

Lumber

Where it comes from, how it's made

by Jeremy Singley

Whenever woodworkers gather, there are sure to be gripes about the cost of lumber. I used to complain myself, until I worked a stint, ten years ago, at the A. Johnson Lumber Mill in Bristol, Vermont. There I learned firsthand that the work starts early and ends late for those who make lumber, because lumber is what the economics professors blithely call "labor intensive."

To begin with, trees have to be fetched; they don't come to you. Once home, a good run of hardwood logs will lose about a third of its bulk as waste. Of the remaining lumber, only about 35% is top grade, but all 100% must be handled, and the only way to sort and stack hardwood boards is to bend down and pick them up, one at a time—ten, a hundred, a thousand a day.

It's like that right down the line. Trees to be cut are marked by a forester who spends every working day walking the woods. They are harvested and dressed by men and women wielding chainsaws, peaveys and axes. The tree-length logs are chained to tractors, drawn out of the woods, and cut to length with chainsaws again. These jobs are performed year-round, in rain and snow, at 30° below and 100° above, from dawn 'til dusk.

To get the whole story of where prime lumber comes from, I talked with some of the people who do these jobs: Tom Bahre, county forester for Addison County, Vermont; Bernie Badger and Bob Slater, loggers; and Phil Johnson, part-owner of the A. Johnson Co. sawmill, a family business that has grown into one of the top 500 mills in the country.

Wood on the stump—When you pull a dozen clear 14-in.-wide boards off the lumber rack, you're handling approximately two cups of topsoil minerals plus around 35,000 days of rain, snow, sun and wind: the makings of a tree. Tom Bahre's job is to see to it that another hundred years hence today's saplings will have grown to produce more of those 14-in. boards. You might think that means he spends most of his time planting seedlings, but growing trees is not his job at all. Bahre's job is to kill trees.

In New England, trees are like ants at a picnic. You can't keep them out. Like ants, trees are greedy. Let the wind and animals carry seeds onto an acre of clear land and in 30 years you'll have so many trees jostling for that acre's nutrients that they'll be murdering each other. Many potentially high-grade trees will be killed off. Leave the stand to mature for another 70 years or so and then let the loggers loose on it and the picnic's over—only weed trees will be left to re-seed the gaps. Do this repeatedly over decades and you'll find it harder and harder to find cabinet-grade lumber. This is exactly what's been happening to our hardwood forests all over the United States.

Forty years ago good trees were so plentiful in the Northeast a team of two loggers, using handsaws and horses, could cut a quarter-million board feet in one winter. The standard board length then was 16 ft., because any stem a logger cut was likely to contain three 16-ft. clear logs. It wasn't unusual to see whole truckloads of high-grade logs as big as 3 ft. in diameter, or sometimes even loads with just one log the full width of the truck bed, 5 ft. across.

Three developments changed all that: the baby boom, the chainsaw, and the tractor. As population (and wealth) increased, demand increased, and the chainsaw arrived just in time to enable the need to be met. When demand outstripped even the chainsaw's output, the tractor showed up to replace horse-drawn sledges. No one thought to improve on nature, however, and woodlands became inexorably depleted.

To counter this trend, the United States Department of Agriculture has long encouraged individual states to adopt land-use



The skidder, a specialized tractor, tows a train of logs toward the decking area, where the logs will be cut to length.

From logs to boards

The route of a log through a mill is fast and efficient. The A. Johnson mill in Bristol, Vermont, supplies the woodworking world with one quarter million board feet a week, by the trainload or by the board, for everything from golf tees to buildings. It begins as stacks of logs in the yard, about 30,000 of them at any given time, which logging crews keep replenished at an average rate of ten truckloads a day.

From the yard, a diesel-powered forklift bites up mouthfuls of 5 or 6 logs at a time and loads them onto the sawmill's debarker deck, the first stop on a fast ride to oblivion:

The debarker (1) rotates each log while a set of toothed wheels chews off the bark, which would otherwise hide defects, dull sawblades and make subsequent saw waste unusable for paper manufacture. The stripped bark is hauled off and used to fire the company's drying kilns.

