qualified consultant or advisor, whether paid or unpaid.
3. Work closely with the consultant or advisor you select to help ensure a clear, mutual understanding of what you want to achieve.
4. Review your consultant or advisor's findings.
5. Plan the modification.
6. Monitor developments.

Educate yourself about electric illumination. This step does not require a return to school for an electrical engineering degree. It does mean learning more about the potential benefits of lighting and ways to consider them with respect to a facility and its operations. It also means knowing about the basic components of lighting systems and some of the general options available. In essence, you need to know enough to be able to converse with whomever it is you rely on for assistance.

Select a qualified consultant or advisor. Do so with care. The individual or organization you rely on needs to be expert. While those who are less qualified will be able to identify certain lighting quality deficits in an existing installation, their capabilities will be limited by their lack of advanced knowledge and experience. Stated simply, they will only be able to spot the most obvious problems. Many problems are subtle, however, and will go undetected by the untrained eye.

Nor will asking workers to identify viewing problems yield optimum results, if only because the eye is such an amazing biological device. It can get used to a variety of problematic conditions and so cause them to go unnoticed, even though they dampen performance. In a number of NLB case histories, most workers recognized how inadequate their former lighting was only after they experienced a new, High-Benefit Lighting system.

Many of those who offer to evaluate existing lighting systems and design or specify upgrades are expert only when it comes to energy conservation. As previously discussed, saving energy should not be the only goal of a lighting system change.

Witness the case history of a federal facility manager who decided to cut lighting energy use in a Social Security Administration data processing office by 50% just by removing half the lighting. True, the manager achieved his energy reduction goal. Unfortunately, the seeing conditions that resulted caused employee productivity to plummet by 28%, wasting \$250 or more for every dollar saved.

Nor is it likely that this modification (which was quickly reversed) saved energy in the aggregate. When people have to work longer hours to achieve

the same result, a building's energy systems have to be used longer, private vehicles typically have to be substituted for scheduled public transportation or car pools, and so forth. Unquestionably, saving energy is important, but optimal seeing conditions should not be sacrificed to achieve this goal.

You should also recognize that much more than the value of prospective energy savings rests on the performance of your source of assistance. No matter who provides the assistance, be it free or a relatively high cost consultant, you need some reasonable assurance that others helped by the person have experienced the kind of results you hope for.

One indicator of quality is the recently developed LC (lighting certified) credential established by the National Council on Qualifications for the Lighting Professions (NCQLP). The organization was established by manufacturers, trade and professional organizations, and public agencies specifically because no other group provided a generally accepted credential attesting to an individual's knowledge of lighting systems.

The lack of an "LC" after a name should certainly not be taken to mean the person is not qualified, however. Nor should you consider the presence of an "LC" to guarantee the qualifications you need. Many sources of assistance are available; and the dollars associated with productivity, error and rejection rates, accidents and so on make it worthwhile to select carefully, even among those who have earned the LC designation. Again, knowledge of the results a consultant has achieved elsewhere can help you assess his or her potential usefulness to your organization.

Work closely with the consultant or advisor you select to help ensure a clear, mutual understanding of what you want to achieve. Assuming the consultant is experienced with facilities such as yours, this step should not take too long. Nonetheless, you want to ensure effective dialogue so neither side makes unfounded assumptions.

Review your consultant or advisor's findings. Findings should be based on an evaluation of the effectiveness and efficiency of the current lighting and of the impact to be derived from doing nothing, enhancing maintenance (one of the most important of all lighting considerations), modernizing some or all of the existing system, replacing some or all of what exists and so forth. The report of these findings should spell out options clearly, indicating the likely costs associated with each and the readily quantifiable benefits.

Note that the most important benefits of all—productivity improvements, safety enhancements and the like—will be difficult to quantify with a high degree of accuracy. For that reason, experienced facility or production personnel need to work with the lighting consultant to make intelligent approximations. To

some extent, you may have to persuade the purchasing or procurement department to accept these approximations because they are based on judgment, not hard data. Unfortunately, that's precisely why so many lighting modifications focus on energy without regard to other, more significant issues.

Installing 1,000 34-watt lamps in place of 1,000 40-watt lamps can result in a guaranteed savings of a certain amount, given annual hours of use and the average cost per watt hour. But what impact will better light have on 450 individuals performing a variety of tasks during a three-shift plant operation? Procurement personnel need to understand that while it is impossible to develop guaranteed projections in such cases, those making estimates are not speculating.

Typically, the cost of labor relates to the cost of lighting as a ratio of at least 250-to-1. For this reason, even a 1% productivity boost would justify doubling lighting expenses. In fact, however, with effective evaluation of High-Benefit Lighting options, productivity gains (among other benefits) of 2 or 3% or even more can be realized through modifications that can cut energy consumption by 50% or more.

Plan the modification. The need for flexibility is often achieved through controls that permit lighting

output to be adjusted to suit the preferences of the people doing the work. In some cases, individual workers can control their overhead lighting by using remote control devices. Flexibility can also be achieved by installing fixtures that can be moved easily to accommodate work area reconfiguration, task changes and so on.

Monitor developments. This step allows determination of the degree to which lighting really helps, not only in energy terms but also in terms of productivity, error reduction, safety, insurance, morale and so on. By monitoring and considering all the ripple effects that can be involved, you will be able to document the extent to which High-Benefit Lighting helps people improve performance of the tasks lighting is needed to support and the extent to which it contributes to the bottom line.

Remember: The purpose of a race car is to win races. It will be far more difficult to do that if the vehicle wastes energy, but it will be impossible to do that if the only thing considered is fuel.

JOHN P. BACHNER is communications director of the National Lighting Bureau in Silver Spring, MD. He holds a bachelor's degree in English from Harvard University.

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