

Dust and the Woodworker

Examining the respiratory hazards

by Kirk Kundtz, M.D.

In 15 minutes of use, this disc sander filled a shop's atmosphere with a cup of powdery dust, the size that can negotiate your lung's smallest airways. The Occupational Safety and Health Administration (OSHA) recommends that your short-term exposure

What serious woodworker doesn't know the pleasure of wiping a delicate film of very fine dust off a well-waxed jointer bed? I like reaching into a tablesaw base and spilling out arm loads of wood dust onto my knees and the surrounding floor. In fact, I don't mind dust in my hair, in my beard and in my pockets. And I've not only come to love the feel and sight of wood dust, but the satisfying aroma as well. I was first tempted to start woodworking when my best friend built a cedar porch swing for me—the air in his shop was filled with the rich scent of the wood. Since then, I've built my own shop and filled the air with dust from a dozen different woods, including sassafras, walnut, redwood, mahogany, teak, cherry, maple, oak and poplar.

Yes, the woodworker in me enjoys wood dust, but the doctor in me is suspicious because the dust so often irritates my eyes and lungs. My concerns led me to the hospital library to research woodworking's effects on the respiratory system. What I found was both surprising and a little disconcerting. A computer search of medical literature revealed more than 250 articles pertaining to the hazards of woodworking. The articles covered a wide range of problems, including traumatic injuries, skin disorders and cancer associations, but most dealt with how wood-dust inhalation affects the lungs.

How much dust is harmful?—Wood comes off tools in many different shapes and sizes, including broad, flat shavings; long, thin splinters; small chips; and coarse and fine powdery dust, such as that produced by the disc sander shown above. Hand-sanding produces fine dust. But power sanders, the big guns in the sanding arsenal, are the tools most responsible for creating lingering dust clouds in the shop. Powdery dust consists of the smallest particles and represents the greatest health hazard to the lungs. This fine powdery dust not only floats in the air for a long time, but it can be inhaled very deeply.

Dust particles can be classified into two groups: those smaller than 10 microns in diameter and those larger than 10 microns (one micron equals one millionth of a meter). The smaller particles are respirable: they are little enough to negotiate the tiny

limit (STEL) be less than one rounded teaspoon of dust in a 24-ft. by 24-ft. shop in 15 minutes. OSHA's permissible exposure limit (PEL) for an eight-hour shift is about one-half of a teaspoon of dust suspended continuously in the same shop's atmosphere.

airways that reach deep into the lungs. Particles bigger than 10 microns tend to get trapped in the larger airways.

Wood dust, as inviting as it may be, is no friend to the woodworker. Given the fact that most of us are not going to sacrifice woodworking to save our respiratory system, the question arises: How much wood dust is too much? Two variables that must be considered are the amount of dust you breathe and how long you breathe it. If you spend just a few hours per week in the shop or if you work mainly on small projects that do not demand much sawing and sanding, you probably do not have to worry about bronchitis, pneumonia or nose cancer. If, however, you spend long hours on big projects that require extensive ripping and sanding, you should be cautious, especially in light of the small amount of dust that researchers and government regulators say is the threshold limit for ambient dust (beyond which lung disease begins to develop).

According to a 1981 report published by the American Conference of Governmental Industrial Hygienists, the maximum level of airborne respirable particles should average no more than five milligrams of dust per cubic meter of shop space in eight hours. Other studies suggest that this level is too high and recommend a maximum of two milligrams of dust per cubic meter. These studies propose that more than two milligrams of wood dust per cubic meter of shop space may damage your lungs.

What do these limits mean to you? Let's suppose your shop is 27 ft. long by 21 ft. wide and the ceiling is 9 ft. high, so it is roughly 170 cubic meters. According to the stricter guideline of two milligrams of dust per cubic meter, you should limit airborne dust to less than 340 milligrams. This is one-third of a gram, which I discovered equals slightly less than one-quarter of a teaspoon of dust. A full sandwich bag weighs almost 50 grams, which is enough to exceed the threshold limit of a 25,000-cubic-meter shop. This is all very disconcerting and even the authors of the cited study conceded that, though ideal, this strict (two milligram per cubic meter) standard is not very realistic.

