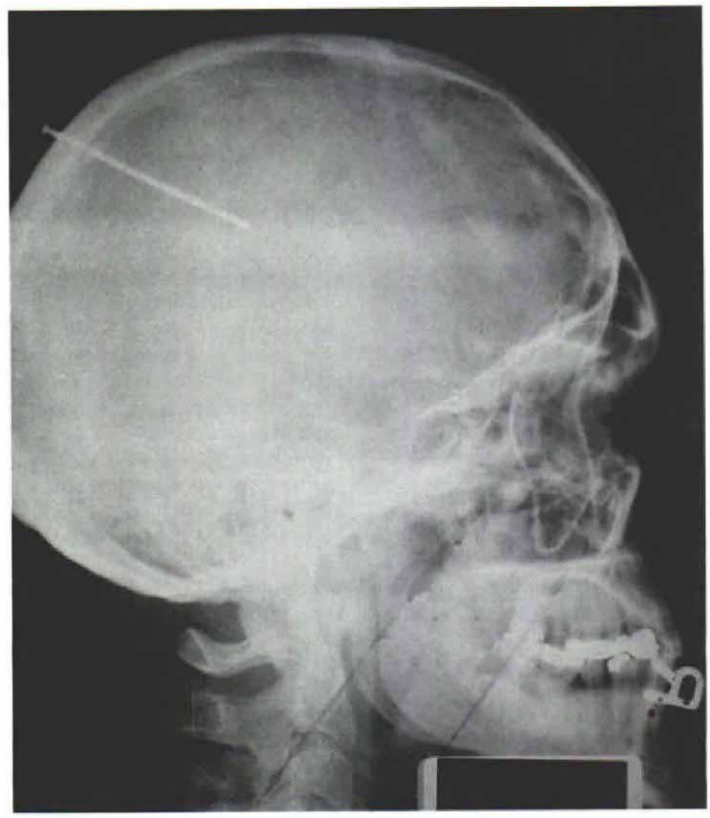
Job-Site Safety

The caliber of your work may have a lot to do with the future of your fingers

by Mark Feirer

If you're a builder or a contractor, you'd be safer working in a munitions factory. Building construction is one of the most dangerous occupations, ranking second only to mining in terms of risk. And despite regulation by agencies such as OSHA (the Occupational Safety and Health Administration), your chances of avoiding death or injury on the job aren't getting much better (see the sidebar on the next page). Accidental injury isn't the only risk you have to contend with. Health problems—cumulative injuries, if you will—are an insidious form of risk, since their effects can take years to show up. From "carpenter's wrist" to "carpet-layer's knee," silicosis to carcinoma, we're gradually learning more about the immediate and long-term health hazards of construction. We'll talk about health issues in a future article; in this one, the focus is on accidental injury.



Risks at the job site—Because it's difficult to find dependable, timely statistics on the exact nature of injuries in the building trades, it's useful to look at insurance rates as a rough guide to the degree of risk involved in various trades. Roofing is rated as the most dangerous house-building job, and not surprisingly, the most common accident involves a fall. A builder who has a medium-sized company in northern Florida told me that his worker's compensation payments amount to 32% of wages for the roofers on his payroll—if the roofer makes $15,000 a year, it takes an additional $4,800 a year to insure him. To put this in perspective, a secretary at the same company can be insured for about $37.50 per year—about ¼% of her $15,000 wage.

The same builder pays about 20% of a mason's wages into worker's compensation. Health-related risks are a big problem for masons, with the dusts generated by mixing, sawing or grinding leading to respiratory disease. But injury is also a significant risk. A California study found that over 80% of all safety and health claims by masons involve injuries from either strain and overexertion (the improper handling of loads, heat stress), falls, or being struck by something, like a brick falling from a scaffold or a stone chip hitting an eye.

Carpenters have a *relatively* good safety record at the construction job site, and their worker's compensation payments amount to only about 9% of their wage. Carpenters are most likely to lose time from their work as a result of back injury. Most back injuries (88%) are due to muscle strain or sprain from lifting improperly or too much. Falls are another major cause of injury for carpenters.

