Machining Quality Control Checklist
Quality Controller

Aim of Quality Assurance Program

1. Establishing limits on process factors that will ensure acceptable product
2. Monitoring production processes and product quality
3. Detecting unacceptable product, determining the cause, and correcting the problem

Important: the best adhesive, varnish, or lacquer cannot compensate for poor machining

When quality control should be done?

- At start-up or at the beginning of a working shift
- Every time there is a change of product, size, or quality
- Every time there is a change of machining parameters
- On a regular basis when batch size is important (frequency recommended: every 1 hour)

Procedure

✓ Validate machining parameters with machine operator based on product requirements or as recommended by the tooling manufacturer

✓ Check sharpness of cutting tools

- Dull cutting edges of planer or jointer knives crush and burnish the wood surface affecting the mechanical properties when gluing boards together
- Blunt tool produces low quality and requires high cutting energy

✓ Measure moisture content of wood boards with a calibrated moisture metre

- Only use seasoned material kiln-dried properly to 10-12% moisture content

✓ Measure chip thickness across the width with a digital calliper by comparing board thickness before and after planning (Minimum recommended sampling: 5 boards, 3 measures per board)

- Recommended chip thickness for finishing cuts: 2 mm OR LESS
- Thickness accuracy of a board should be within 0.1 mm
- If the thickness isn't the same at both edges, the knives are not parallel to the table
- If the planer cuts a deep snipe at the beginning or end of a board, either the bed rollers aren't properly set or the feed roller pressure is not adjusted correctly

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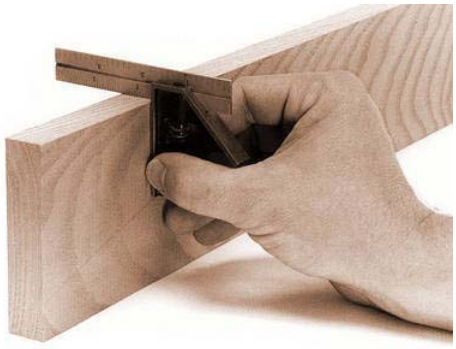
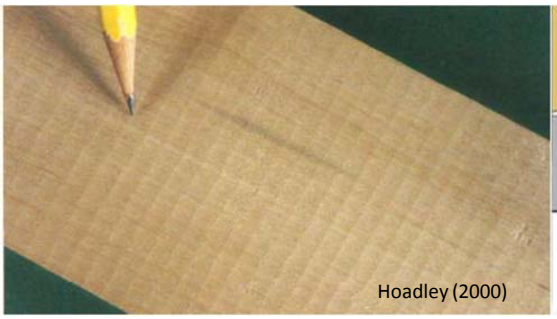
Surface assessment quality control procedure (when machine planing)

- ✓ Select randomly 30 boards as they emerge from the machine
- ✓ Mark the ends of each board in a manner that it indicates the direction of feed and the side that has just been machined
- ✓ Check squareness of finished boards

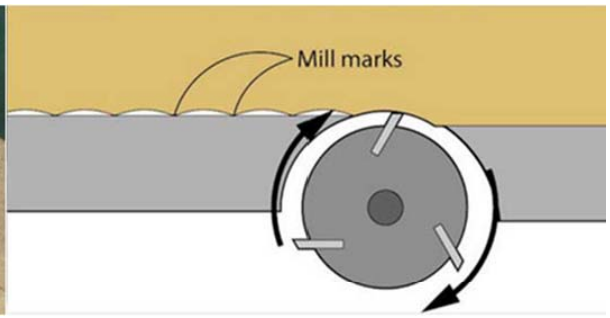


  - ➢ Uniform thickness is necessary for gluing. Flatness is required to allow surfaces to be brought into close proximity

- ✓ Check the surface of produced boards by counting the number of knife marks per 2.54 cm and adjust feed rates and cutter-head speeds if necessary



Hoadley (2000)



