# Structural Lumber Grading 101

## Introduction to the Basics

**The "Why" and "How" relating to nominal thicknesses of 2" lumber**

June 2021 by Lon Sibert, President of RRA

**“When you change the way you look at things,**

**the things you look at change.”**

**Author: Dr. Wayne Dyer**

# How do we go from conifer trees in a forest ……

# ….. to structural lumber suitable for wood-frame construction?

The limited time available today only allows for a "teaser" orientation on the subject of **structural lumber features**. We do **NOT** have the time to review:

1. Details about the ALSC system of accredited grading agencies (American Lumber Standard Committee) & how it all ties to the Voluntary Product Standard PS-20.
2. How **RRA** fits into the ALSC framework;
3. Details about lumber design values, how lumber properties are determined and what the properties mean.
4. Non-structural features, such as knot quality, wane, skip, warp, pitch pockets, stains, checks, etc.
5. Appearance grades of 1" thick boards, "Factory" or "Shop" Lumber, Decking grades (5/4 x 6 RED), & Timber grades ( ≥ 5" thickness).

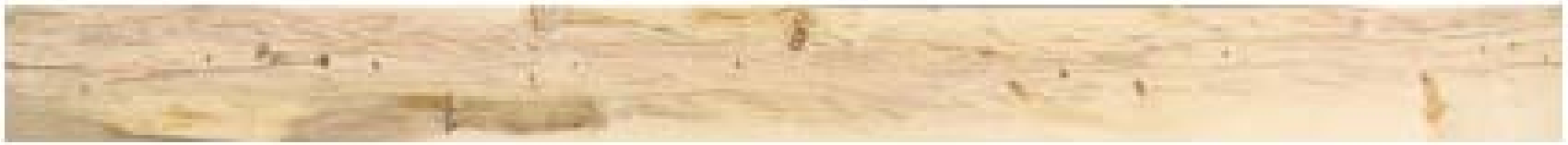
# Six ALSC Accredited Lumber Grades Rules - November 2018


Although the grading rules differ on the grading of “Boards” (1” thickness) & “Timber” (5” + thickness), all six sets of grading rules carry, word-for-word, the “National Grading Rule for Dimension Lumber” developed by the National Grading Rule Committee, of which all such agencies are members along with other representatives of the industry.

## *DISTINCT* from the grading of "Boards" of 1" nominal thickness, which are graded for APPEARANCE from a "Face" & a "Reverse":

Select or Finish Grades

2 Common or No. 2 Board Grades



3 Common or No. 3 Board Grades

# The Basic and Key Concept in the grading of Structural Lumber is the DISPLACEMENT of wood fiber by knots in any CROSS-SECTION.

- The "Cross Section" is any three-dimensional section.
- We have to contemplate the analogy of a "chain is as strong as its weakest link" (or cross-section).
- One can imagine a Cross Section as a potential weak link in an otherwise strong chain of wood fibers.

## Engineering Design Values are assigned to the different grades of lumber:

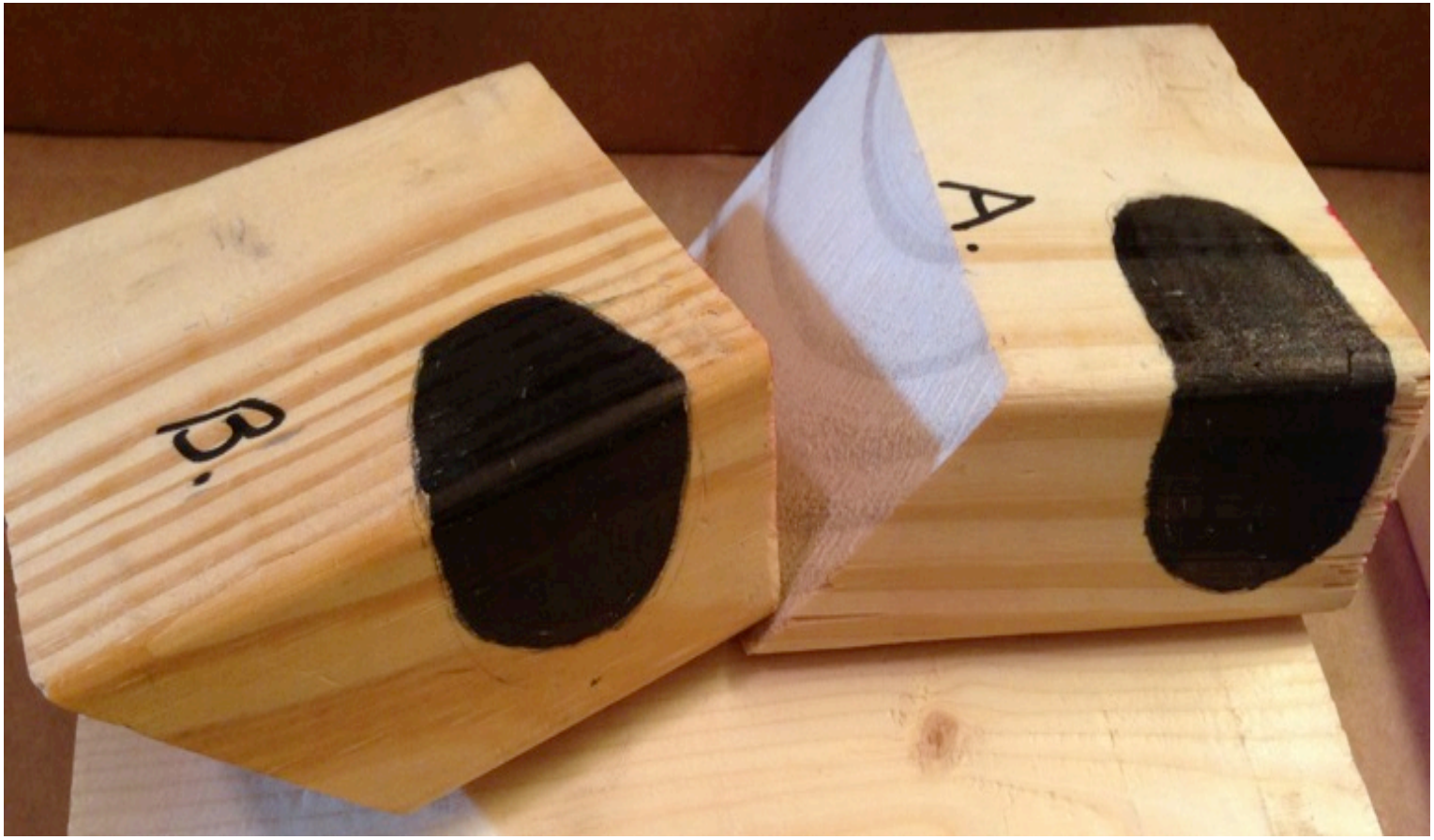
- To permit the safe and efficient use of lumber.
- Therefore, different grades & species of lumber can resist different loads.