Some of the most dramatic accidents are caused by the misuse—and abuse—of tools. According to one manufacturer of woodworking machinery, table saws are by far the most dangerous (see the sidebar on p. 53). Ask a carpenter how he feels about the guard on his table saw and you're likely to find the reason. He considers it a nuisance and removes it.

'Every carpenter thinks it will never happen to him.'

If you think that only electric power tools maim carpenters, however, consider the following incident. A construction company in Florida had suffered only one serious accident involving an employee in 13 years. It happened to one of their most experienced carpenters, and it happened with a hammer. Joe was working setting blocking in a confined space where visibility was poor. With a tap he started a 16d nail, not seeing that it was near a knot. When he struck the nail to drive it home, it skidded off the knot, spun into a nearby duct and ricocheted into his eye, penetrating the eyeball and nearly severing the optic nerve. There's a permanent hole in Joe's iris, though he's lucky: his vision is impaired, not lost.

Other tradespeople on the job site risk injury to lesser degrees, and the specific danger varies from trade to trade. The most common hazards to drywallers are cuts from knives, saws and metals, and electric shocks (see the sidebar on p. 54) as electric cords are abraded by sharp materials. Plasterers often suffer from skin irritation and respiratory problems, and also run the risk of eye injuries related to the use of pneumatic equipment. People who install insulation have to cope with various respiratory problems and heat stress, along with scratches of the eyeball from fiberglass.

Some people are more likely to suffer injuries than others. In 1985, an OSHA report linked the following factors to a disproportionate share of injuries and illnesses at the construction site:

Younger workers have higher accident rates than older workers. There are probably several reasons for this—differences of experience, a process of elimination that weeds out accident-prone workers over time, and the slower pace of older workers. Several contractors I talked to, in fact, stressed a steady, careful pace as being crucial in avoiding injury on their crews. One builder said he fires hot-shot carpenters who work at a pace too frenzied for safety.

New employees have a higher accident rate than long-time employees. They're less familiar

with the work habits of their co-workers and with the style and pace of work that are required by their employer.

Medium-sized firms have higher accident rates than small or large firms. Large firms can afford to send supervisors to safety-training classes. In small firms, the level of teamwork is generally high, and because fewer people are on the job, it's easier for workers to keep track of what's going on around them.

Using hazardous substances increases risks considerably. Frequent contact with materials like asbestos or with chemicals, such as wood preservatives or concrete-cleaning acids, increases the danger of developing health problems, particularly over time.

Human error and injury—At some point in nearly every coffee-break discussion of job-site safety, a debate will flare around the question of who's at fault. In a number of conversations with builders and contractors, nearly everyone told me that injuries begin more often with the worker than with the tool being used. Figuring out why isn't easy.

Studies of why and how people take risks have shown that when the task is easy—low risk—the tendency is to underestimate your ability (be conservative). As the task becomes more difficult, the tendency is to overestimate your ability (take more risks). So it seems that we're not very good at estimating the probability of success when the task is either relatively easy or relatively hazardous.

Another reason for human error is fatigue—working after hours to meet a deadline. One carpenter who rolled into our office (he's on crutches now, and glad to be rid of his wheelchair) swore that he'd never work tired again. He had been staying overnight at the site of a major remodeling project in order to save himself a long drive home. After a quick dinner, the evening looked long and dull so he decided to work on a few details on the second floor. While reaching to close a window shutter, he leaned against another shutter that he thought was bolted—it wasn't. When he hit the cobblestones below, he fractured both heels. "It was carelessness bred of fatigue. At eight in the morning I would've tested the shutter before I put all my weight on it, but I was tired, and just wasn't playing with a full deck." Next time, he says he won't push himself so hard. "Even if you don't damage your body by working late, you don't do great work anyway."

Researchers have tried to figure out what causes accidents. One theory presumes that some people are just accident prone because of certain personality traits. A second blames management systems that push people to work fast-

Regulating safety

Construction safety laws and standards aren't new. In about 2200 B.C., the Code of Hammurabi called for the death penalty for any builder who, through carelessness, built a house that caused the death of its owner. In 1912, a group of corporations formed the National Safety Council in response to escalating accident rates. The NSC uses a voluntary process to encourage industrial safety, and now includes about 95% of the 500 largest U. S. corporations, along with medium and small-size businesses, government agencies, trade associations, insurance companies, and labor organizations.

