

Lighting for the Workshop

Tips for figuring how many and what types of fluorescent lights you need to create a comfortable working environment

BY JACK L. LINDSEY

The owner of a small shop can seldom justify the services of a lighting design professional. So the task of lighting a shop is usually accomplished by putting up a few fixtures and, if that doesn't work, adding a few more. Sometimes this works, but learning some of the basics about lighting will produce better results faster and more economically in the long run. The most common mistakes are using the wrong type of lamp or fixture, installing too few fixtures and putting fixtures in the wrong locations.

The first step in lighting a shop is to de-



FIXTURES

Two basic types of fluorescent fixtures, called strips or industrials, are commonly used for shop lighting. Strip fixtures are simply metal channels fitted with lamp holders and ballasts. For really tight spaces, you can use a low-profile strip fixture with lamps mounted on the sides of the fixture instead of the bottom. Industrials are equipped with a white metal reflector mounted above the lamps.

Strips should be used when fixtures are mounted directly to a finished ceiling that has been painted flat white. Industrials work better when the ceiling is not flat, not painted white or when fixtures must be suspended below the ceiling.

Industrial fixtures are available in two types—apertured and nonapertured. Apertured fixtures have a series of holes in the reflector that allow air to pass through, which helps keep lamp and fixture surfaces clean. Also, air circulation cools the ballast, thus extending its working lifetime. A ballast in an apertured fixture can easily last twice as long as one in a nonapertured fixture.

cide what strategy to use: To light the whole shop in a reasonably uniform manner or to concentrate light at machines and work areas.

For small shops, I recommend uniform lighting because it allows you the freedom to change the location of machines and workstations within the shop. It also means you can install fluorescent fixtures in continuous rows. This reduces the cost of electrical wiring by allowing you to run wires through the fixtures instead of installing a separate feed to each fixture. If you take this approach, wires are run within 3 in. of