From the debarker the logs move to a holding area (2), from which the head-rig carriage (3) picks them up. The head-rig sawyer, stationed in his electronic control booth, directs a hydraulic cant turner near the carriage to juggle the log into position for the first cut. Seeking the best face, he may flip the log almost one full turn in a series of short hops. Working up to 30 switches per minute, and making split-second decisions as fast as the debarker can deliver logs, the sawyer inspects the surface for defects hidden inside. He aims to slice off the most valuable timber from the log with the first cuts, which, as shown in the drawing at right, produces the highest proportion of valuable boards.

The head-rig sawyer directs the carriage along a set of rails past the head

rig's 38-ft.-long by 1-ft.-wide bandsaw blade. Powered by a 150-hp motor, this saw routinely slices the length of a 16-ft. log in less than two seconds.

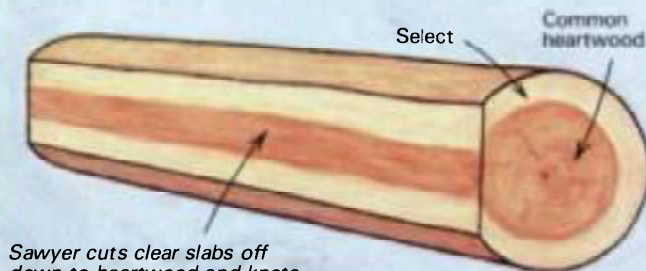
If the first sawn slab contains no usable lumber, the saw's outfeed conveyor (4) is shunted aside (5) to let the slab drop to a shaking conveyor trough in the basement. This conveyor jostles useless slabs and other waste to a chipper that works something like an oversize lawnmower, chewing up the average slab in about a second. Chipped waste eventually goes to a pulp mill or to wood-fired utilities. In a sawmill, everything salable is sold. This is partly to get every cent's worth out of the tree, but it's also necessary to keep the mill from being buried in its own waste.

Usable slabs are caught on the saw's outfeed conveyor and directed to an edge trimmer (6) that cuts the irregular edges square and parallel. Meanwhile, the head sawyer may take one or two more passes from the first face of the log—this is the best time to slab off an 8/4 or 12/4 clear board, if the log has one in it.

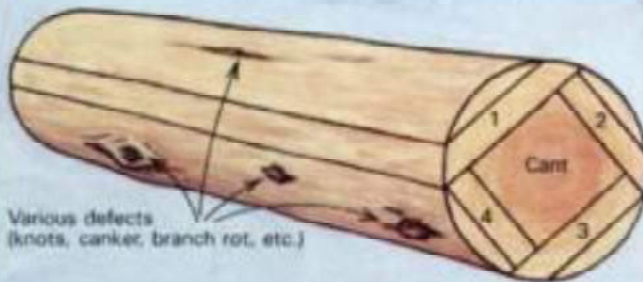
Next the sawyer will flip the log a quarter-turn and repeat the process. Two more quarter-turns leave the log square.

The squared logs, called cants, are dropped from the head-rig carriage onto the outfeed conveyor and directed to a second holding area (7) feeding the resaw (8). The resaw sawyer will then take repeated cuts from the best face of each cant until he exposes inferior-grade stock, then he'll flip the cants to cut the second best face, and so on. The first and best resaw cuts make the widest boards; the last cuts, near the tree's heart, are the lowest grade.

Cutting strategies at the mill



Sawyer cuts clear slabs off down to heartwood and knots. Another cut on this face would yield a low-price board with #3 common center, 'throwing away' the clear wood on the edges. Sawyer therefore turns log to new face for next cuts.



The sawyer cuts the best face first because this yields the widest board after edge trimming. Other faces are cut in the order shown so that the worst wood ends up in the narrowest board.