In 1918, another group of U. S. companies formed what is now known as the American National Standards Institute. The ANSI of today is composed primarily of manufacturers and trade associations. It has developed hundreds of product standards, most of which cover such things as the pitches for screw threads. But a few are directed at occupational safety and health, like the standard for safety glasses. These standards are voluntary, arrived at through a consensus decision-making process. Just because ANSI has a standard for hard hats, manufacturers don't have to make them to that standard.

***OSHA*—In 1970, Congress passed the Occupational Safety and Health Act (OSHAct), which placed legal responsibility on employers to prevent Injury and illness. A common misconception among residential builders is that this act covers only the largest construction businesses. It in fact covers *all* employers and employees in the U. S., with few exceptions (self-employed people, operators of family farms, and workplaces already protected by other federal agencies). The OSHAct is summed up by its general-duty clause:**

"*Each employer shall furnish to each of his employees employment and a place of employment which are free from recognised hazards that are causing or are likely to cause death or serious physical harm.*"

As a part of the OSHAct, Congress created one federal agency to supply the brains, another to wield a club and a third to keep the second from getting out of line. The National Institute of Occupational Safety and Health (NIOSH), under the Department of Health and Human Services, supplies basic research. The Occupational Safety and Health Administration (OSHA), under the Department of Labor, develops regulations based on NIOSH research, makes them law and enforces them by inspecting job sites and levying penalties against employers. Finally, the Occupational Safety and Health Review Commission (OSHRC) was created as an independent, quasi-judicial agency to field complaints about OSHA inspections. Any employer, employee or union can contest an OSHA action before the OSHRC.

To give OSHA a head start on regulating the workplace, Congress gave it the right to adopt safety and health regulations from other organizations without having to wait for NIOSH to get rolling, and without having to test the regulations. About 90% of the standards OSHA started out with came from ANSI, while the rest came from trade associations or other governmental agencies. This means that most OSHA standards were developed not by a federal agency but by private organizations.

There are a lot of OSHA regulations and standards (the 1985 book of construction standards runs 450 pages), and most have been criticized by nearly everybody. Labor berates them as insufficient to protect workers, while business figures they're too costly, stringent and inflexible. All OSHA regulations have to pass a cost-benefit test, but that doesn't always make them easier to swallow.

For builders, there's a pocket-sized version of the construction-standards book (with a safety orange cover, of course). It's called the "OSHA Safety and Health Standards Digest—Construction Industry" (furnished free by OSHA), and should be a fixture in the toolbox of everyone on the job site.

***Dealing with Inspections*—Builders I've talked to about OSHA inspections recently have been blunt: "I think they should stay out of residential construction!" OSHA "compliance officers," while less than popular, have the legal right to enter and inspect any construction site without delay or harassment, and with very few exceptions, inspections are made without advance notice. The Supreme Court determined that OSHA can't conduct such "warrantless" inspections without an employer's approval. But if there's evidence of a safety violation, OSHA can get a search warrant and inspect anyway.**

Under the OSHAct, every employer must inform employees of OSHA standards that apply to their job, so if you don't know what they are, ask. And any employee has the right to request an inspection if he feels there's something at the job site that may cause physical harm.

Trying to spend dollars where they will do the most good, OSHA has begun to target specific industries where the risk of injury is high, and building construction Is in their sights. In 1973, about 27% of all OSHA Inspections were at construction sites. In 1984, however, nearly 60% (about 94,000) of all inspections were at construction sites, making construction the only industry showing an increase in inspections over this period.

What happens if compliance officers show up at your job site? First of all, check their identification against the picture ID card that all officers must carry. The purpose of the inspection should be explained to you right away, and you can accompany the officers if you want. They can go anywhere and talk to anyone, though interruptions of work should be minimal. Any violations discovered during the tour and corrected immediately may still figure in a citation later on.

