



Part 1: Measurement Methods

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Lumber size control is one of the more complex parts of any lumber quality control program. When properly carried out, lumber size control identifies problems in sawing-machine centers, sawing systems, or setworks systems. It is a key component of all good lumber quality control programs. In processing both large and small logs, lumber size control is an essential element in maximizing recovery.

Size control has two aspects: measurement and analysis. Analysis is discussed in OSU Extension publication EM 8731, *Lumber Size Control: Size Analysis Considerations*.

Lumber size is one part of the manufacturing process that can be quantified very well. Even though it requires time to take the measurements, given current technology, the benefits of size control far outweigh the cost of the time required.

The information obtained from a size control program is a powerful management and production control tool. As the mechanical condition of a sawing-machine center or sequential flow pattern becomes apparent in detail, maintenance priorities can be determined more easily. It is easier to attach dollar values to proposed machine improvements if management has size control information. Results of lumber size analysis are valuable for justifying new equipment and for setting specifications for that equipment when it is installed.

The goal of a size control program is to minimize the sum of kerf, sawing variation, and roughness. Also, the effect of minor changes in saw kerf or feed speed can be determined immediately. Developing an effective size control program requires hard work, understanding, and patience, but the payoffs are considerable. A mill manager who minimizes the amount of wood cut per saw line without losing grade recovery will maximize the dollar return. Companies that have implemented size control programs, and have reduced rough green sizes and kerfs as a result, have realized value increases from \$300,000 to \$1,000,000 per year depending on the amount of improvement and the mill's production level.

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Lumber measurement

Tools

The days of evaluating sawing accuracy with tape measures have faded into history. Most of today's modern sawing machine centers rely on digital networks where targets are set to thousandths of inches. Lumber measurement demands the same accuracy. In past years, sawmill personnel expressed sizes using the traditional English system of measurement; e.g., 1½ inches. Today, mill personnel express measurement in decimals; e.g., 1.5 inches.

Several tools can be used to measure lumber sizes accurately. Each is described below.

Dial calipers

Dial calipers once were considered exclusively a tool of machinists in machine shops. Times have changed. Modern sawmills have become "machine shops" for wood and so require appropriate tools.

To measure in decimals requires using dial or digital calipers. Figure 1 illustrates two different types. Diagram A shows a set of dial calipers with the "ears" filed off. Some quality control (QC) personnel prefer to grind off the sharp points ("ears") that are used primarily to measure inside dimensions and so are of limited use in measuring lumber. This diagram also shows the serrated rack on

top of the slide groove. A top rack tends to collect less sawdust than a bottom rack (Diagram B) and should stay in calibration longer. Diagram A also shows the dial indicator with 0.1 inch for each full rotation around the dial. In Diagram B, the dial shows 0.2 inch for each rotation. Sometimes the latter type of caliper is more confusing to read because there is a zero at top and bottom of the dial. Either will work perfectly well if personnel are properly trained.