A guide to your respiratory system Dust's affect on your lungs, however, is realistic, but you must first understand your

Getting out of the dust

by Theodore J. Fink, M.D.

Getting rid of dust in a woodshop is like trying to eliminate salt from your diet, which is impossible because almost everything you eat or drink contains sodium. So the goal is not to totally eliminate dust, but to minimize your exposure. This can be accomplished with a three-phase dust-control plan that includes: decreased dust production, wood-dust capture and personal protection.

Decrease your dust production: Your woodworking techniques and tools determine the quantity and size of dust particles you produce. The larger the particles, the less hazardous the dust. Large particles settle quickly, are more easily captured by dust-collection systems and are not respirable. The finest dust particles, which are the most hazardous, tend to escape most collection methods. If you shine a beam of light through a dark, presumably clean workshop, the airborne particles you will see are those larger than 20 microns in size. Respirable dust (under 10 microns) is invisible.

You can reduce very fine wood dust by minimizing the need for sanding. By cutting rather than scraping when turning wood and by planing and scraping rather than belt-sanding, you will produce shavings rather than dust. All sawblades, planer blades and bits should be sharp, because dull blades produce finer dust. You should select the proper blade and feed rate to produce smoother surfaces when sawing. When bandsawing scroll work, you can get a finer finish requiring less sanding by using a blade with more teeth per inch (t.p.i.) and with standard tooth form (not a hook tooth). When ripping with a hook-tooth blade, be sure it has a large-size gullet that will accommodate large particles and use a fast feed rate. To decrease the amount of finish-sanding, be sure stock is precisely dimensioned by planing and jointing before assembly.

Dust capture: Despite your best efforts, you will make dust. Therefore, you should attempt to capture the dust before it becomes airborne. The most efficient method includes a dust-collection system hooked directly into stationary tools (see *FWW* #67, p. 70). Also, when buying small power tools, such as sanders and power planes, select those equipped with dust-collection bags. Although these are commonly called "dustless" and greatly reduce the amount of dust put into the air, they fail to capture some of the very fine dust.

Whenever wood is machined, a wide assortment of particle sizes is produced and to each particle a positive electrical charge is imparted. This is especially important for



3M's model 8500 dust mask, on the right, should be used "for comfort only," and isn't approved by the National Institute for Occupational Safety and Health (NIOSH). The Gerson 1710 and 1725, in the center, are approved for dust and some mist protection. The 1725 has an easy-breathing valve. The NIOSH-approved Willson 1200 series cartridge respirator, on the left, comes with replaceable particle filters, and an assortment of cartridges is available that protect you from a variety of hazardous chemical vapors and mists.

the smallest particles, which, because of low mass and positive charges, remain suspended in air for hours after production. Eventually these fine particles do settle, but because they repel each other, they are easily resuspended in the atmosphere when swept with a broom. Thus, it is much better to vacuum dust whenever possible.

Skin and eye protection: Coveralls that can be taken off before leaving the shop protect most of your skin. The coveralls should be cleaned regularly and dust remaining on skin and hair should be washed off immediately after leaving the shop.

Standard safety goggles provide some eye protection from fine dust, but if you are using a very irritating wood or one to which you have developed an allergy, an airtight full-face mask or diver's (underwater) goggles may be necessary.

Respirators and dust masks: The amount of exposure to the skin and eyes is minuscule compared to the surface area in the respiratory tract. Furthermore, all the respiratory surfaces are moist and very reactive to foreign substances. Thus, the most critical personal protective equipment is the dust mask or respirator.

These items, which must cover nose and mouth, vary widely in cost, comfort and effectiveness. The most comfortable, least expensive and least effective is the lightweight molded mask that is commonly held in place by a single elastic band, such as the 3M 8500 (shown above on the right) or the Gerson 1501 (not shown). Although these masks filter out up to 95% of airborne dust, air leaks readily around their edges. Neither mask is approved by the National Institute for Occupational Safety and Health (NIOSH).