After the inspection, the officer will report findings to an OSHA area director, who will determine what citations, if any, will be issued. A fine of from $60 to $1,000 may be assessed for each violation, and if a subsequent inspection finds a repeat of an earlier violation, the fine might

er or harder than they should; piecework systems are often cited, and unions agree. A third theory figures that poor "fits" between worker and environment lead to accidents, and would redesign tools and the workplace for a better match between worker abilities and attitudes (the Swedes take this approach, and they've had some success with it). But no single theory tells the whole story, and despite all the safety regulations, experienced home-building professionals still get hurt.

I talked to an experienced carpenter from Maine who lost the end of his left ring finger to a table saw. He said that until the accident, he didn't think much of safety: "Every carpenter thinks it will never happen to him." Since the accident he's become a lot more concerned. Personal experience is indeed a good teacher, but where safety is concerned it's a rather painful and costly way to learn, and the lesson comes a little late. The best bet is to learn from the mistakes of others.

Case histories—A cabinetmaker/builder in Idaho got the call at 2 a.m.: a trailer loaded with satellite dishes had crashed through the front wall of a nearby gun shop, and the damage had to be repaired immediately. Ordinarily he would have worked with his own crew, but he was paired instead with an experienced carpenter he had never met. By mid-morning the damage was repaired and the two were finishing up trim work on the facade. As the carpenter was backing down a ladder, nail gun in hand and finger on the trigger, he bumped the gun into the cabinetmaker, who was tacking up some trim at the bottom of the ladder.

The nail gun fired, sinking a 10d nail in the cabinetmaker's skull: "The impact knocked me unconscious, and when I came to 10 minutes later, my head felt like it was lodged between the jaws of a Jorgensen clamp." After a rush to the hospital, surgeons extracted the nail. It had been traveling on a path from the back of the cabinetmaker's skull to his right eye—until the nailhead was snagged by his baseball cap. The Xray on p. 51 tells the tale.

Look in just about any listing of safety rules for pneumatic tools and you'll see a caution against carrying tools with your finger on the trigger. The cabinetmaker (who suffered no permanent damage) saw another danger: neither man knew what the other was working on, or where. He had some other observations about safety, too. "Experience in a trade doesn't have too much to do with avoiding accidents, and may in fact add to the problem because experienced tradesmen sometimes think they're infallible. Almost daily on jobs I'll see people abuse the table saw by cutting with the blade too high. A blade ⅛ in. above the stock won't do nearly as much damage as when it's 2 in. above—a blade can't tell the difference between wood and meat. Part of my own awareness of dangers on the job site comes from teaching industrial education. I got used to seeing lots of beginners around tools, and catching dangerous techniques before they turned into injuries."

A builder now working in New England had only one major accident in 15 years as a framing carpenter. "I wedged back the guard on my circular saw so I could follow a cut line and keep one hand on the lumber. I finished the cut but forgot the guard was up, and rested the saw against my knee. It took three dozen stitches to close me up." If you want to pep up a flagging conversation with a group of carpenters, ask them about saw guards. Most find the devices awkward on occasion, and sometimes a nuisance. Here's how one California contractor sees it: "I block the guard up when I have to cut a slight bit off the end of a board and sometimes when I'm cutting an angle across a board, because the guard can get hung up as it gets pinched between the saw and the edge. You sure have to concentrate on what you're doing, though. I got used to working with an open blade when I did timber framing with a chainsaw. One time the chainsaw backed out of the log I was working on and caught me at the in-

go to $10,000. If an employer knowingly or intentionally commits a violation (if he knows, for example, that an open stairwell exists and makes no reasonable effort to guard it), the penalty for each violation might reach $10,000. And for willful violations resulting in the death of an employee, a six-month prison term might be added to the maximum fine.

But like a toothless dog, OSHA's bark promises more than its bite delivers. The fines actually imposed are small—the average penalty for violations that threaten "death or serious physical harm" is less than $200. In fact, the amount of the fine is usually less than the cost of providing the safety, so it's not surprising that OSHA hasn't been very effective.