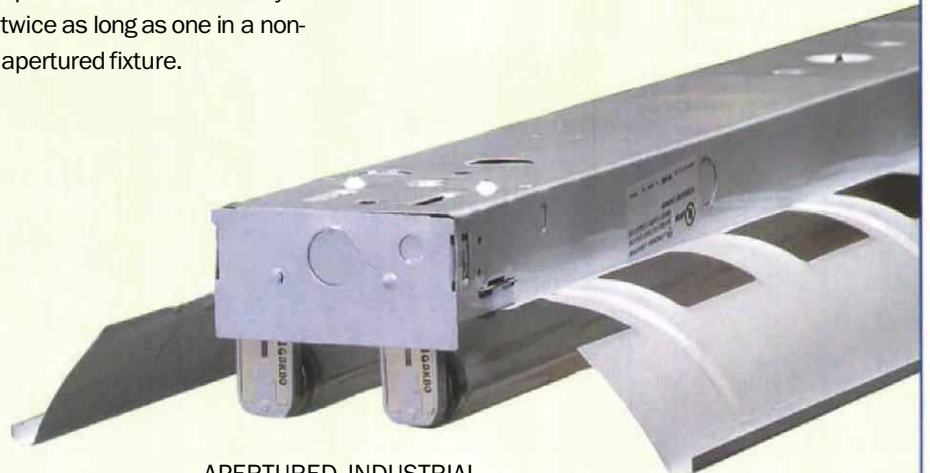
STANDARD STRIP



SIDE-MOUNT STRIP



NONAPERTURED INDUSTRIAL



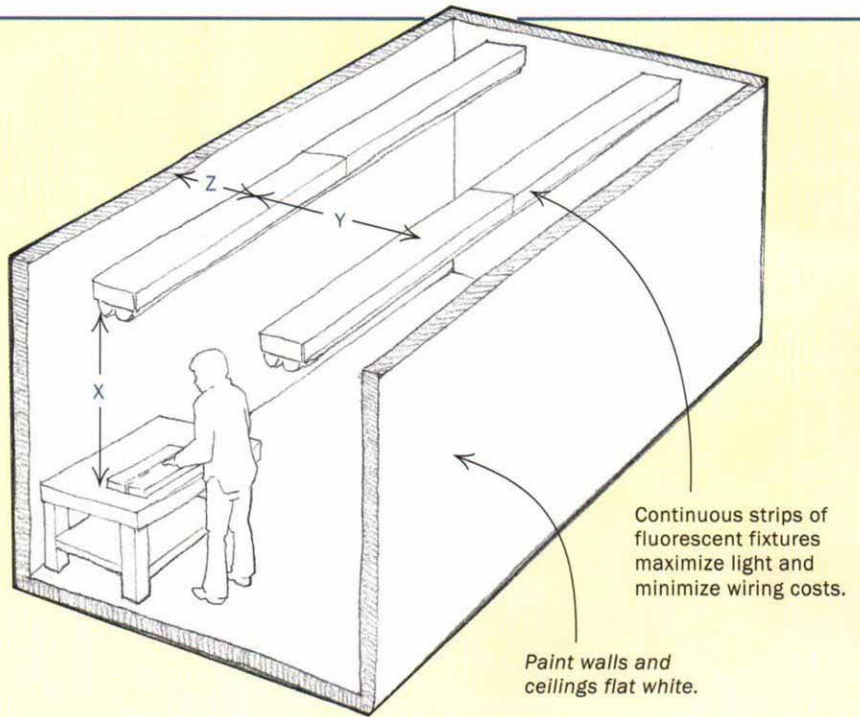
APERTURED INDUSTRIAL

PLACEMENT

The older you are and the more detailed the work you do, the more light you need. Concentrated spot or task lighting works, but a uniformly lit space, like the one shown at right, will allow you more flexibility and improve your working environment.

Here are the steps for determining the placement of light fixtures:

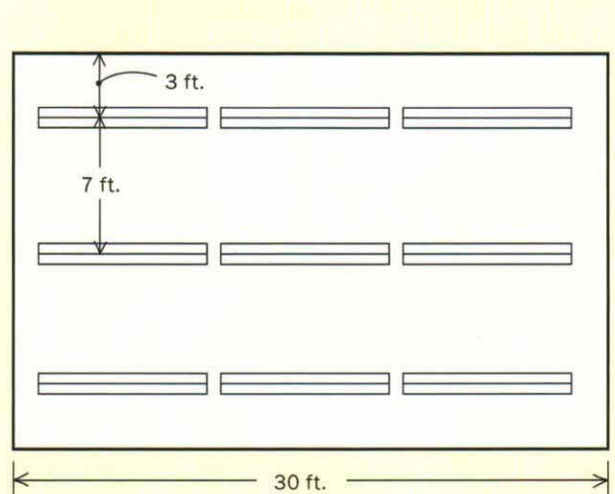
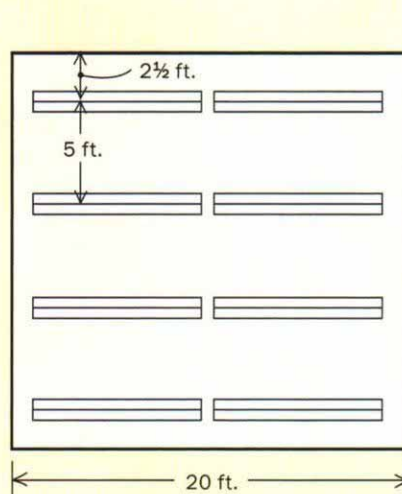
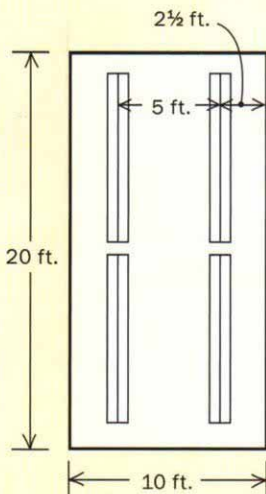
1. Measure the distance between the light source and the horizontal work surface (X).
2. The distance between rows of fixtures (Y) should be a maximum of $1\frac{1}{2}$ times the distance X.
3. The distance between a wall and a row of fixtures (Z) should be approximately a third to half the distance Y.



CALCULATING HOW MANY YOU NEED

Here is a breakdown of how many two-lamp, 8-ft. fluorescent fixtures you will need to light a workshop uniformly to 100 fc of light. For 4-ft. fixtures, just double the numbers in the chart. Consult a qualified electrician to determine the size and number of circuits required to power your lighting needs.

ROOM SIZE	ENERGY SAVING 60 WATT	FULL WATTAGE 75 WATT	HIGH OUTPUT 110 WATT
10 ft. by 20 ft.	5	4	3
20 ft. by 20 ft.	8	7	5
20 ft. by 30 ft.	12	9	8
30 ft. by 30 ft.	17	13	11
30 ft. by 50 ft.	29	23	19



the ballast, so you must use wire that is rated for 90°C.