  - ➢ Best surface for finish lumber is produced with 12 to 25 knife marks per 2.54 cm
  - ➢ More than 30 marks and/or extremely slow feed rate will cause frictional heat producing glazed surface and boards not acceptable for gluing
  - ➢ Fewer than 12 will give an irregular or chipped surface and low quality

- ✓ Visually examine side just machined of each board carefully for planning defects
- ✓ Check presence of burnishes on wood surface

  - ➢ When subjected to high temperatures during processing, oily extractives migrate to the surface affecting quality of finishing systems and/or gluing

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- ✓ Grade any planning defect that may be present according to degree and record on quality control form

- ✓ Classify the planning characteristics of each specimen by visual examination on the basis of five grades or groups as follows: Grade 1, excellent; Grade 2, good; Grade 3, fair; Grade 4, poor; Grade 5, very poor.

Grading system for the production of high-quality wood furniture

Grade 1	Excellent
Grade 2	Good
Grade 3	Fair
Grade 4	Poor
Grade 5	Very poor

- ✓ Determine if each board produced is acceptable or not (based on machining operation)

Grades acceptable per machining operation for the production of high-quality wood furniture

Machining operation	Performance criteria (i.e. Acceptable)
Planing	Grade 1 and 2 (Excellent and Good)
Shaping	Grade 1 and 2 (Excellent and Good)
Mortising	Grade 1, 2, and 3 (Excellent, Good, and Fair)
Boring	Grade 1 and 2 (Excellent and Good)
Turning	Grade 1 and 2 (Excellent and Good)
Sanding	Grade 1 (Excellent)

- ✓ Regularly assess machine operator decision making skills and provide recommendations (e.g. boards are to be fed in the machine so that cutting tools is cutting with the grain)

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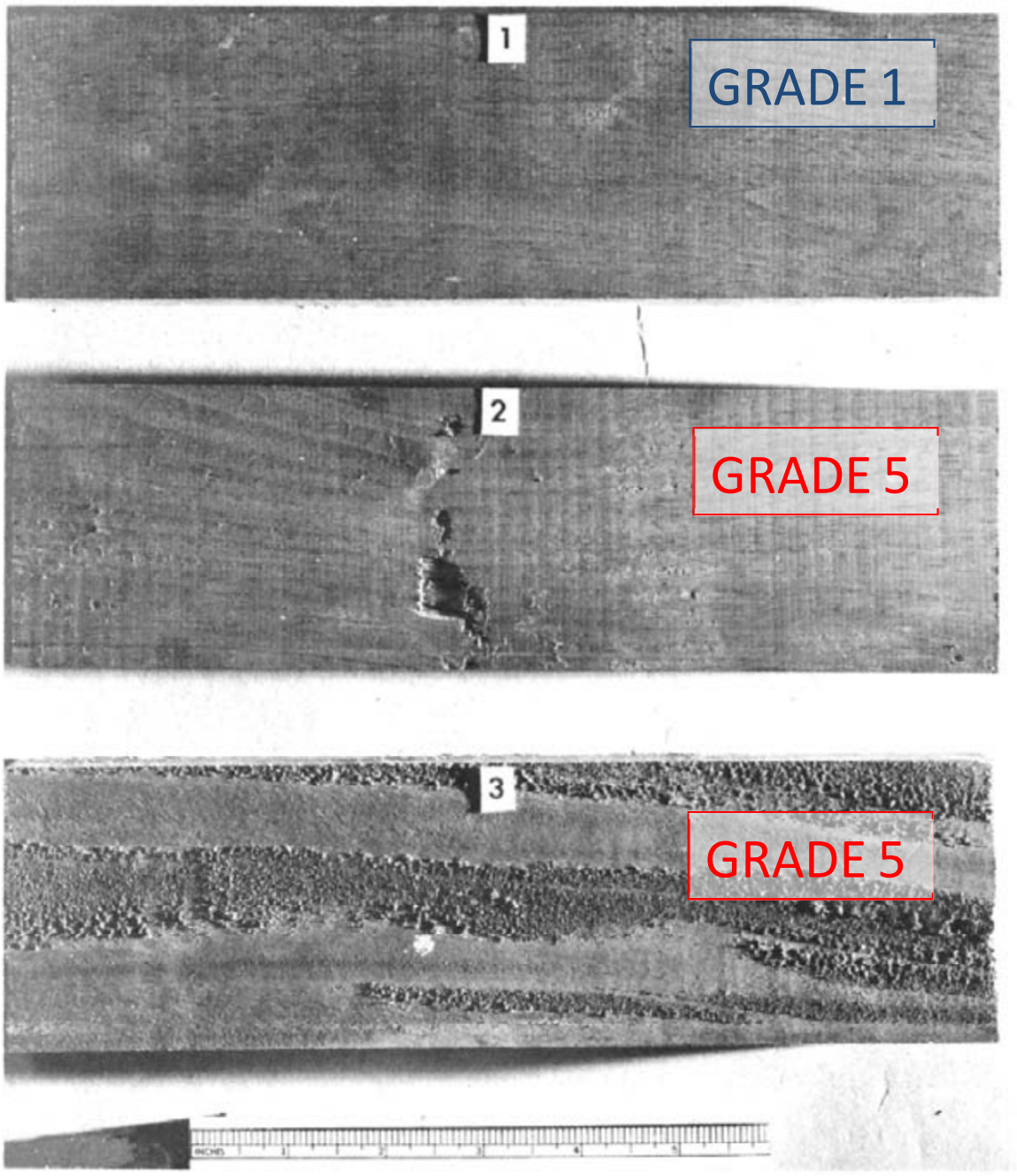
Planing defects definition and possible causes