Builders and contractors might be more inclined to accept OSHA if the agency could prove that it was saving lives at the workplace. A 1985 study by the Office of Technology Assessment, a federal agency, couldn't find much that would support this claim. Several researchers have found favorable but generally small changes in job-site accident rates, while others have not found any significant correlation between OSHA activity and workplace injuries. OSHA paints with pride to injury rates that have been declining since 1981 (eleven years after passage of the OSHAct), but the OTA study suggests that OSHA can't take the credit. It concluded that the economic recessions and resulting high unemployment, along with a shift away from smokestack industries, are the most likely reasons for this decline. ***—M. F.***

Preventing kickback

"The block was in the street before I knew it, and my hand was in the blade..." It's a classic description of table-saw kickback. The carpenter I was talking to had been more used to circular saws than table saws, and he lost the end joint of one finger learning about their differences. Kickback doesn't always result in mangled fingers, but since this carpenter was working so close to the blade, when the block shot toward the street his hand was there to take its place. You won't see it happening either—only the results.

According to the Power Tool Institute, table-saw kickback happens for several reasons. Sometimes the kerf in whatever you're cutting will close up and pinch the rear of the blade. Or the material can get wedged between the fence and the rear of the sawblade, as when the fence and the blade aren't parallel to each other. And if you start off with a crooked cut, the wood can bind against the side of the blade. Splitters help to keep the kerf open, and anti-kickback pawls can stop the workpiece before it becomes a projectile headed your way. Never tilt the sawblade toward the fence; if you do, the wood will be trapped between them and you'll be in trouble.

Kickback with a circular saw offers slightly different but equally grim results. It, too, can be caused by pinched blades and wedged wood. But instead of the stock kicking back at you, the saw may spin your way, and an uncontrolled circular saw is real trouble. Whenever you feel the need to force the saw through the cut, something's wrong. Shut off the saw and find the problem.

Frequently, builders and contractors I talked to prefaced the description of their accident with something like: "Funny thing is, I *knew* it was dumb when I started, but I just went ahead anyway..." Most of them could distinctly remember a spilt second of decision, and an internal "bell" or "small voice" that warned of danger ahead. And all of them wished they had listened.

On a radial-arm saw, kickback occurs when the stock binds between the back of the blade and the fence. Stock will be ejected toward the rear, or the saw may "climb" the work and race toward you. Always keep your body, particularly hands and arms, away from the line the saw would take if this happened. When you crosscut, pull the saw forward only enough to cut the stock; if you pull too far, the blade may catch the stock on the return trip and throw it.

On any of these saws, a dull or dirty blade can increase the chances of kickback; a buildup of pitch, for example, increases friction on the blade's surface and makes it more susceptible to binding. A warped blade is real trouble. Be sure that the set of the blade's teeth is adequate to provide clearance in the saw cut, otherwise the blade is likely to bind. And it really is time well spent to read the directions enclosed with your tools.

—M. F.

Electrical safety

His shirt was still wet from perspiration when they found him in a crawl space beneath the house, dead. A journeyman electrician, he had been working with a double-insulated drill plugged into a droplight, which in turn had been plugged into a receptacle upstairs. From the severe burns that seared his back, it was easy to see what had happened. When he rolled over on his back to get a better angle on the holes he was drilling, a length of cord became pinned between his body and the ground. When he lifted the drill above his head, the drill plug separated slightly from the droplight and made contact with his damp shirt. When investigators unplugged the droplight cord upstairs, they saw that the grounding prong was missing.

It doesn't take much electricity to snuff out a life on the job site, particularly since the presence of moisture can turn a poor conductor into a very good one. Dry wood, for example, has a high resistance to the flow of electricity, but when saturated with water it becomes a pretty good conductor. The same is true of dry and wet skin. And shirts.

Electricity travels in closed circuits, flowing from and returning to a point of origin through some conductor. You become a part of this loop when you touch both wires of the circuit, or when you touch the hot wire and the ground (electricity will flow through yon to the ground, and back to the source). You will also get a shock if the metal case of the tool you're using comes in contact with the hot wire of the circuit.

The plastic housing of double-insulated tools acts as an insulator for any short circuit within the tool, but it doesn't eliminate all danger of shock. So it's still crucial to maintain the integrity of the grounding system. If you or the tool ever become part of the hot circuit, electricity will flow through the ground wire, not through you. Any break in the grounding system renders it useless—and puts you at risk.