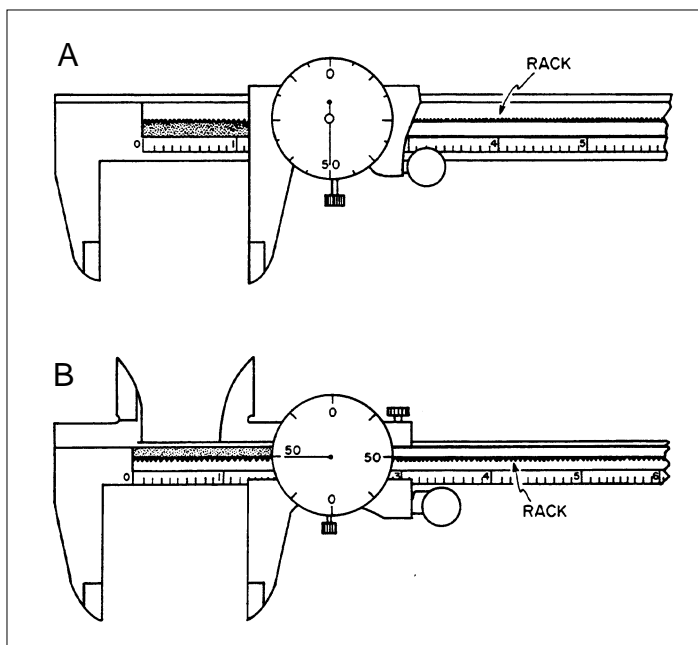


Figure 1.—Dial calipers.

Digital calipers

Digital calipers have become the preferred caliper for sizing lumber (Figure 2). It is easy to read sizes directly from the numeric display, and the calipers can display sizes in both

English and metric units. The greatest advantage of digital calipers is that they have a data port to output digital information to external devices. Several commercial lumber-size-control software programs use this feature to interface with their proprietary data-collection devices.



Figure 2.—Digital caliper.

Caliper care

Either caliper type should be considered a precision instrument and treated as such. Sawmills are hostile environments to many precision instruments. Sawdust and water can interfere with caliper operation. Keeping calipers clean and lubricated with a good water-resistant solvent or lubricant is important. To remain accurate, check calibration often. Refer to the manufacturer's manual for the proper procedure.

Caliper size

Most sawmills will want several sizes of caliper. The most commonly used is 8 inches, a size that compromises between portability and utility. For larger lumber, use a 12-inch caliper.

A person responsible for size checks routinely carries an 8-inch caliper in some type of protective holster and uses the 12-inch caliper as needed.

How to measure

The following technique measures lumber with greatest precision and applies to both dial and digital calipers. First, check the caliper with the jaws closed to make sure the display or dial reads zero. Next, open the calipers enough to bridge the distance being measured plus a little more. Squeeze the jaws of the caliper closed with your fingers using even pressure and a slight rocking motion to get a good “seat” of the caliper against the wood. As you do this, take a full bite of the caliper if measuring one edge, less than a full bite if measuring both edges' thicknesses. Angle the dial or display slightly away from you so you can read it easily. Figure 3 (page 4) illustrates this technique. It is very simple and easy to learn.

Measurement precision

Dial calipers can measure to one one-thousandth of an inch (0.001 inch). Digital calipers can measure to five ten-thousandths of an inch (0.0005 inch). It is important to realize, however, that these fractions describe only the resolution of the measuring device. Actual lumber measurements cannot be precise to that degree. A practical definition of precision is the ability to *repeatedly* measure something and get the same result. In that sense, it is impossible to measure a board to a precision of one ten-thousandth of an inch. How precisely *can* a QC technician measure lumber? That depends on the technique used, the roughness of the lumber, and the density of the wood.

I have conducted a measurement exercise in almost every quality-control workshop I have taught over the past 20-some years. I ask two participants to measure a board in four places, then to repeat the measurements. The results are very interesting. When measuring a dense species like southern pine, one person may be able to take measurements within 0.003 to 0.005 inch of each other in successive tries. On less dense species such as fir or spruce, most people's measurements vary between 0.005 and 0.009 inch on successive tries. When comparing the measurements made by two people, the variation usually is between 0.010 and 0.015 inch.