A important precedent is the following table of *relative* "bending strength ratios" for structural lumber, in comparison to a piece of lumber free of characteristics.

## Grades of Structural Lumber

| | |
|---|---|
| Select Structural: | 65% |
| No. 1: | 55% |
| No. 2: | 45% √ |
| No. 3: | 26% √ |
| Stud: | 26% |

# OK, which knot is “larger”?




**Knot "A" appears larger by its superficial extension on the piece of lumber, but**

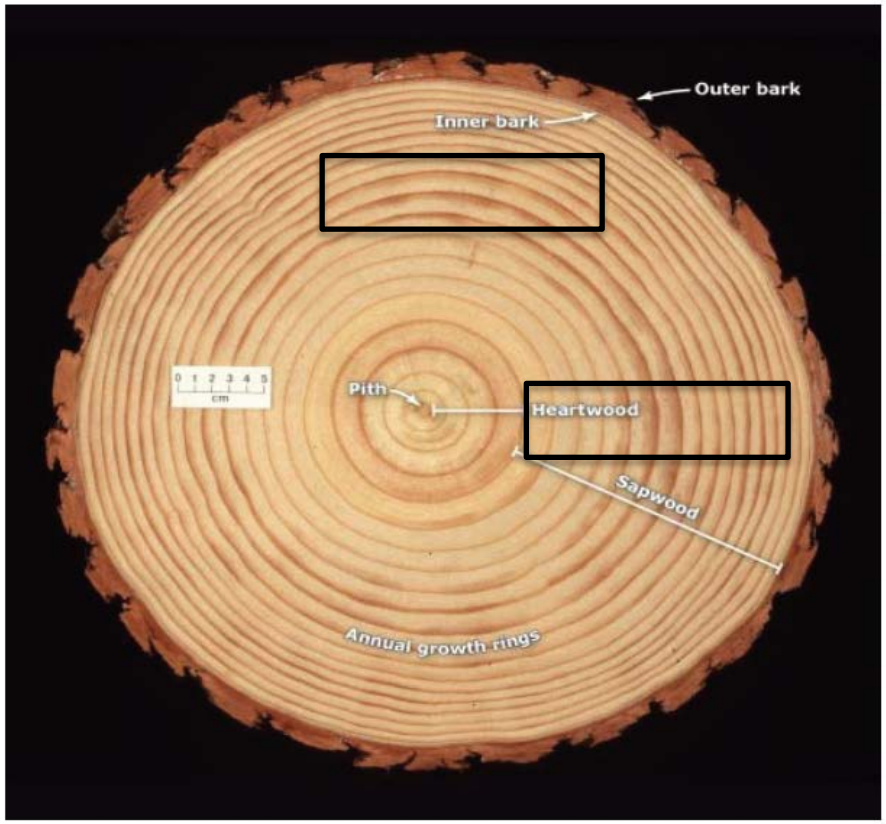
**Knot "B" actually DISPLACES more wood fiber. Therefore, *Knot "B " is larger*.**

**To make the determination, you have to know where the PITH of the tree is in relation to the *Cross-Section* of lumber being judged.**