The drawing on p. 45 shows why—within the fully grown tree is the skeleton of the sapling it once was, complete with overgrown branch stubs and all the other scars incurred in the past. The bigger the log, the better. Whether a log is 10 in. dia. or 20 in., it will likely contain the same 5-in.-dia. heart of #3 common lumber. In fact, a hollow log may yield as much cabinet-grade lumber as a solid one.

The resawn boards move to the trim saws (9). The trim saw operator electronically selects from a bank of circular cutoff blades hovering above the conveyor and directs selected blades to drop down and cut each board to length. A 16-ft. #1 common board that is knotty on only one end will fetch more at market if cut into an 8-ft. select and an 8-ft. #2 common.

Finally, the trimmed boards are sorted by a grader (10) who feeds them, according to grade, thickness and species, into different slots in the "slot machine" (11). Rollers between the slot

machine's fences carry the boards to different loading decks, where laborers stack and sticker them into packages ready for drying.

Periodically during the day, forklifts will move the finished packages to the drying kilns. There they will remain for up to 50 days, after which the dry lumber will be re-sorted for grade. Dried and graded lumber may be milled, warehoused for later sale, or loaded on trucks for shipment to wholesale buyers; most low-grade lumber is wholesaled green.

The path of a log through the mill is meant to be as efficient as possible, which is one reason the price of lumber hasn't risen over the past decade. The total elapsed time from debarker to slot machine is usually about three minutes—not much time, you'd think, for the sawyers to take much care in what they do.

Yet this, too, represents an efficiency—a human one, honed by generations of experience—found all along the line from forest to kiln.

—J.S.

The mill

1. Logs move on a chain conveyor to the debarker, which abrades the bark away.

3. Logs are fed onto a carriage where they are turned by the sawyer until the best first cut is lined up with the laser beam, then dogged down. A 16 ft. log will pass through the 150HP bandsaw in less than two seconds.

2. This second chain conveyor is a holding area that advances logs to the head-rig bandsaw.

5. This retractable conveyor normally covers the basement chute. If a slab contains usable lumber, it advances to position B, where it hits a brake-board that stops its forward motion. The conveyor rollers continue to turn, and the spiral roller-pattern worms the slab off onto a chain conveyor that takes it to the edging saw.

8. With slabs removed, the squared cant is braked at C, wormed off toward resaw bandsaw.

6. Slabs are edged by two movable sawblades on one arbor. Shadows cast by strings over the slab show the sawyer where the lines of cut will be. Edges go to chipper.