Mechanical devices, like fuses and circuit breakers, are another way to protect against shock, but they're intended primarily to protect wires and equipment from an excess of electricity that could damage them. They work by breaking the circuit when it's overloaded. A ground-fault circuit interrupter (GFCI) is a fast-acting circuit breaker that's better at protecting people. It senses imbalances in the flow of electricity through a circuit, and when the amount of electricity going into a protected system is greater than the amount coming out, the GFCI assumes that current is leaking somewhere and quickly breaks the circuit. The idea is to eliminate any leak that might allow electricity to course through a person.

At the job site, GFCIs should be provided for all 15-amp or 20-amp circuits that aren't a part of any permanent wiring. (For more on ground-fault protection, see *FHB* #6, pp. 39-41.)

—*M. F.*

step. The doctor lost count at 50 stitches, but I was back on the job in two weeks."

Most builders and contractors get the job done without disabling the blade guard. The idea is to plan the work to avoid awkward situations that might tempt you to block back the guard. It takes a little forethought, but it's done all the time by experts.

Safety, speed and quality—Many builders see an inverse relationship between speed and safety. As the builder in New England puts it: "One of the reasons our crew has had a reasonably good safety record over the years is that we emphasize care and quality on our jobs, not speed. When I was working on production framing jobs in Alaska where speed was of the essence, there were frequent minor accidents, mostly with nail guns. I think safety is the incidental benefit of care and quality."

From a builder in Massachusetts I heard some similar comments: "I've had no major accidents in over 30 years working in the trades. The most important safety skill is anticipation, thinking one step ahead, and having your mind entirely on the job. I know very well that the radial saw can take a finger quickly, and so I'm always a little bit apprehensive about the tool, enough to respect its power. My message to apprentices is this: if you work for a safe boss, you're likely to develop safe habits. But if you see the boss doing things you know aren't safe, your first safety action should be to leave the job. Speed often leads to safety problems, so learn to work at a proper, consistent pace. Take a break if things get too frantic."

Others I talked to made a connection between the quality of their work and the safety of their workplace. A carpenter's coffee break may be much maligned, but it has probably saved more than a few fingers. If you're running a crew, take a lesson from basketball coaches who call time out when they see signs of frustration and fatigue.

"There are five people in my company," said another carpenter in Maine. "We've had some relatively minor incidents with jointers and routers, but no major accidents in six years. We've had most of our problems with hand tools, I think, because we let our guard down and don't expect the degree of danger found in our power tools. People get into safety trouble when they're preoccupied with something off the job, or overtired."

A woodworker in Connecticut who was trained in Japan reported that he never had a major accident. "I was originally trained to use hand tools only, and there the dangers are relatively minor. So I'm careful in the extreme with power tools, and always wear hearing protection and goggles. I guess I'm particularly careful with my eyes and head, because if I lost an arm or a leg, I could at least transmit my craft by telling someone else what I wanted and what to do. But if I lost my capacity to think or my eyesight, I would lose my craft entirely, and it's all that I have."

I've never seen it on a job, but this woodworker is so concerned about his eyes that he doesn't use carbide blades on a table saw because of the danger of carbide bits loosening and flying toward the operator at high speed—he saw it happen to an apprentice. Carbide blades on radial-arm or portable circular saws, he feels, aren't a danger because the rotation of the blade is away from the operator.

Aids to safety—Though a proper attitude may be the most valuable safety device you take to the job site, many contractors are more aware of safety glasses, hard hats and the like. These things help to minimize injuries and are definitely worth using, but they can't be relied upon entirely to keep you out of harm's way. The federal Office of Technology Assessment, in a survey of workplace safety, concluded that the effectiveness of many safety devices hasn't been demonstrated, particularly under job-site conditions: "Laboratory test results tend to exaggerate the effectiveness of personal protective devices." OSHA hasn't expressed a lot of confidence in such devices, either. It has a priority list of techniques for preventing accidental injuries, and the use of personal protective devices is at the bottom of it. In order of preference and effectiveness, OSHA would rather *eliminate hazards* from machines, methods or materials; *control the hazard* by enclosing it or isolating its source; *educate workers* to follow safe procedures; or *prescribe personal protective equipment* to shield them from the hazard. In this policy, OSHA is in agreement with other safety organizations. A major reason why larger-scale, more expensive solutions are preferred is that workers usually won't voluntarily wear safety devices. For a list of suppliers of safety devices, see the sidebar on the facing page.