3M's Model 8710 mask (not shown) and the Gerson 1710 mask (shown above, second from the right) filter in excess of 99%

of respirable dust. Both have two wide elastic straps for a tight, form fit, yet they're still quite comfortable, lightweight and disposable. And they are durable enough for extended use. Both are adequate for fine-dust protection, but not for harmful vapors.

If you need protection from paint, varnish or other harmful vapors, as well as dust particles, NIOSH recommends a cartridge-type mask, such as the Willson 1200 respirator (shown above on the left) or a similar model from 3M, U.S. Safety or North Safety Equipment. The Willson comes with replaceable particle filters and you can purchase an assortment of cartridges that protect you from a variety of hazardous chemicals.

Masks and respirators are only as good as their fit, and a tight fit may be difficult if you have a beard. The air helmet, such as the Airstream Dust Helmet (or similar battery-powered air-purifying respirator/hard-hat combinations), may be a solution for bearded woodworkers.

Respirable dust remains suspended in the air for hours and it's invisible. Therefore, once you put on a mask or respirator for a dust-producing operation in the shop, leave it on for the rest of the workday.

As a mask or respirator is used, retained wood particles clog its pores and breathing becomes more difficult. As this happens, the effectiveness of dust capture by the mask actually improves, provided there are no air leaks around the mask. When you notice the increased breathing difficulty, it is time to change filters or the mask.

Before using any respirator or dust mask, always be sure to read and follow all instructions and warnings supplied by the manufacturer and NIOSH. □

Dr. Fink is an internist in Shelburn, Vt., a consulting physician for Digital Equipment Corp. and an amateur woodworker.

respiratory system so that you realize just how injurious dust can be. The lungs are extraordinary organs that continually bring fresh air into very close contact with your body's circulatory system. Structurally, the lungs are like sponges with millions of tiny air pockets. Their ultimate purpose is to remove carbon dioxide from the blood stream and replace it with fresh oxygen from the atmosphere. This process is called gas exchange. The air pockets are called alveoli, shown in the drawing on the facing page, and gas exchange takes place within them. When you breathe in, the alveoli fill with air and oxygen passes through their ultra-thin walls and into the surrounding blood. At the same time, carbon dioxide from the blood passes into the alveoli, where it is expelled during exhalation.

The flow of air in the lungs takes place through a set of airways that spread out very much like the branches of a tree, as shown in the drawing. The tree trunk corresponds to the trachea, the first large branches are the bronchi and the smaller branches are the bronchioles. In this analogy, the alveoli are like the leaves of the tree.

In addition to moving air in and out of the body, the lungs must keep themselves and the air clean, warm and moist. This job is accomplished by the "mucocilliary transport" system, a term for the mucus-producing tissue that lines the "bronchial tree" (see the drawing). We are all familiar with mucus, though we may not be familiar with its purpose. Not only does it serve to moisten the air, it also protects the underlying tissue from drying out. In addition, it acts like flypaper to catch the microscopic dust and dirt in the air we breathe. Once these dust particles are trapped, they must be discarded. This is done by the other part of the mucocilliary transport system, the ciliated epithelial cells. These cells have hundreds of tiny little arms that literally sweep the dust-laden mucus up and out of the lungs. In addition, a backup mechanism, the "alveolar macrophage," serves to clean out dust that gets into the alveoli. This system consists of cells that wander around in the alveoli like little street cleaners, sweeping up particles that threaten to interfere with the crucial gas-exchange system.