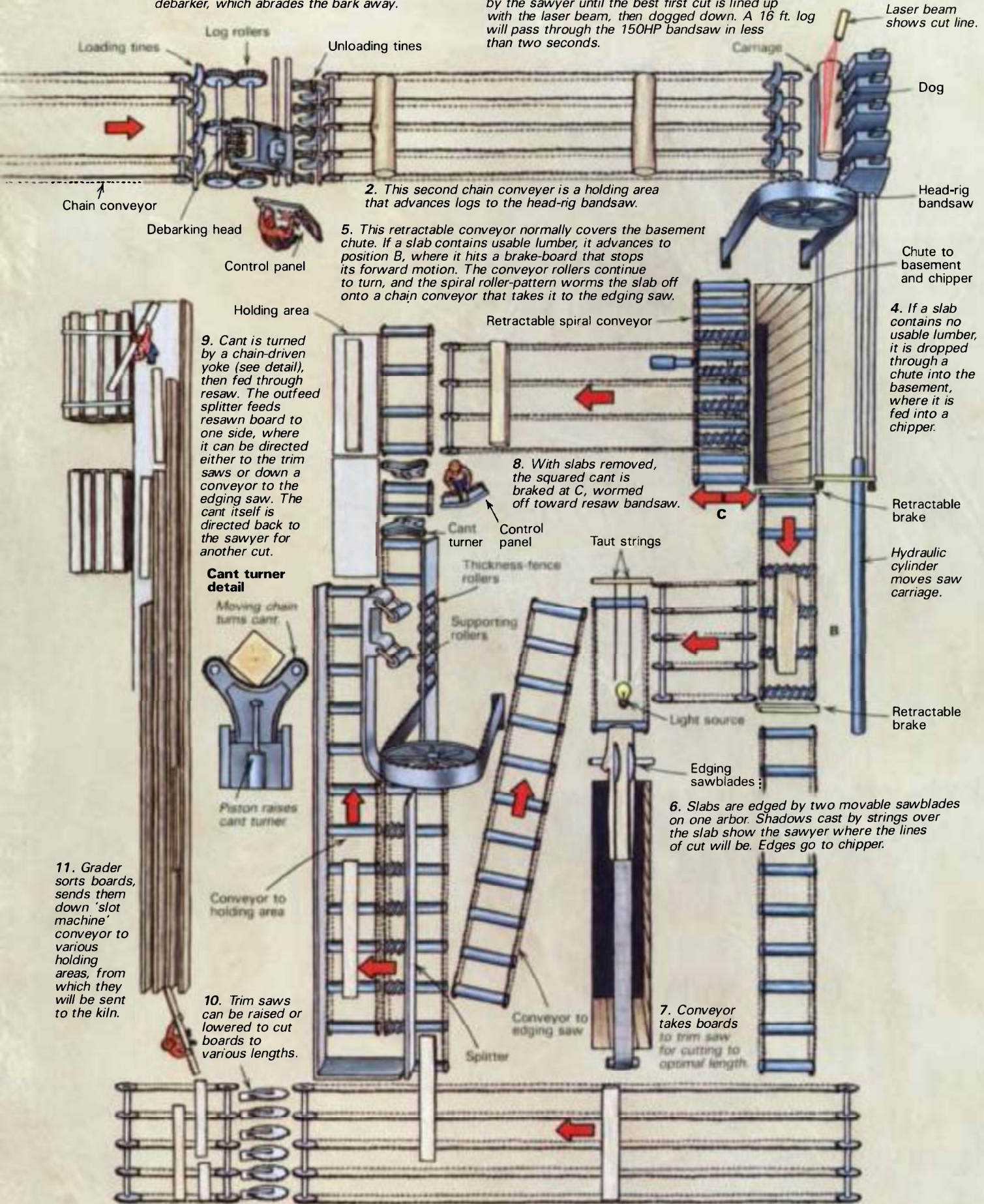
9. Cant is turned by a chain-driven yoke (see detail), then fed through resaw. The outfeed splitter feeds resawn board to one side, where it can be directed either to the trim saws or down a conveyor to the edging saw. The cant itself is directed back to the sawyer for another cut.

Cant turner detail



10. Trim saws can be raised or lowered to cut boards to various lengths.

11. Grader sorts boards, sends them down 'slot machine' conveyor to various holding areas, from which they will be sent to the kiln.





With a normal backlog of 30,000 logs on hand, high-power machinery, like this debarker, is necessary to keep things moving. Three minutes from now, this log will have been sawn into boards ready for grading.



The headsaw, a 150-HP bandsaw, can slice the length of a 16-ft. log in less than two seconds. Here the log is being manipulated for a second cut; the red line is a laser beam that shows the sawyer where the cut will be.



Squared-up logs, called cants, are sawn into boards on a bandsaw similar to the head rig shown above and on p. 40. Here the sawyer has just seen a defect in the cant, and is flipping it to a new, clean face for the next cut.

management programs. In Bahre's province, the state pays half to two-thirds of the owner's property tax in return for his agreement to manage his woodlot. That's when Bahre gets out his paint gun and starts marking trees for execution.