Tool safety—The other half of the who's-at-fault debate pins the blame for injuries on unsafe tools. The issue of responsibility for accidents is not just academic—it comes up every time a liability suit is brought against a tool manufacturer. There has been a spectacular growth in the number of product-liability cases during the past few years, and in their costs. Plaintiffs are increasingly likely to name in the suit anyone who can be remotely tied to the cause of the accident. In a recent case involving a table-saw accident, nine separate parties were named as defendants, including the manufacturers and distributors of the table saw, the dado blades and the special blade guard, which wasn't even being used at the time of the accident. Of course, each party had to be represented by a separate attorney.

Prudence requires that manufacturers reduce the hazards of tool use in order to avoid costly suits, though only about 1% of product-liability suits ever go to trial. The rest are dropped or settled out of court. The increase in the number of suits may be due to the greater variety and number of tools available, or to new laws that require tool manufacturers to anticipate misuse of the tools and guard against it. It may also have something to do with Worker's Compensation insurance.

Early in this century, it was very difficult for employees to sue their employers for damages if an accident occurred. During the Progressive

Safety resources and equipment

For more information about job-site safety, the following sources are recommended.

OSHA Publication Distribution
Room S-2403
U. S. Department of Labor
Washington, D. C. 20210

OSHA publications are free. "OSHA Safety and Health Standards Digest-Construction Industry" is the best way to get an idea of what regulations affect you. "Personal Protective Equipment" will tell you what to look for in safety devices. "All About OSHA" offers most of what you need to know about how the agency operates, including detailed information about your rights and responsibilities.

National Institute for Occupational Safety and Health
Department of Health and Human Services
5600 Fishers Lane
Rockville, Md. 20857

NIOSH is primarily a research organization, but will provide free information on the dangers of substances at the construction job site.

United Brotherhood of Carpenters & Joiners of America
101 Constitution Ave. N.W.
Washington, D. C. 20001

The Occupational Safety and Health office at the UBC provides information to its members about safety and health, and its publications are available to members and non-members alike. Their volume "Health & Safety Hazard Identification Program" ($20.00) is a fairly complete collection of what the dangers are and how to avoid them.

Power Tool Institute
501 W. Algonquin Rd.
Arlington Heights, Ill. 60005-4411

The Institute is a trade association of power-tool manufacturers, and they have some of the most readable safety guides around. The best is "Safety is Specific" ($1.50; more than 20 copies, $1.00 each)

Klein Tools
7200 McCormick Rd.
Chicago, Ill. 60645

The booklet "Proper Use and Care of Hand Tools, Pliers, Screwdrivers, Wrenches, Striking & Struck Tools" (86 pp.) is full of tips and techniques.

There are many manufacturers and distributors of safety equipment, but the ones Following have comprehensive or unusual product lines. Only toll-free phone numbers are given.

Bilsom International, Inc.
11800 Sunrise Valley Drive
Reston, Va. 22091

An informative catalog of hearing, eye, head and face protection.

H. L. Bouton Company
P.O. Box G
Buzzards Bay, Mass. 02532

Safety spectacles and goggles.

Direct Safety Co.
7815 South 46th St.
Phoenix, Ariz. 85044-5399

Safety cones, fire extinguishers, first-aid kits and other safety products.

HTC Products
120 E. Hudson
Royal Oak, Mich. 48067

Feed tables and work supports.

Industrial Products Company
21 Cabot Blvd.
Langhorne, Pa. 19047
(800) 523-3944
(800) 562-3305 (in Pennsylvania)

Comprehensive distributor of safety equipment.

Kenco Safety Products
78 Glasco Turnpike
PO Box 385
Woodstock, N. Y. 12498

Eye protection.