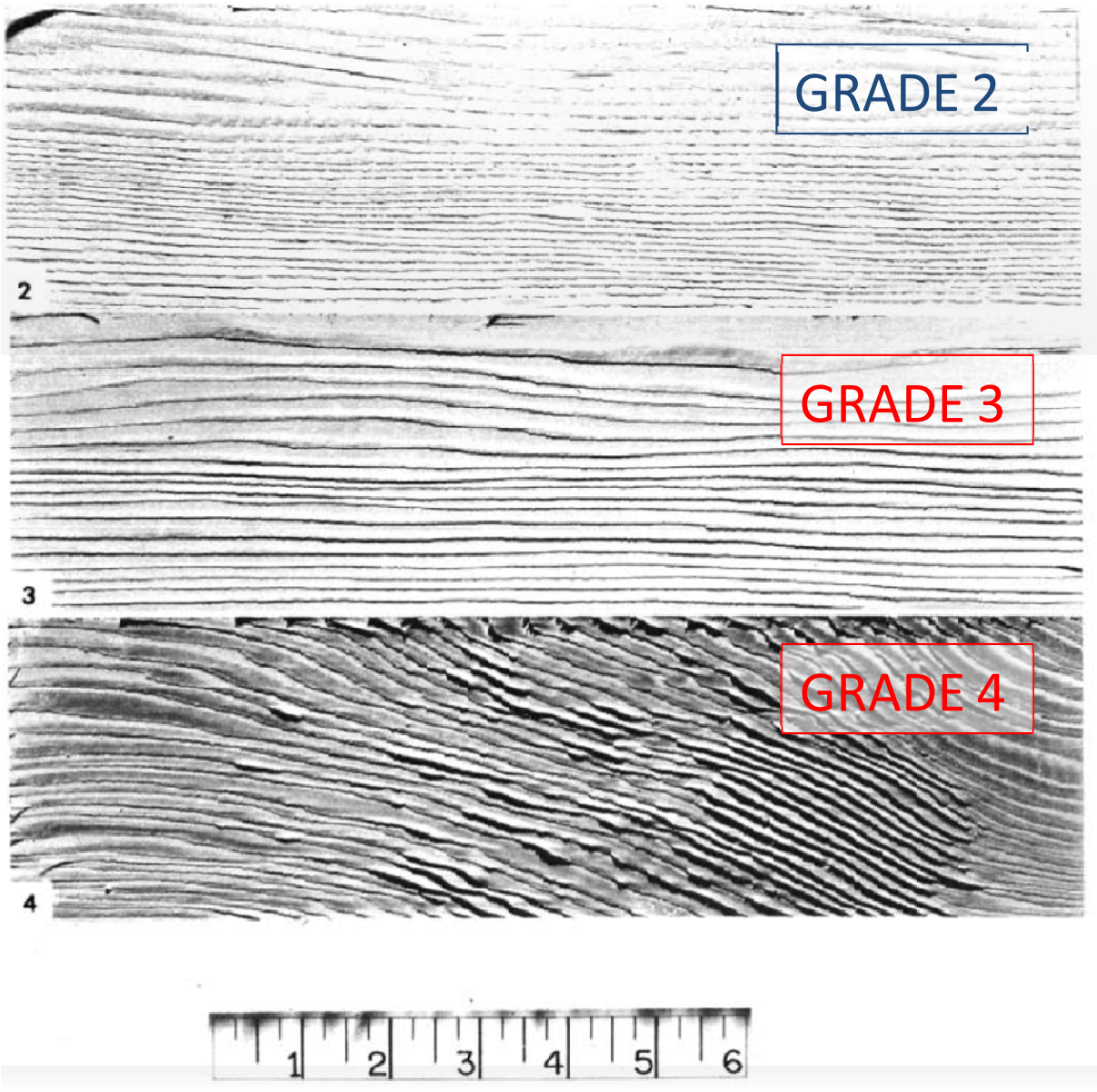
Raised Grain	Raised grain is a roughened condition of the surface of lumber in which part of the annual ring is raised above the general surface, but not torn loose from it. Among the factors that contribute to development of raised grain are dull knives, and too high a moisture content in the lumber.
Fuzzy Grain	Fuzzy grain consists of small particles or groups of small particles or groups of fibres that do not sever cleanly in machining, but stand up above the general level of the surface. Can be minimized by keeping knives sharp. The moisture content should be kept low, not above 12 percent.
Chipped Grain	Chipped grain is a chipped surface where very short particles are broken out below the line of cut. Torn grain is similar but more pronounced in degree. Typically, chipped grain is associated with cross-grained lumber and occurs at spots where the knives are cutting against the grain. Where the slope of grain is wholly in one direction, chipped grain may be avoided by the grain. The most important single factor in preventing chipped grain is the number of knife marks per 2.54 cm. Woods will often show a vast improvement if feed rate and cutterhead speed can be so adjusted as to give 16 to 20 knife marks per 2.54 cm.
Chip Marks	Chip marks are shallow dents in the surface caused by shavings that have clung to the knives instead of passing off in the exhaust as intended. Chip marks may result from an inadequate blower system or from too much air leakage. Too fast a feed may result in a bigger volume of chips than the blower system can handle properly.
Burnishes	When the board get stuck in the machine or the sharp edge of a cutting tool become dull with breakage and wear creating negative clearance angle causing heated wood surface. Dull knives heat and glaze the surfaces rendering the wood physically and chemically unsuited for gluing (even though it is smooth and flat)