How many fixtures do you need?

How much light you need depends on the visual difficulty of the work you do and how well your eyes function. Eyesight deteriorates with age, so we need more light as we grow older. Lighting levels are described by a unit of measure called the footcandle (fc). A woodshop should be lit uniformly to a level of 50 fc to 100 fc. You can provide higher levels, if needed, with a separate fixture. Plan for 50 fc if the average worker is less than 40 years of age and doesn't do much work that is difficult to see, such as small, intricate shapes or dark colors. For workers who are more than 40 years of age or who do work that is difficult to see, plan for 100 fc.

As light leaves a fixture and travels to your workbench, it spreads but. You get higher lighting levels near the fixture, with those levels dropping rapidly as the distance from the fixture increases. Because of the diminishing levels of light, you need to limit the maximum spacing between fixtures to avoid dark spots. To figure the maximum spacing between fixtures, you need to know the type of fixtures and the horizontal plane in which visual tasks are performed—for most shops that means the top of the workbench, which is 2½ ft. to 3 ft. off the floor. If fixtures are mounted 10 ft. above the floor and the workbench height is 3 ft., the distance between the fixtures and the workbench is 7 ft.

Typical strip fixtures should have a maximum spacing of 1.6 times that distance, or 11.2 ft. Industrial fixtures should not be spaced more than 1.5 times the distance, or 10.5 ft., for that workspace. Changing the fixture mounting height or the work-plane height will change the maximum spacing. Please note that this recommended spacing is not the optimum; it is the maximum. Closer spacing is usually required to achieve desired lighting levels. And remember, walls and ceilings should be painted with a flat white paint whenever possible to reflect light more uniformly around the shop.




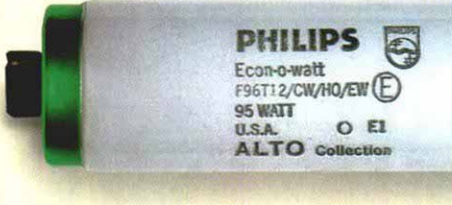

Another general rule will help to avoid dark shadows where you least want them: The distance from the wall to a row of fixtures should be one-third to one-half the distance between rows of fixtures, because we often locate equipment and work-



The variety of fluorescent lamps to choose from can make the uninitiated consumer dizzy. Full-wattage 8-ft. slimline lamps draw 75 watts, and the 4-ft. F40s consume 40 watts. Their energy-saving counterparts (labeled by manufacturers with such names as Watt-miser, Supersaver and Econ-o-watt) are rated at 60 watts and 34 watts, respectively. Full-wattage high-output 8-ft. lamps use 110 watts; the 4-ft. versions use 60 watts. To complicate matters more, T12 lamps come with three different styles of bases that must be fitted to matching fixtures.



Match the lamp base to the fixture. Fluorescent lamps in all sizes come with a variety of bases to choose from (clockwise from the top): bi-pin, single pin and recessed double contact.

4-FT. LAMPS	8-FT. LAMPS
	
FULL WATTAGE	
	
ENERGY SAVING	
	
HIGH OUTPUT	

benches along walls. See the drawings and the chart on the facing page for more on determining how many fixtures you'll need for a workspace and where to put them. The calculated number of fixtures is seldom a perfect match to the layout of a space, so some juggling may be necessary to fit the fixtures into the room. Don't be

afraid to look at alternate layouts before settling on a plan.

Shedding some light on lamps

Fluorescent lamps (shown above) are best for lighting small shops. The 8-ft. slimline lamp and the 4-ft. F40 are the most common. Both of these lamps are T12 lamps,