In a managed woodlot the aim is to make virtually all growth productive. Undesirable trees, or "culls," are removed and sold for firewood or pulpwood. If the remaining high-grade trees are still overcrowded, some will be removed and sold for pulp or, if big enough, timber. The hardwoods that remain will then receive their full share of sun and nutrients. The amount of wood fiber the stand will produce will be no greater than it was before managing, but its yield of cabinet-grade wood will often be doubled or tripled. Harvesting roughly 20% of the trees every 20 years, a rate that doesn't exceed the soil's ability to regenerate, can ensure a steady supply of prime lumber forevermore.

Lean times—All in all, the future of our managed forest lands looks bright. At the moment, however, loggers have to work harder for every dollar they make than at any time in the past. As independent logger Bob Slater says, "Considering the culls we have to take out and the small percentage of high-grade trees we're allowed to cut, the amount of clear lumber being trucked out of the average woodlot is a small proportion of the material removed." On most jobs Slater must cut two or three times as much firewood as sawlogs. Not that anyone's complaining. Good logs are so scarce today that loggers must get into the firewood business anyway, in order to cover the costs of moving their equipment onto a woodlot.

It wasn't always so tough to make a living logging, a job Bernie Badger retired from in 1970. In his more than 35 years in the woods, he figures he's cut at least 40 million feet of timber. His was a case of being in the right place at the right time—the trees were there, and he had the tools.

Badger saw his first chainsaw at a demonstration in Albany, Vermont, in 1950. With a 6-ft. blade and a 1-qt. oiler at the tip of the bar, the two-man machine weighed 109 lb.

Badger recalls: "My boss, William Blake, asked me what I thought of the saws, and I told him that they were bound to change everything and I wanted one, but I couldn't afford it. It cost \$800, which was a helluva lot of money in 1950. Mr. Blake said he'd buy one for us and take 50 cents per thousand log feet out of our pay. By the end of the year we had two saws bought and paid for. We started that year working two horses and ended it working five. The year before we had cut about 500,000 feet, that year we cut almost two million."

Moving the timber, though, was still a crude operation, because horses drew timber on sledges that needed snow to run on. That meant logging could only be a half-year job. By 1954, when Badger went to work for the Ward Lumber Co. of Stockbridge, Mass., that part of logging changed, too. The Ward Company replaced their horse teams with tractors.

"We'd cut brush and the tractors would pack it down to make what we called a 'beaver road' because it looked a lot like a beaver dam. With those roads, the tractors could haul logs out of the woods year-round."

Since Badger's day chainsaws have gotten smaller and tractors bigger, evolving into a machine built especially for moving logs: the skidder. Modern skidders weigh in at 6 to 12 tons and sport quarter-ton tires as big as 7 ft. in diameter. All four wheels are powered by a diesel engine, and the tractor's frame is articulated at its waist to enable it to maneuver in the woods.

In the mountains of New England, skidders are used in con-

junction with bulldozers. The latter machine is used to clear and grade an "archroad" or "dugroad" from the nearest road to the farthest end of the lot, often a distance of several miles. As each log is felled and trimmed, the 'dozer drags it from the woods to the archroad. There a skidder picks logs up in bunches with a multihooked cable, called a gang-hitch, and hauls them to the end of the road, where they are "decked," loosely stacked on a level clearing made for the purpose. There the logs are trimmed to length for the mill. Cutting strategies can make the difference between profit and loss at this point, and some considerations are shown in the figure at right. From the deck the logs are loaded into a truck with a built-in crane and are trucked off to the mill.

In most operations in the Northeast, all these jobs are performed by crews of just two or three people, who spend some of their time on the ground and some operating machinery. On an average day they will get out one truckload of 5,000 bd./ft. of sawlogs plus twice that in firewood and pulpwood. That's about 35 good trees and 100 bad. For the sawlogs, they may receive from \$20 per thousand bd./ft. (for hickory in a bad year) to \$500 (for oak in a good year). The firewood will go for about \$30 a cord, wholesaled in log lengths. Under the best conditions that's \$2,500 for saw timber plus maybe \$500 for firewood. When you subtract the \$1,500 stumpage fee paid the landowner, this leaves \$1,500 per 10-hour working day for three people. Sounds great, until you consider that it costs more than \$5,000 per month to run the equipment. (For openers, a skidder tire can cost \$1,000.)