Examples: Chipped grain and Fuzzy grain



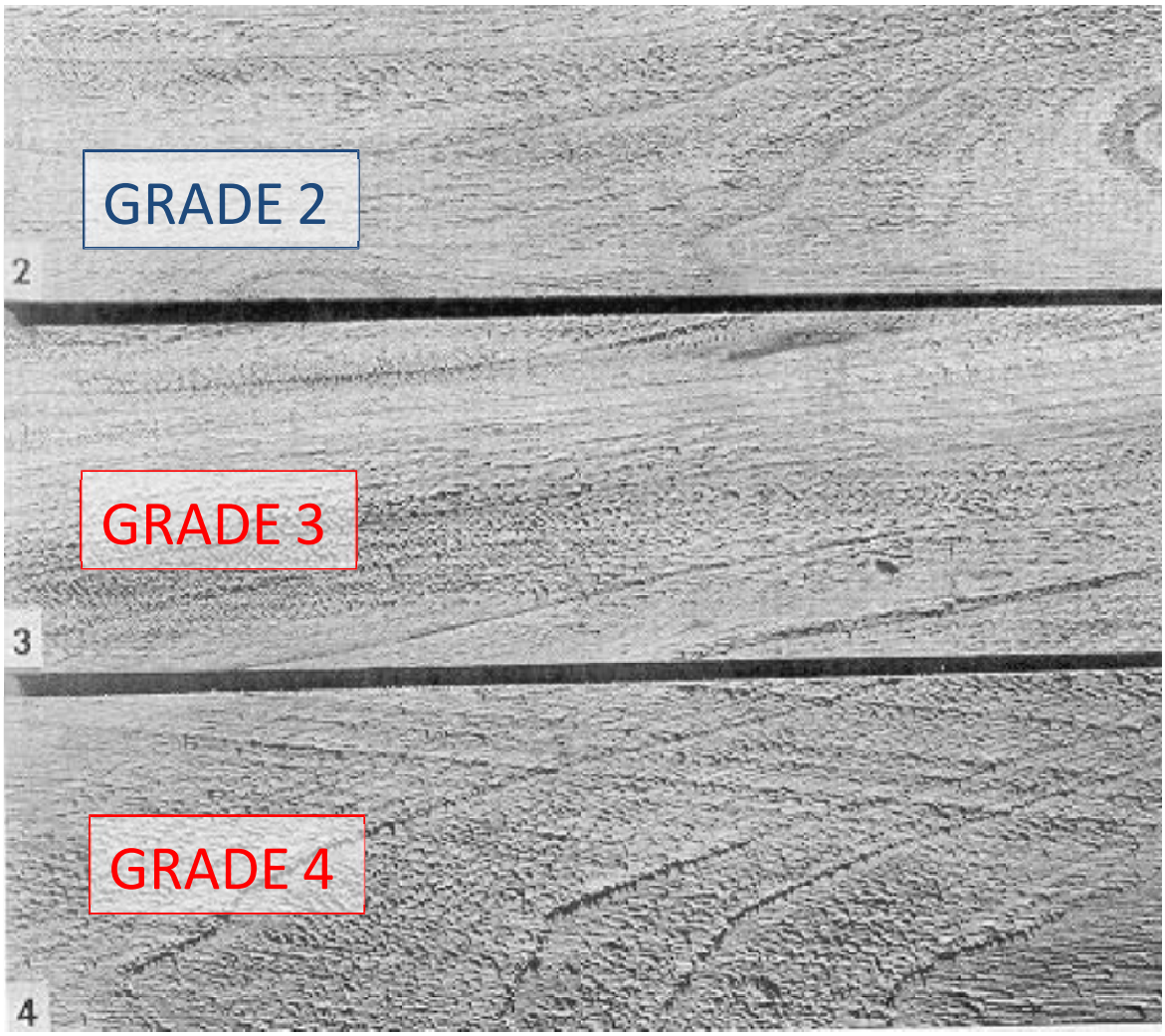
Planning grades Nos. 1 and 5: 1 Black Walnut Grade No. 1; 2 Black Walnut Grade No. 5 because of chipped grain; 3 Mahogany Grade No. 5 because of extreme degree of fuzzing probably due to abnormal fibres [11].