**The "Pith" is the tree-center.**

Photo Credit : Geoffrey Cottenceau

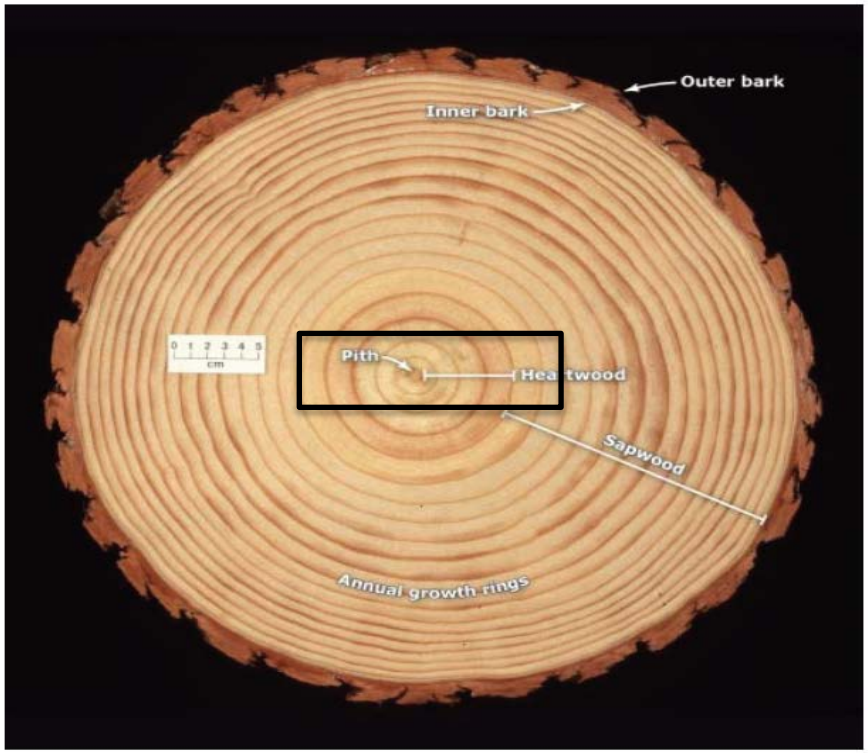
Cross-section of a pine log




**What are we seeing here, in terms of the "Annual Rings" and "Wood Fiber"?**

**Consider the "Displacement" of a 1" knot coming from the pith.**

## Cross-section of a pine log



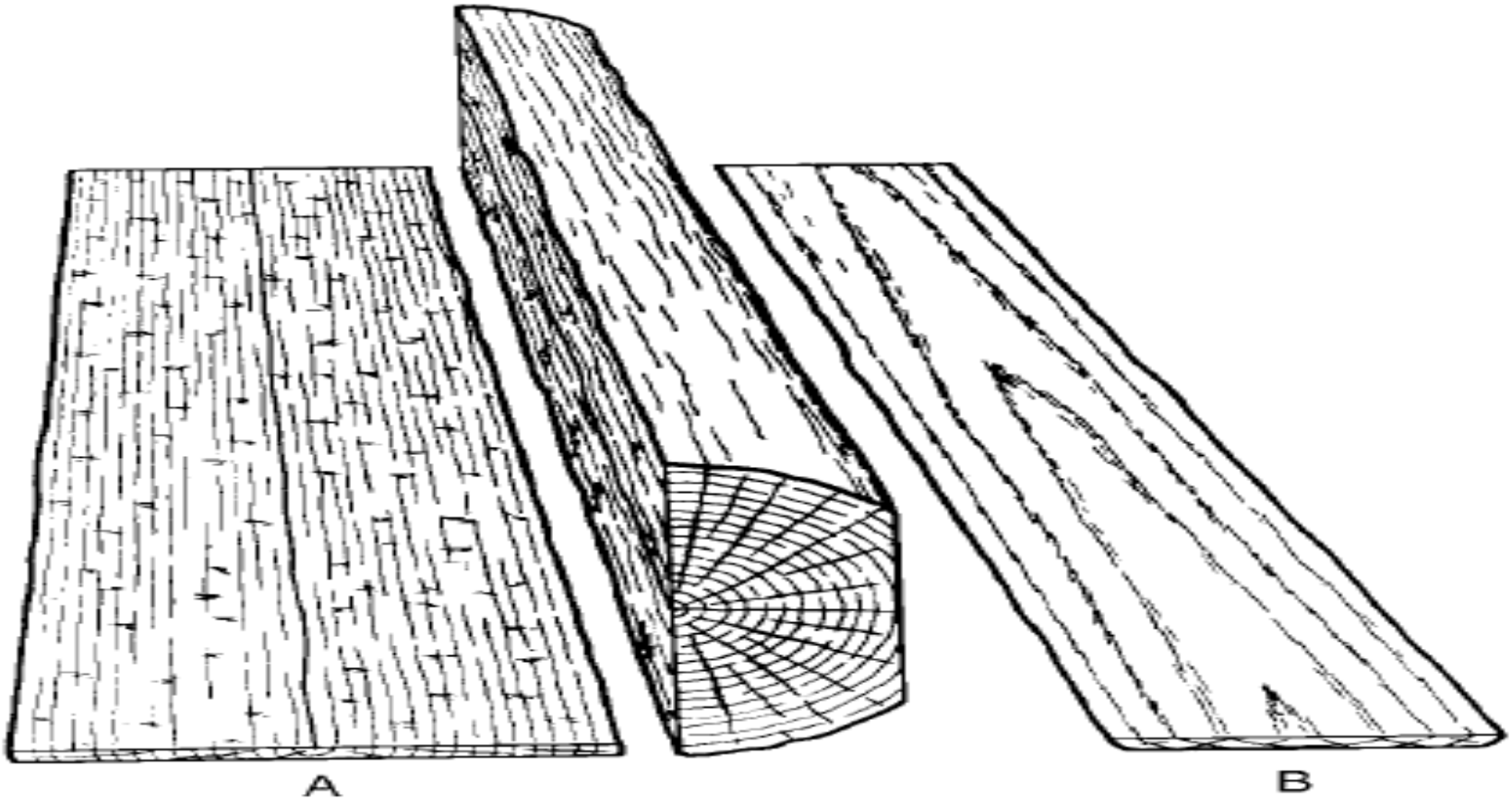
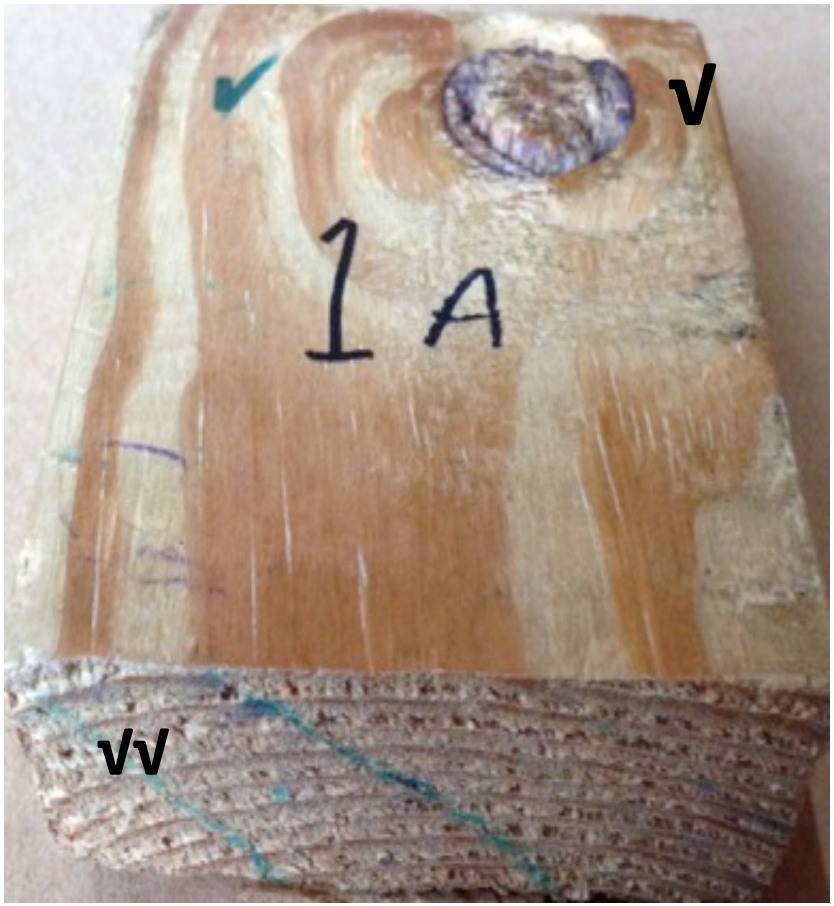