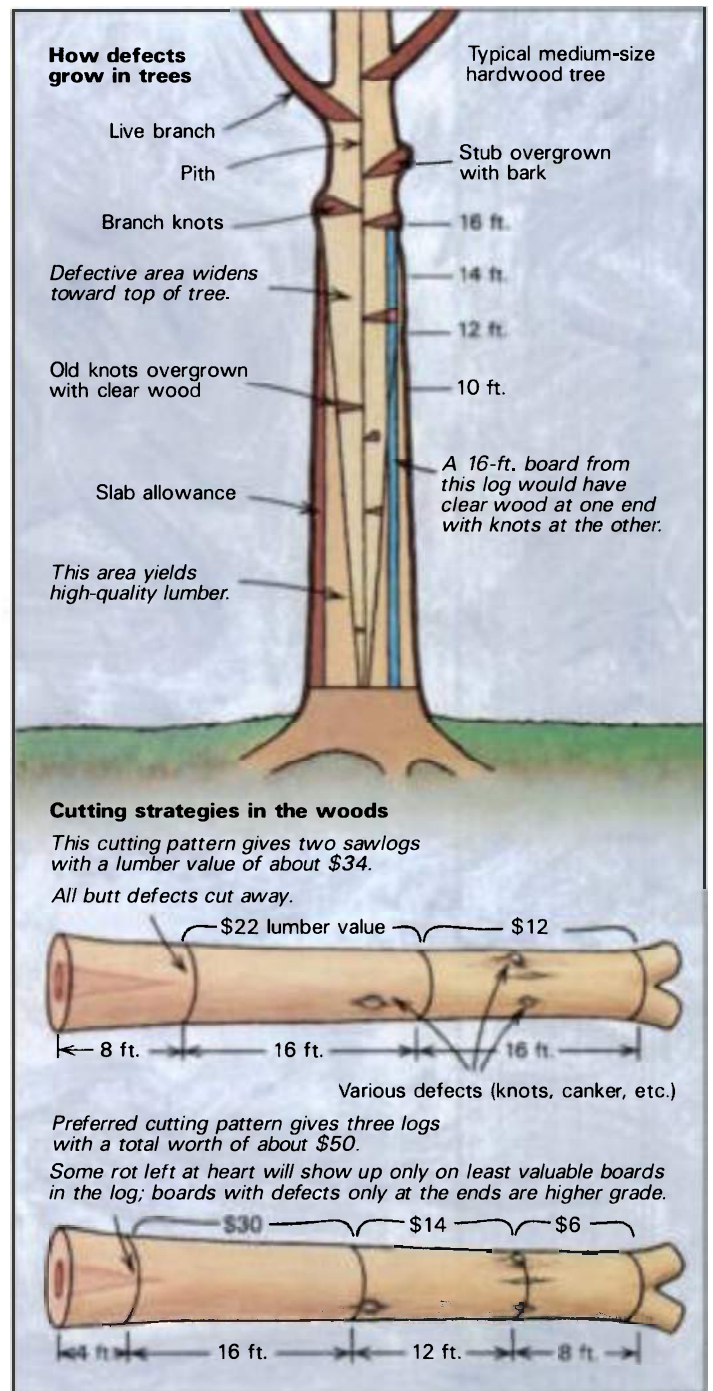
Then, of course, there's Mother Nature. On any logging site, the standard conversation opener is: "How are they opening up?" which means how much red rot, wind shake, blister rust, scale, insect damage, dozey-center, blight, stain, brush, etc., etc. are you finding hidden inside those nice-looking trees you paid good money for?