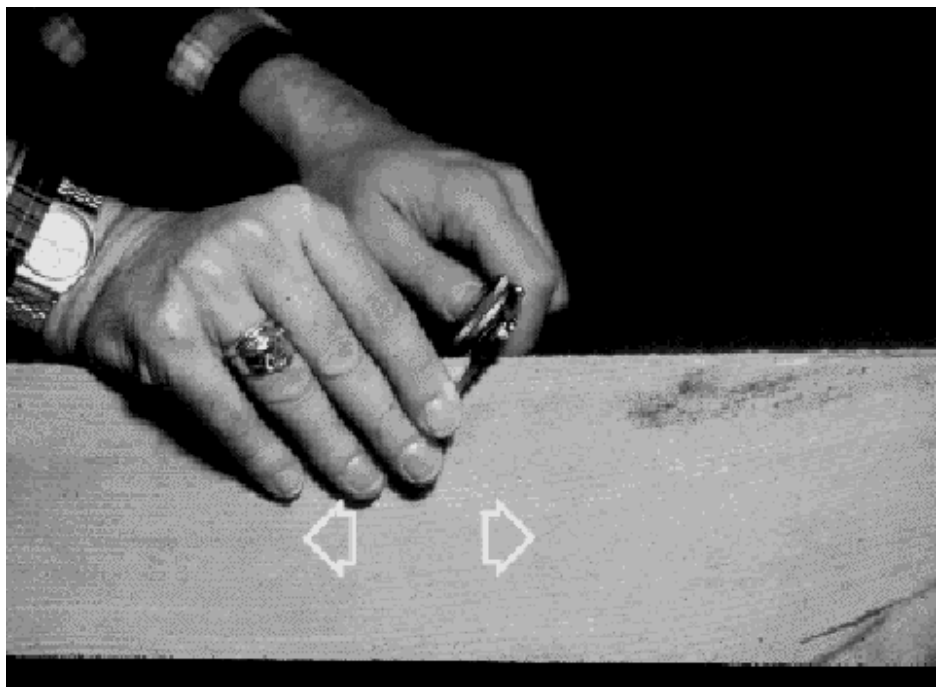


Figure 3.—Caliper being closed with hand for measuring.

If a mill is looking at raw data of individual size measurements and trying to evaluate machine center performance, small differences (i.e., 0.005 inch and less) are probably meaningless due to imprecision inherent in measurement.

What to measure

Because a great deal of time is spent measuring lumber, it is critical to obtain the most useful information. Some situations require that the lumber be measured more thoroughly than usual. These situations include developing a new baseline on sawing accuracy, certifying a new machine center, or troubleshooting a problem machine center. In general, measure only what is necessary to get the job done without sacrificing critical information.

How do you know what is critical and what is not? This depends on several factors: how many measurements you take on a board, at what points on the board you take them, and how many boards you measure. These factors will be discussed in this section.

Single-point versus multiple-point measuring

For quick size checks, measuring several boards at only one place on each board can give a “quick and dirty” sense of the size being cut and of any board-to-board size variation. This is a necessary and useful part of any size control program, but it should never substitute for the in-depth analysis that multiple-point measuring provides.

Multiple-point measuring allows a more thorough evaluation of how a sawing-machine center is performing, or of how several machines are performing if the material was created by more than one machine. Measuring multiple points along one edge of a board reveals variation in thickness or width down the length of the lumber, variations described as *end-to-end taper* (see Figure 4, page 6) or as *snake* (variation along one board face relative to the opposite face). Measuring multiple points along both edges can detect *edge-to-edge wedging*.

Measurement locations

Measurements need to be taken at a minimum of four points per edge on a board. If a machine center produces boards with little or no edge-to-edge wedging, then only one edge of the board needs to be measured to monitor thickness. If edge-to-edge wedging *is* a problem, then both top and bottom sides need to be measured.

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Machine center problems ...

usually show up at the ends of lumber; for example, in end taper and snipe.

In the early days of size control, this would have taken quite a lot of time. Today, with the widespread use of data logging devices, measurements can be taken five times as fast as by hand.

Four measurements along a 16-foot board give less information than four measurements on an 8-foot board. Using data logging devices, a QC technician can measure more than four places on an edge taking very little additional time. It is important to take those measurements at points that give maximum information about the machine center or sawing sequence. Some statisticians might argue that each measurement should be taken at a random location along the length. I don't agree. Machine center problems show up predominantly at the ends of lumber; for example, end taper and *snipe*, in which a short length of board near the end is cut too small. To detect manufacturing errors at the ends of lumber, I recommend that two of the measurements be taken within 6 inches of each end and that the remaining measurements be spaced about equally between the first two, as shown in Figure 5.