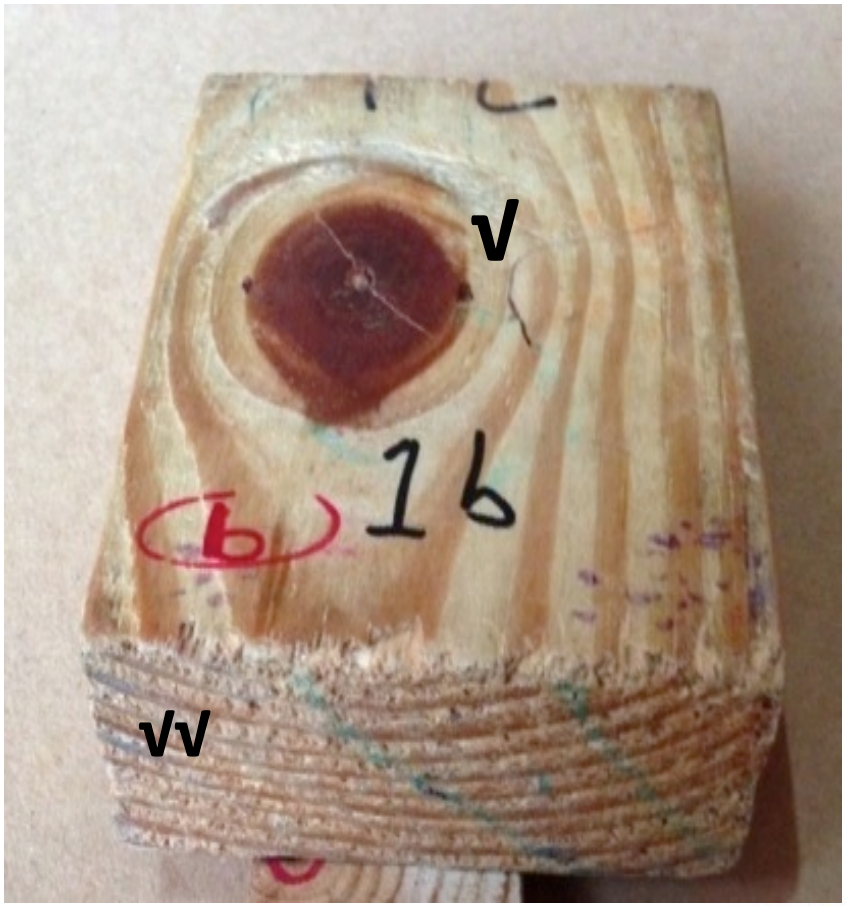

**Figure 3–14. Quartersawn (A) and plainsawn (B) boards cut from a log.**

US Forest Products Lab “Wood Handbook”, Page 3-15

**Note the importance of being able to "read" a piece of lumber by the its grain pattern or figure.**

**Examples of "Round Knots" or "Oval Knots" in pieces of lumber sawn <u>from the outside section</u> of a log, with a "Tangential Cut" sawing pattern.**