The next question is "How are they selling?" You can get \$2,500 for a load of oak only if the mill wants oak that badly. They're just as likely to not want it at all. "When I send out a load that I've scaled at 5,000 feet and the mill sends back a slip saying it was 600 to 700 feet less, they're telling me in very direct terms they'd rather not see any more oak," says Slater. Which is too bad, because he's already paid for the trees.

A sawmiller's tale—How can one person's measure of a log load differ from another's? "There are more methods of grading and scaling logs than there are logs in the state of Vermont," according to Phil Johnson, whose great-grandfather started the sawmill in 1906. When the demand for logs drops, things like catfaces (roundish distortions on the bark that indicate a knot inside) can make a marginal log unacceptable.

Slater and Johnson, by the way, are personally on the best of terms. Most loggers realize that the mill owner is in the same roulette game, and for much higher stakes. A competitor of Johnson's is a case in point. He bought a plot of standing oak when the oak market was running away three years ago, paying \$410 a thousand for 60 acres of 2-ft.-diameter trees on the stump, \$97,000 total. The selling price of milled oak lumber dropped too low to yield paying lumber before one tree was cut. The trees are still standing, and until he cuts them he'll not only pay interest on his money, but, according to his contract, he'll be charged for the accrued timber growth as well.

The story could have been sadder. The demand for other woods has dropped even more than for oak. Economic slow-downs are part of the cause, but Johnson believes competition from more efficient overseas companies is hurting U.S. wood



products far more. "About 10% of our lumber is exported, mostly to Japan and Hong Kong, but also to Italy, Germany, Denmark, Australia and Korea. During the big dock strike in the early '70s, the Japanese were so desperate for lumber they were flying it over in planes. They buy our best maple to make ceiling-fan blades and pool cues. Then they ship them back here."

Curiously, considering all the effort to get big, clear boards from a tree, most of Johnson's highest-grade lumber gets cut up into small bits. Items include parts for toy pianos, actions for real pianos (Steinway), golf tees, door harps, dollhouse siding, paintbrush and putty-knife handles (Red Devil), and parts for folding beach chairs. Some does find its way into furniture, mostly mass produced, and perhaps 15% is sold directly from Johnson's warehouse for local consumption. Of this, an increasing amount is going into architectural work. Cherry or elm flooring, solid oak

Buying retail from the mill

When buying anything, it's tempting to get as close to the source as possible, thus cutting out the middlemen. Buying lumber directly from a mill *can* save you money, but it's not quite the same as dealing with a retail lumberyard.

First, keep in mind that a yard that deals by the million board feet is doing you a favor selling you a pickup load, and no mill owner has time to haggle. But if you like the price, consider that what the mill has in stock can fluctuate radically. If you see wood you know you'll need later, buy it now.

If you buy lumber often, it's a good idea to pick up a grading handbook and learn the basics—if your project calls for lots of small parts, it's often cheaper to buy more of a lower grade and throw the defects away. (An introductory booklet on hardwood grades is available from the National Hardwood Lumber Association, P.O. Box 34518, Memphis, Tenn. 38184, for \$1.25 postpaid.)

Get price and availability quotes over the phone. Grade is grade, but color, figure, size, straightness and soundness can vary. Check to see if the mill will cut and plane lumber to order. Most won't. Sawmill boards are random-sized, so you'll need to buy about 30% extra to allow for overage.

If you want top-of-the-line, expect to pay extra for picking through the pile (and remember that some grades are one face only; flip each board and check the back). In my experience, it's better to buy lumber as it comes and get plenty of extra.

Don't be embarrassed if you don't know what you're looking at. Even pros get their species mixed when handling rough-sawn boards. Also, small mills may sell only green or air-dried lumber, but even with kiln-dried, there's no way you can tell how dry the wood is without a moisture meter. Even if you have one, the yard probably won't let you drive its prongs into their boards, so plan to buy a sample board to test. Many woodworkers play it safe by wintering their lumber on stickers in a heated room before using it. Take along a tarp to cover your truckload in case it rains.