How does dust harm these organs?—In the healthy person, occasional dust particles in the lungs is not a serious problem because the lungs have built-in defense mechanisms, such as the mucus that lines the airways, that halt harmful substances like dust. The dust-laden mucus is then expelled from the lungs by the sweeping-motion cells lining the airways, as well as by coughing. Unfortunately, however, chronic inhalation of wood dust may damage the lungs' cleaning systems. When this happens, a vicious circle begins as more dust collects and further damages the lungs. The body then responds as it does to skin injury—it mobilizes an inflammatory response. That is, the bronchial airways become red, swollen and painful. Swelling decreases the diameter of the airways and produces shortness of breath, induces coughing and increases sputum, which is saliva and other discharged matter from the respiratory passages. A number of studies have shown that these symptoms are common in active woodworkers: those that spend long hours in the shop. Other studies have shown that woodworkers tend to develop lung problems similar to those found in patients with chronic bronchitis and emphysema—diseases associated primarily with cigarette smoking. Inhaling wood dust, while probably not as harmful as smoking, can be dangerous.

Perhaps the most documented effect of wood-dust exposure is nose cancer. Dozens of studies in more than 10 countries have shown an increased rate of this relatively rare form of cancer

among woodworkers. Medically it is known as "nasal adenocarcinoma." Mucus-secreting glands in the noses of woodworkers tend to become cancerous at a rate 1,000 times greater than non-woodworkers, apparently because of the dust. Fortunately, this type of cancer is relatively rare even among woodworkers (only about one in 1,500 active woodworkers will ever develop it), and the time lag between exposure and the onset of symptoms is as much as 40 years.

Finally, wood dust can cause respiratory illness because it contains many types of allergens and toxins. These range from chemicals deposited on the tree from the outside, such as pesticides and fungal spores, to chemicals created by the trees themselves, such as alkaloids, saponins, aldehydes, quinones, flavonoids, steroids and resins. Individuals respond differently to these various toxins, but the symptoms are universal: coughing, sneezing, increased phlegm and sputum production, runny nose, red eyes and, in extreme conditions, bronchitis, pneumonitis, and asthma. These symptoms are found in woodworkers more often than in the general population.

You are probably more familiar with some toxins and allergens than with others. Perhaps woodworkers are most aware of the allergen called plicatic acid, a substance in red cedar that is responsible for a condition known as red-cedar asthma. This very debilitating condition occurs in about 5% of people who work with red cedar. Another similar condition is maple-bark disease, a severe form of asthma probably caused by fungal spores found in maple bark. Two other North American woods considered to have significant allergenic effects are boxwood and sequoia redwood.

Clearly, the concern about dust is not just academic and all of us woodworkers must be aware of these insidious problems. Most of us don't hesitate to use goggles, push sticks and blade guards, but how many of us use face masks and dust collectors regularly? Not many, I'm afraid. Dust masks can be uncomfortable and dust collectors are expensive, but both are well worth the investment. As with many other items I've bought for my shop, I've agonized over spending money on a dust-collection system, but I'll probably wonder how I ever got by without it once I use it. □

Kirk Kundtz is a resident physician in internal medicine at Mount Sinai Hospital in Cleveland, Ohio, and is an active woodworker. Thanks to Drs. Lawrence Martin and James Edmonson for assistance in preparing this article.

Sources of supply.

Dust masks and respirators are manufactured by:

Louis M. Gerson Co., Inc., 15 Sproat St., Middleboro, MA 02346; (508) 947-4000.

Glendale Protective Technologies, 130 Crossways Park Drive, Woodbury, NY 11797; (516) 921-5800.

Mine Safety Appliance Co., Box 426, Pittsburgh, PA 15230; (412) 967-3000.

North Healthcare, 1515 Elmwood Road, Rockford, IL 61103; (815) 877-2531.

North Safety Equipment, 2000 Plainfield Turnpike, Cranston, RI 02921; (401) 943-4400.

Racal, Airstream Division, 7305 Executive Way, Frederick, MD 21701; (301) 695-8200.

3M/Occupational Health & Environmental Safety Division, 220-3E-04 3M Center, St. Paul, MN 55144-1000; (800) 328-1667, (612) 733-8029.

U.S. Safety, 1535 Walnut St., Kansas City, MO 64108-1312; (816) 842-8500.

Willson Safety Products, Box 622, Reading, PA 19603; (215) 376-6161.

The respiratory system