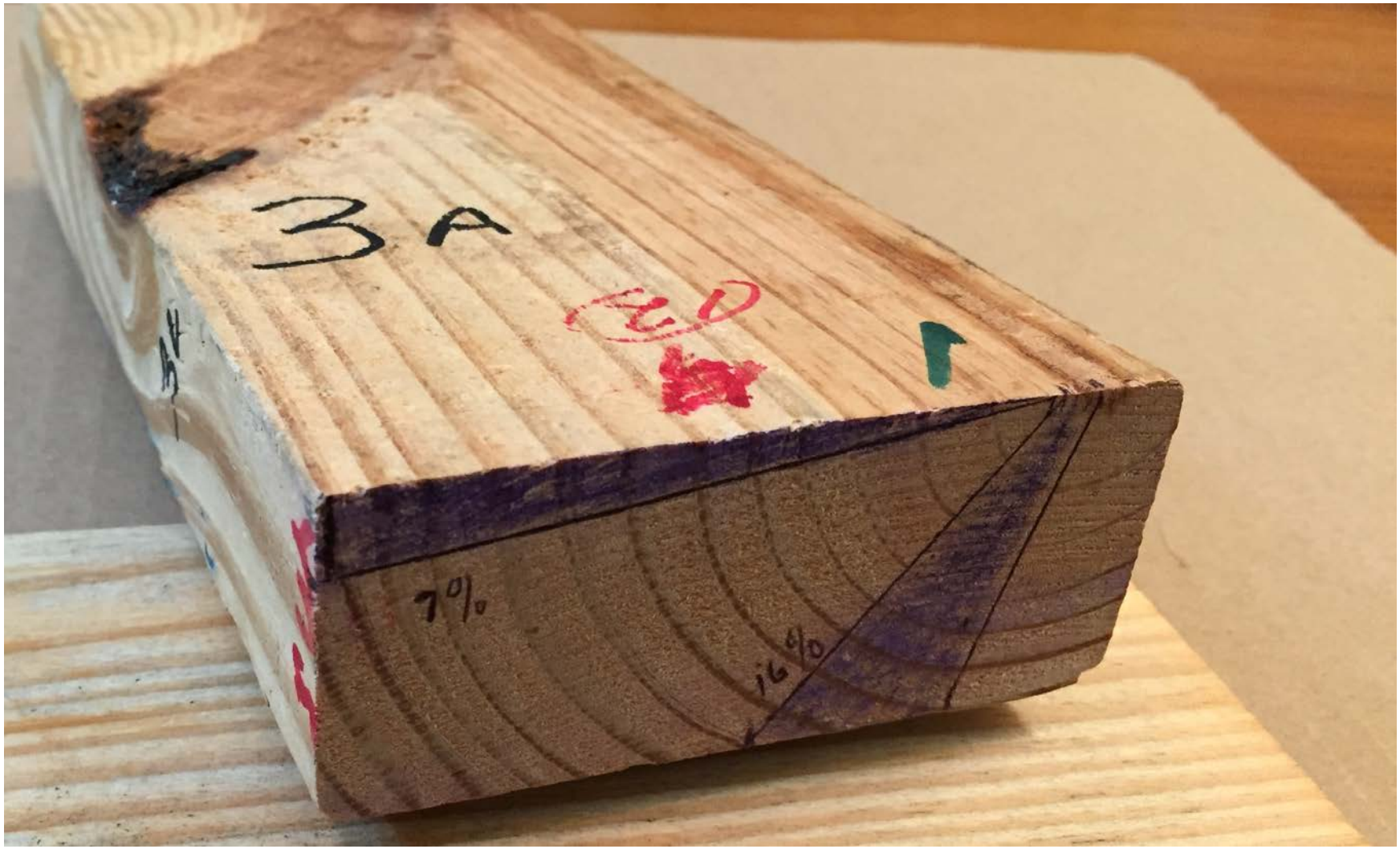



# Examples of “Spike Knots” in lumber showing a “Vertical” or “Radial” Grain pattern.



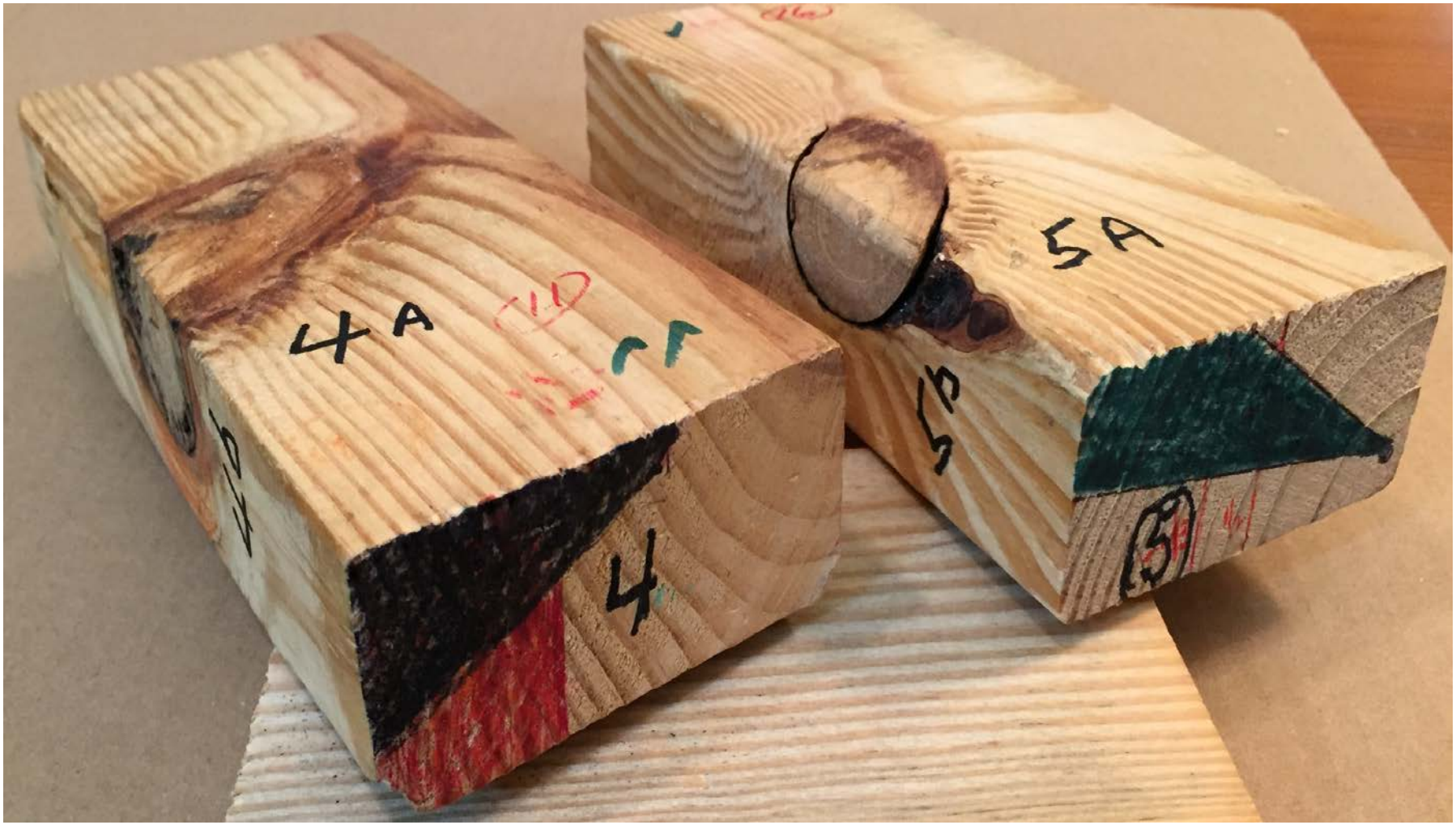
**Note the evolution of the knot, from a “live-red” knot to a “dead knot” & later to a “decayed knot”.**

# An example of a “shallow knot” in a Cross Section of wood with a “Radial” or ”Vertical” grain” pattern.



# OK, which knot is “larger” in this “real” example?

# From this perspective, which knot is larger?



**OK. You now have an appreciation for the subject of *KNOT DISPLACEMENT* and the projection of knots to (or from) the pith.**

**The obvious next question is: How do we determine the *location of the pith* in the multitude of cross sections along the length of a piece of lumber???**

***As human beings, we lumber graders do not have X-RAY VISION!***

# A lumber grader “reads” the grain or “figure” of a piece of lumber to determine the actual or relative position of the pith:

From Left to Right: Flat Grain (tangential) – Vertical Grain (radial) – Flat Grain

Note the “arrow” patterns on the Flat Grain cuts.

Let's apply that concept, of being able to "read" the grain pattern of a piece of lumber. Let's open a piece of wood that shows a "narrow face knot" going to (coming from) the pith about 3/4 of the way across the width & at the midpoint of the thickness. Note the "vertical grain" section. Note the section with the "arrow pattern". We are looking at a #3 grade of structural lumber.


## Consider this example of “Knot Displacement”:
## The knot laps a wide face and narrow face & goes to a pith on the opposite corner of the piece. It displaces a lot of wood fiber.