If you find major hidden defects inside a board (such as honeycombing), don't work it any further. Take it back to the yard. Minor defects, on the other hand, are a matter of course. That's one reason to buy extra. —J.S.

paneling and pine siding can add inestimable charm to a building, and, bought directly from the yard, can be surprisingly inexpensive. Johnson's kiln-dried maple flooring, for example, sells for \$1.30 a foot, cherry for \$2.00.

Cabinetmakers also buy retail lumber from Johnson, who stocks maple, oak, cherry, ash, hickory, yellow birch, pine and other woods in a variety of thicknesses. Lately, hobbyists have begun to buy there, too, which Johnson encourages (see above), although this business barely takes a chip out of the mill's million-board-foot monthly production.

Coke bottles—The pace of a modern sawmill is astounding. The head-rig bandsaw at the Johnson mill can take a slab off a 16-ft. log in less than two seconds. A typical log's ride through the mill is diagrammed and explained in the box on p. 42. When all goes right, a log goes in one end and becomes boards, bark, chips and

sawdust in about three minutes. But sometimes things go wrong.

Trees have a habit of growing around man's debris: "We've seen sawn through Coke bottles, splitting wedges, chains, cables, and fence wire, but the thing we hit most often is sap spouts left by maple-syrup makers," laments Johnson. When that happens the blade must be removed and rolled into the sharpening room, where new teeth will be welded on in place of broken ones. Occasionally, all the teeth must be ground away entirely and new ones filed in, an all-day job.

Johnson can list lots of other things that can go wrong. "About ten years ago I was sawing a big ash log on the headsaw. Apparently the tree grew on the side of a hill, because when the blade had cut all but the last foot or so of the first cut, tension wood popped the log open and sent the slab flying. It took off the top of the control booth three inches above my knees."

These kinds of problems are difficult to prevent, but the unforeseen accounts for only a small portion of slowdown. Human error is the most frequent cause of accidents, and "while you can't prevent stupidity," as Johnson says, "you can guard against it. We've had people walk across toothed conveyor rollers while they were operating. A fellow lost half his foot that way here last year." Another man lost two fingers when he tried to clear a jammed planer without shutting down.

To prevent such accidents, Johnson's mill is installing such safeguards as deadman's pedals to automatically shut machinery down when the operator leaves his post. These changes are being made as part of a general overhaul to make the mill more efficient. Other changes include programmable electronics to set up the bandsaw and trim-saw cuts and direct material to different conveyors, and the installation of a faster "skrag" saw to rip the undersize cull logs that must be removed from managed lots. One change that has already shown substantial savings is the conversion of oil-fired drying kilns to bark-fired. This step has reduced oil consumption from over 25,000 gallons per month to less than 2,000 per year.

"We're probably at the end of an era here," says Johnson. "Mills are becoming more and more efficient. Already there are softwood mills on the West Coast where lumber is never touched by human hands."

Johnson's era has some time yet to run. While softwoods are usually gang-sawn indiscriminately into construction lumber, producing quality hardwood boards is still a one-on-one job. Woodworkers still need everybody down the line—forester, logger, sawyer—to ensure we get the boards we want.

The result of increased mill efficiency has been a virtual freeze in wholesale lumber prices over the last ten years, despite the fact that our nation's tree supply has been at its lowest ebb for the same period. In fact, if inflation is figured in, the wholesale price of lumber has been steadily dropping for a decade.

With over 400 million acres now under management, our forests should be making a comeback, so it's likely the news will get even better. That's encouraging, because forester Tom Bahre tells me that, without enforced management, trees would be made into pulp faster than the environment could replenish them. Personally, if this meant western man had to settle for plastic fan blades and golf tees, I wouldn't be too upset, but a polyvinyl Windsor doesn't much appeal to me. Besides, when it comes to trees, my sentiments match Bernie Badger's: "Lord, I hate to see 'em go." □

Jeremy Singley, who wrote about making chairs in FWW #46 and #50, lives in East Middlebury, Vt.