Notice the labels "lead" and "trail" in Figure 5. *Lead* is the end of the board that enters and exits the machine center first; *trail* is the opposite end. It is vital to keep these orientations as the QC technician measures the lumber and to note them correctly if data are being recorded manually.

Sample sizes

No discussion of size control is complete without addressing how many boards to measure from a machine center. That question has been debated as long as lumber has been measured. Several aspects relating to statistical accuracy and levels of confidence are beyond the scope of this publication. Whatever the sample size,

it must be a practical compromise.

One of the greatest strengths of statistical analysis is the ability to sample small numbers of items being produced by a machine and make useful predictions about *all* the items coming from the machine. In most cases of lumber manufacturing, the number of boards measured at any one time usually is not enough to

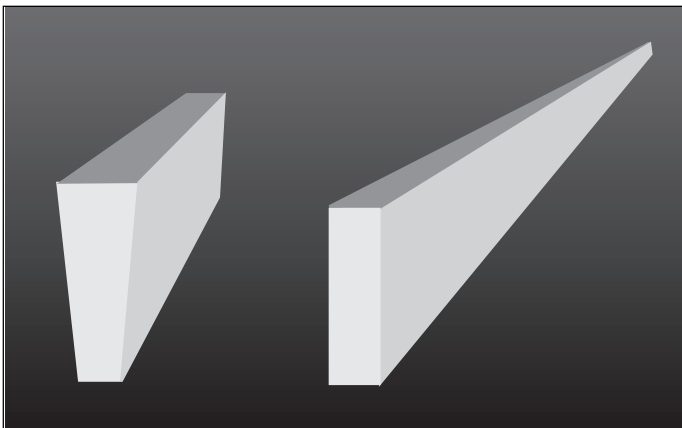


Figure 4.—Edge-to-edge wedging (at left) and end-to-end taper.

accurately predict overall sawing performance. Depending on sawing accuracy, 50 to 150 boards might have to be measured to meet statistical requirements for predicting sawing accuracy. Obviously, this is not practical for most sawmills that measure manually.

Sawmills need practical QC programs that produce useful results; therefore, we sacrifice some statistical accuracy to assure that a size control program will be effective over the long term. Requiring mills to measure the number of boards needed for true “statistical accuracy” would doom virtually all size control programs. Risking the long-term viability of a size control program for the sole purpose of assuring true statistical accuracy is out of the question. Besides, many mill managers have increased revenues anywhere from \$500,000 up to \$1,000,000 a year because of a size control program that uses small samples.

So, how many boards should you measure from a machine center at any given time? That depends on whether you are beginning a size analysis program for a particular machine center or you are monitoring an ongoing program.

If you are beginning to collect size information on a new or recently modified machine center, measure 100 to 200 boards to get a good baseline. If you are monitoring a machine that has not undergone major changes, measure a minimum of 10 boards at any one time. Obviously, the more boards measured, the more statistically accurate the overall picture.

An important development in size control is the creation of computerized size control programs. These programs are analytical tools and sophisticated databases that track sawing data over time. They can combine a mill’s data samples taken on a given shift or day into larger data sets representing a week or more. These larger sample sizes give a truer statistical view of how the machine center is sawing over time.