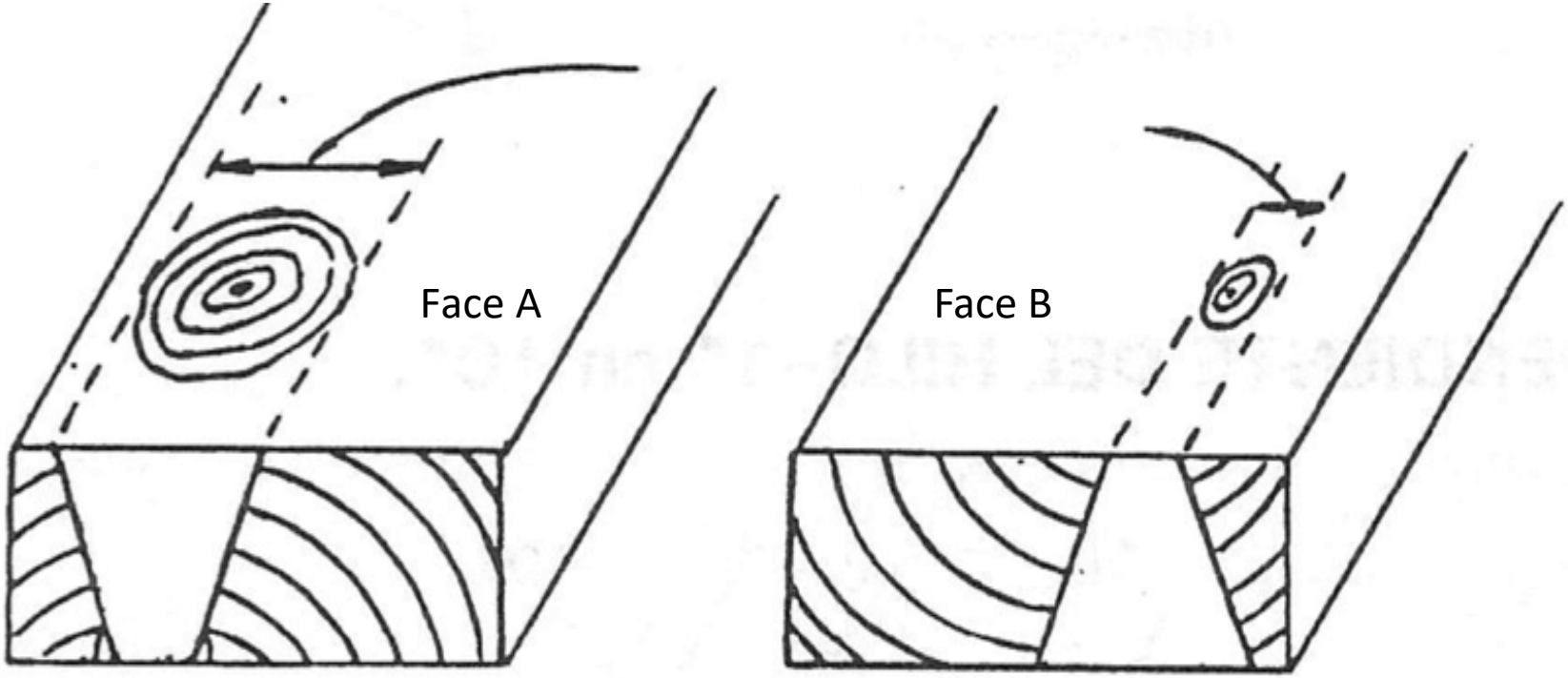

# Examples of two cross sections of two pieces of 2 x 10, showing two ugly knots in the superior piece and one not-so-ugly-knot occupying part of the face and edge in the lower piece.

Before cutting through the knots


# The same two pieces of 2 x 10 after having cut through the knots in the respective cross sections:


# Important Subject: How to measure a knot that shows on opposite wide faces in pieces of lumber without the pith.

Example: Knot on Face “A” of an example “2x4” (with net dimensions of 1 1/2” x 3 1/2”) measures 1 1/2” between lines parallel with the edges, and 1/2” on Face “B”.
The **knot size** – averaging both wide faces – is **1**” or about **28%** of the cross-sectional displacement of the displayed 2x4.



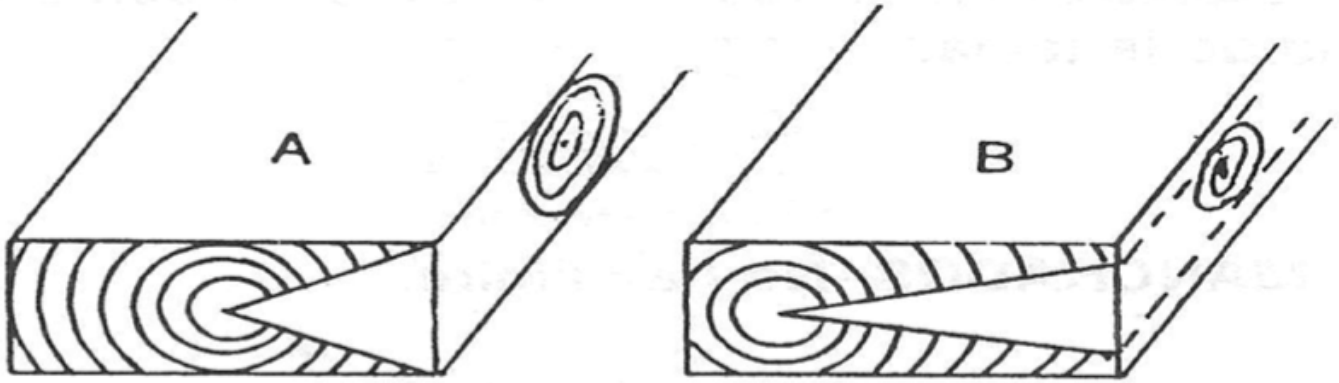

From the SPIB “Graders Manual for Boards & 2”Dimension

# Important Subject:
# How to measure "Spike Knots"?

**Spike knots are measured on the basis of "Equivalent Displacement"**

**to the stated maximum allowable "Edge-of-Wide-Face Knots", which translates roughly to about 1/4, 1/3 and 1/2 of the cross section, for the respective grades of #1, #2 and #3.**

As an example, the displacement of Knot A and Knot B, below, are both 25% of the subject cross-section, qualifying both pieces for the grade of No. 1.



# The National Grading Rule for Dimension Lumber ("NGR"):
# Theory – Examples of Knots in the Grade #2:
# "Edge of Wide Face Knots", or Knots that occupy the majority of the Narrow Face.

**Compare to #1 & #3 grades, using 2x4 as an example.**
**Similar concepts apply to other widths.**

# The National Grading Rule for Dimension Lumber ("NGR"): Theory – Examples of Knots in the Grade #2: Knots located in the Center of the Wide Face and/or Combinations of Knots in the same Cross Section.

In the case of #2 grade, individual knots located in the center of the wide face, or any combination of knots in the same cross-section, are limited to between about 42% & 57% of the Cross-Section, depending on the net width of the surfaced lumber.