BALLASTS

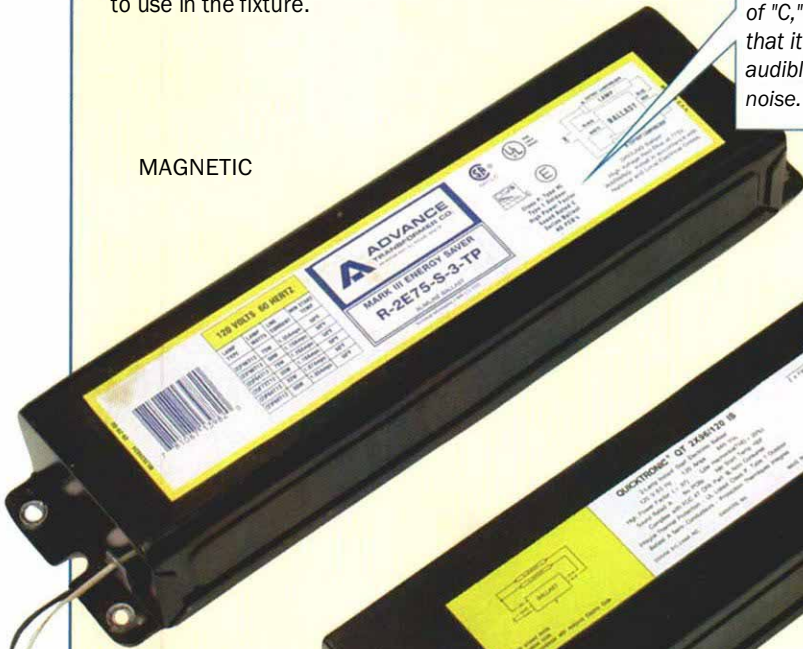
When you buy a fluorescent light fixture, you're paying mostly for the ballast. Magnetic ballasts are less expensive and more common. With magnetic ballasts, you want to ask for a commercial-grade product. Electronic ballasts weigh less and cost about twice as much. All ballasts make noise—some more than others—and they're all rated on the label to indicate how much noise they make. An "A" rating is the quietest. Be certain the specifications on the ballasts match the size and number of the lamps you want to use in the fixture.

RATING NOISE

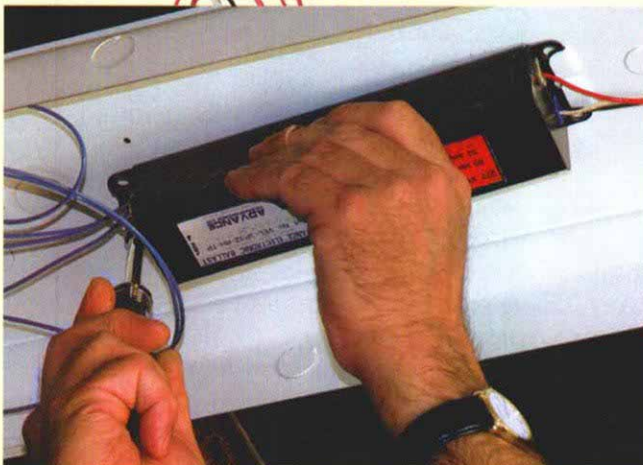
Class P, Type HL
Type 1 Outdoor
High Power Factor
Sound Rated C
Series Ballast
NO PCB's

The label shown indicates a sound rating of "C," which means that it emits a clearly audible humming noise.

MAGNETIC



ELECTRONIC



Some noise is fixable. Most ballasts slip into a tab on one end and are fastened with a sheet-metal screw into the fixture on the other end. A loose fitting at either location can cause noisy vibrations. Bend the tab or tighten the screw to cure the problem.

meaning the thickness is described in eighths of an inch: $\frac{1}{8}$ in., or $1\frac{1}{2}$ in. dia. High-output lamps can be used when higher lighting levels are desired. Smaller T8 (1 in. dia.) lamps are widely used for commercial and industrial lighting, but availability is largely limited to 4-ft. lamps.

Fluorescent lamps are sensitive to ambient temperature, especially when first turned on, and most lamps are produced in two versions—full wattage and energy saving. All full-wattage lamps start reliably at 50°F or higher when operated on standard magnetic ballasts, and 0°F when operated on low-temperature ballasts. Full-wattage high-output lamps will start as low as -20°F on standard ballasts. All energy-saving lamps are rated to start at temperatures of 60°F or higher regardless of the ballast type. Contrary to what the names seem to imply, full-wattage lamps are actually more energy efficient than their energy-saving counterparts, which save energy by burning less brightly, not by being more efficient. To understand why a little history may help.

The National Energy Policy Act of 1992 banned the sale of low-cost, full-wattage lamps in most standard colors, such as cool white and warm white, and required that we buy more expensive energy-saving lamps. This was done as an energy-conservation measure, but it created starting problems in cold climate areas. As a result, full-wattage cool-white F40 and 8-ft. high-output lamps have been reintroduced in some areas of the country as cold or low-temperature lamps. Unfortunately, full-wattage cool-white 8-ft. slimline lamps are not available in cold-temperature versions. The only 8-ft. full-wattage slimline lamps available are the high-color rendering types exempted from the Energy Policy Act because of their superior color and premium prices. For example, energy-saving cool-white slimline lamps are available for less than \$2 each in case quantities at discount stores such as Costco. Full-wattage, high-color rendering lamps are typically priced at \$7 to \$9 each.