Magid Glove & Safety Manufacturing Co.
2060 North Kolmar Ave.
Chicago, Ill. 60639

Safety clothing and gloves.

Shophelper
P.O. Box 238
Tulare, Calif. 93275

Anti-kickback stock feeders for table saws and shapers.

SINCO Products Inc.
Hog Hill Road
P.O. Box 361
East Hampton, Conn. 06424
(800) 243-6753

Nets, safety belts, lifelines.

era, laws were passed to remedy this, and courts began to hit employers with costly judgments. So it was manufacturers who pressed for passage of Worker's Compensation laws. Under this system, workers are compensated for medical expenses and lost wages, but employers can't be sued except when they've willfully violated safety standards. By 1948, all states had Worker's Compensation laws. Because an injured worker can't sue his employer, he might instead aim the suit at the manufacturer of the tool that injured him in order to recover damages in excess of what worker's comp pays.

Tool manufacturers can be held liable for accidents caused by very old tools. If a worker in 1975 was injured on a tool built 40 years earlier, the manufacturer of the tool could be called to account for the accident, even if the tool hadn't been produced for many years. But between 1979 and 1981, laws were enacted in a number of states that set limits on liability of from five to twelve years. Some of these "statutes of repose" have been ruled unconstitutional, however, and legislation is pending in Congress to establish a national statute of repose. Until then, manufacturers may still have to defend outmoded tools.

Because of the rapidly escalating costs of product-liability suits over the past two years, tool manufacturers are spending more time and effort to ensure that their products are safe. To get an idea of what they do, I headed for Pittsburgh to visit Delta Manufacturing Corporation. Mat Ros, claims manager, told me that Delta uses one of three methods for safety-checking its tools. The most exhaustive method is called failure modes-and-effects analysis, and is used during the development of an altogether new tool. During this process, each part of the product prototype, down to the last nut and screw, is examined. For each part, an analysis is made of the possibilities of failure, the effect of failure on other parts and the likely result of such a failure in terms of operator safety and tool operation. An estimate of effect—from negligible to catastrophic—is assigned, and so is an estimate of frequency. Finally, a preventive measure is determined and costed out. All these bits of information are then factored into a simple equation and formulated into an "action priority," which tells Delta how important it is to make a change. Since a typical power tool can have 300 to 500 parts, it isn't surprising that this analysis method is used only for new, unproven tools. As we talked one afternoon in his office, Ros pushed a 200-page tome across his desk—it was the analysis of Delta's 10-in. radial saw.

To study new tools that are "evolutionary"—a new model of an existing table saw, for example—project managers at Delta can use one of two other analysis methods. Fault-tree analysis involves the construction of a logical, branching network of events that could lead to accident. The method used more often is called "hazard analysis." It's based on a checklist, filled out by the project engineer, and provides a systematic examination of possible safety problems. Can chips or dust ejected cause injury? Can the machine be inadvertently turned on? Are potential pinch points guarded?

On the floor of his office, Lou Brickner, Delta's director of product development, gave me the engineering view of product development and safety. He unfurled a product-development PERT (project evaluation and review technique) chart that stretched from his door to the opposite wall—and it's not a small office. A typical Delta product takes about two years from inception to production in a 14-stage process. While safety is an early consideration, it doesn't show up formally until the fourth development state—about six months into the project.

Later on, I asked Brickner about saw guards. He told me that one of the problems in designing them for a table saw is that the tool is so versatile, and what works perfectly in a ripping operation isn't ideal when the saw is set up for dadoing. "Any guard can be defeated, particularly on mobile tools like a circular saw," he said. "Guards are just added weight to contractors—until they hurt themselves."

Unique dangers—What sets the construction job site apart from most others in terms of safety is that what is built can cause as much injury as the tools and techniques used to build it. Earlier this year in Florida, the trusses of an unfinished roof, supported by a single brace that snapped, fell to the deck and killed a building inspector. And during the torrential rains last February in California, a man whose name is familiar to many was crushed to death when the experimental building he was sleeping in collapsed. Ken Kern died in his own construction of bark, mud, plastic pipe and concrete. He was the author of *The Owner-Built Home* and other books. □