**The grade rule takes into consideration Tension versus Compression forces relative to "Edge Knots" and "Centerline Knots".**

**Compare to #1 & #3 grades, using 2x4 as an example.**
**Similar concepts apply to other widths.**

# The National Grading Rule for Dimension Lumber ("NGR"): Theory – Examples of Knots in the Grade #3: "Edge of Wide Face Knots", or Knots that occupy the majority of the Narrow Face.

**Compare to #1 & #2 grades, using 2x4 as an example.**
**Similar concepts apply to other widths.**

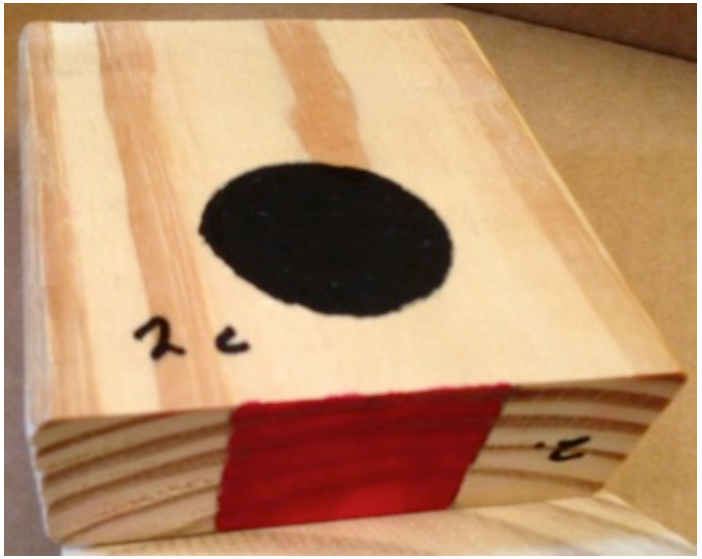
# The National Grading Rule for Dimension Lumber ("NGR"): Theory – Examples of Knots in the Grade #3: Knots located in the Center of the Wide Face and/or Combinations of Knots in the same Cross Section.

**In the case of #3 grade, individual knots located in the center of the wide face, or any combination of knots in the same cross-section, are limited to between about 57% & 71% of the Cross-Section, depending on the net width of the surfaced lumber.**

**The grade rule takes into consideration Tension versus Compression forces relative to "Edge Knots" and "Centerline Knots".**

**Compare to #1 & #2 grades, using 2x4 as an example.**
**Similar concepts apply to other widths.**

# How to measure round and oval knots:



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# The art of lumber grading: How to measure spike knots and knots going to a pith located within the cross section, including combinations of both in the same cross section:

# Other natural characteristics that affect the strength of lumber. Consider the *family known as* "*Slope of Grain*" - with characteristics that occur without and with knots.




Cross Grain

►► Abnormal Grain Around Knots



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## “DENSITY”

## “Natural Breaks” & “Processing Breaks”




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# Examples of "Compression Wood"


# Examples of Compression Wood

# Other natural characteristics that affect the resistance of lumber: Examples of "Decayed Wood" - Heart-Center Decay


# Examples of "Decayed Wood" in Canadian Spruce Bug-Killed Timber

# Example "Decayed Wood" in Canadian Spruce



# Examples of "Decayed Wood" Known as "Honeycomb" in Canadian SPF

# Other examples of "Decayed Wood" developing from "green lumber" and package or pile rot:



**PLEASE,**
**Do not assume that you can simply read the grade rules & attempt to apply them!**

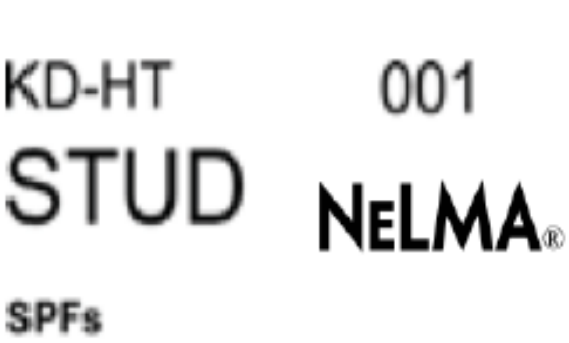
**The training of graders takes time and a rigorous process.**

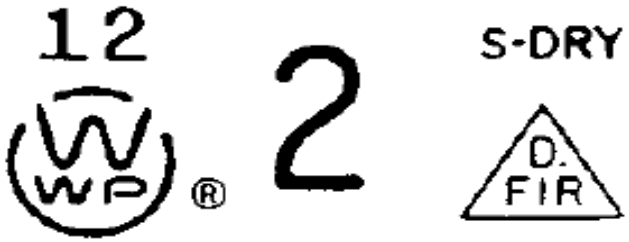
The graders have to take into account many characteristics and imperfections to be able to assure that the buyer would receive the desired grade &/or the grade marked by a stamp recognized by the ALSC.

**The task of grading requires training, supervision, experience and systems of control & auditing.**

# Examples of ALSC-recognized USA Gradestamps:




Date - Nov 2019

***Consider the value and merit of the ALSC system of continuous audits!!***

- Approximately 910 sawmills and/or lumber manufacturing plants in the USA & Canada.
- Approximately 98% of the coniferous wood used in the USA.

# I trust that you will now look at lumber differently!

When you change the way you look at things, the things you look at change.

**Author: Dr. Wayne Dyer**