In moderate climates, where temperatures at ceiling level are 60°F or higher, energy-saving lamps are preferred because they're cheaper. But if temperatures are normally lower than that, consider heating the shop before turning on the lights. Otherwise, you'll have to use the expensive full-wattage, high-color rendering

slimline lamps, cold-temperature high-output lamps or cold-temperature 4-ft. F40s. The drawback to 4-ft. lamps is that twice as many lamps and fixtures are required to light the space, which increases the labor required to install the system.

Lamps are rated for color—Fluorescent lamps come in many different colors and prices. Cool white is the most common and is usually the least expensive, and it has a fair color rendering. If you have to use full-wattage slimline lamps because of temperature constraints, consider the high-color rendering type. GE calls these lamps SP, Osram-Sylvania uses the Designer designation, and Philips calls them Ultralume. A numeric suffix describes the visual perception of the warmth or coolness of the lighted space: 3,000 is warm, 3,500 is neutral and 4,100 is cool. Full-wattage deluxe color lamps (such as Cool White Deluxe) are cheaper than high-color rendering lamps, but they are not the best choice for lighting a workshop because they're 25% to 33% less efficient.

If color matching is important in your work, you can buy special Chroma 50 lamps made specifically for this task. But because they are very expensive and less energy efficient, I would restrict their use to an area where color matching is done.

Weighing in on ballasts

Fluorescent lamps require a ballast to operate. The ballast provides the high voltage needed to start the lamp and the lower voltage required for normal operation. Ballasts are either magnetic or electronic, with magnetic being more common.



Let there be light where it's needed. Even though Lindsey chose a uniformly lit approach for his own shop, he had to fill in some areas with task lighting.

Magnetic ballasts used in fixtures designed for commercial and upper-end residential applications are commercial-grade, transformer types. Almost all 8-ft. fixtures employ this type of ballast. Many 4-ft. fixtures use commercial-grade ballasts, but others contain less expensive residential grades. The commercial versions drive lamps at about 95% of their rated light output. They also contain a capacitor to reduce the amount of current drawn by the ballast and can be identified by their larger size and the letters CBM (certified ballast manufacturer) inside a diamond shape on the label. Residential-grade ballasts pro-

duce lower light output, shorten lamp life and draw more current—all good reasons not to use them.

Some of the 4-ft. shop lights that sell for less than \$10 at many retail outlets contain an inexpensive electronic ballast that does not meet the industry standards for commercial ballasts, meaning that lamp life and light output may suffer. But commercial-grade electronic ballasts regulate voltage and current quietly and efficiently, and they seldom produce audible noise.

Magnetic ballasts hum. The bigger the lamp, the more noise the ballast will make. Some hum more than others, and cold temperatures exacerbate the problem. All ballasts have a noise rating printed on the label—an A rating is the quietest. Although ballasts can be very noisy when they are started in a cold shop, they should be significantly quieter after they warm up. If you hear excessive noise from one or more fixtures, the cause may be a loose mechanical connection between the ballast and the fixture. Most ballasts are installed with one end slipped into mounting tabs and a screw securing the other end. Make sure the tabs and the screw are tight; if not, tighten the connection. If you still find that one ballast is much noisier than the others, replace it. And if the low-level hum that is typical of fluorescent fixtures in a normal operating mode annoys you, consider masking the noise with a fan, a dust filter or a radio. □

Jack Lindsey retired to the mountains of Oregon in 1996 after a long career as an engineer for the Southern California Edison Co. specializing in commercial and industrial lighting.

Clean lights are more efficient

A little routine maintenance goes a long way toward maximizing the performance of your lighting system. Fixtures and lamps collect dirt and dust, even in the cleanest of shops. A good dust collector and a ceiling-mounted dust filter can't capture all of the dust from woodworking equipment. Dust and dirt on lamps and fixtures can reduce light output by 10% or more during the first year, with additional losses of 5% or more each year after that. You should clean fixtures and lamps at least once a year to recover this loss. First turn off the power to the fixture. Then remove the lamps, and wash both the lamps and the fixture with a mild solution of water and dishwashing detergent. Rinse with a damp cloth, and dry the surfaces with another clean cloth, or let them air-dry before turning on the power again.



Clean lamps shine brighter. Dust reduces the light output of fluorescent lamps. Clean them at least annually with a damp cloth and dishwashing detergent.