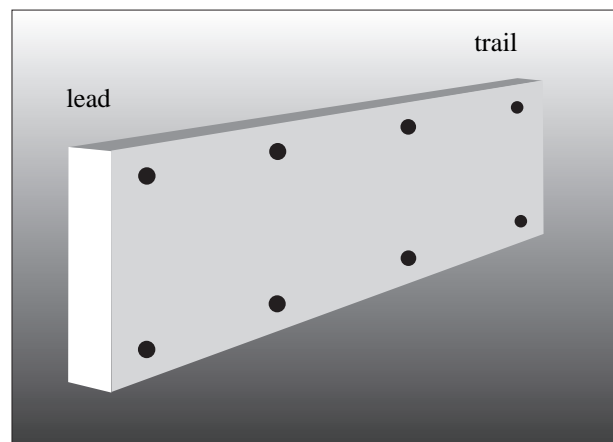


Figure 5.—Measurement locations on a board.

Many mill managers...
 have increased revenues by \$500,000 to \$1,000,000 a year with size control programs that use small samples.

The data sheet

Mills that use automatic data-logging devices attached to calipers do not need to construct data collection sheets but do need to be systematic and consistent in collecting data. Size data usually are downloaded to a stand-alone size control program or can be printed out directly. In either case, the data can be printed out in data sheet format.

Mills that manually enter caliper data on data sheets must include some important elements on each data sheet (Figure 6). Elements that any data sheet must include are: date, shift, and time the measurements were taken; who took the measurements; identification of the machine center and sawline; nominal size of lumber; data for each measurement on the board; and identification of entering and exiting edges and of leading and trailing ends.

Sample data sheet

Machine center: Rotary gang
 Date: 06/06/00
 Shift: Day
 Time: 9:45 a.m.

Species: pine
 Sawline: 2
 Size: 1.700
 Recorded by: TDB

| | Lead | Measurements | | Trail | |
|---------|-------|--------------|-------|-------|------------------|
| Board # | 1 | 2 | 3 | 4 | Comments |
| 1 | 1.682 | 1.716 | 1.708 | 1.709 | |
| 2 | 1.716 | 1.721 | 1.707 | 1.710 | |
| 3 | 1.700 | 1.688 | 1.702 | 1.690 | |
| 4 | 1.702 | 1.692 | 1.688 | 1.698 | |
| 5 | 1.695 | 1.702 | 1.696 | 1.699 | |
| 6 | 1.697 | 1.712 | 1.718 | 1.705 | |
| 7 | 1.701 | 1.706 | 1.692 | 1.696 | |
| 8 | 1.689 | 1.714 | 1.710 | 1.695 | |
| 9 | 1.685 | 1.696 | 1.705 | 1.715 | End-to-end taper |
| 10 | 1.703 | 1.709 | 1.712 | 1.781 | End-to-end taper |

Figure 6.—Lumber size-control data sheet.

When to measure lumber

A mill measures lumber for several different purposes. One is to test new equipment. Typically, whenever new saws are installed on machine centers, several boards should be measured to see whether sizing is on target. Allow a few boards to go through before choosing boards to measure so that the saw comes up to normal operating temperature and any filing burs are worn off the teeth.

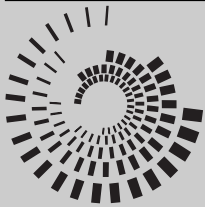
Another reason to measure is as part of a mill's size control monitoring program. A QC technician routinely takes measurements at each machine center during every shift, usually selecting 10 or more boards per machine center. It's best if the QC technicians vary the sampling times day to day among the various machine centers. That will give a representative sample of how each machine is performing throughout the shift.

The third reason to measure is to respond to what could be a sawing problem. It is best to check the lumber as soon as the QC technician, production supervisor, or operator sees a problem; don't wait for a saw change or for the routine size checks.

Summary

This publication has focused on taking the measurements needed to run a lumber size control program. None of the steps is difficult, but they must be carried out in a consistent and systematic manner by all personnel involved to ensure that the data and subsequent analysis have meaning.

The next publication in this series, EM 8731, *Lumber Size Control: Size Analysis Considerations*, discusses how to work with data collected by measuring lumber. That discussion includes the components of target size, sawing variation, standard deviation, critical size, and the mathematical calculations used to determine the components of sawing accuracy.



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