Examples of Raised grain



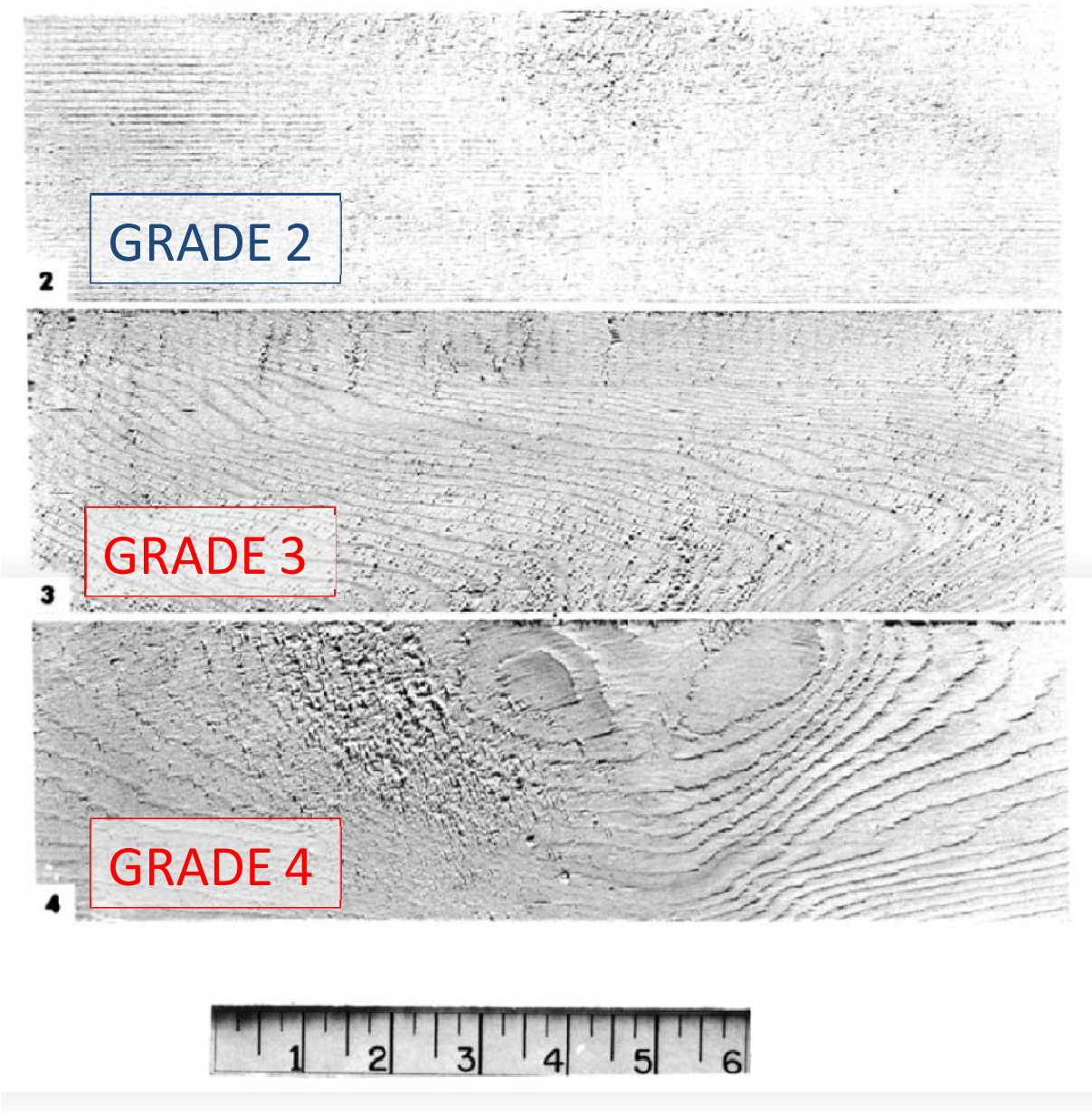
Raised Grain in Douglas-Fir, Grades Nos. 2, 3, and 4 [11].

Examples of Raised grain



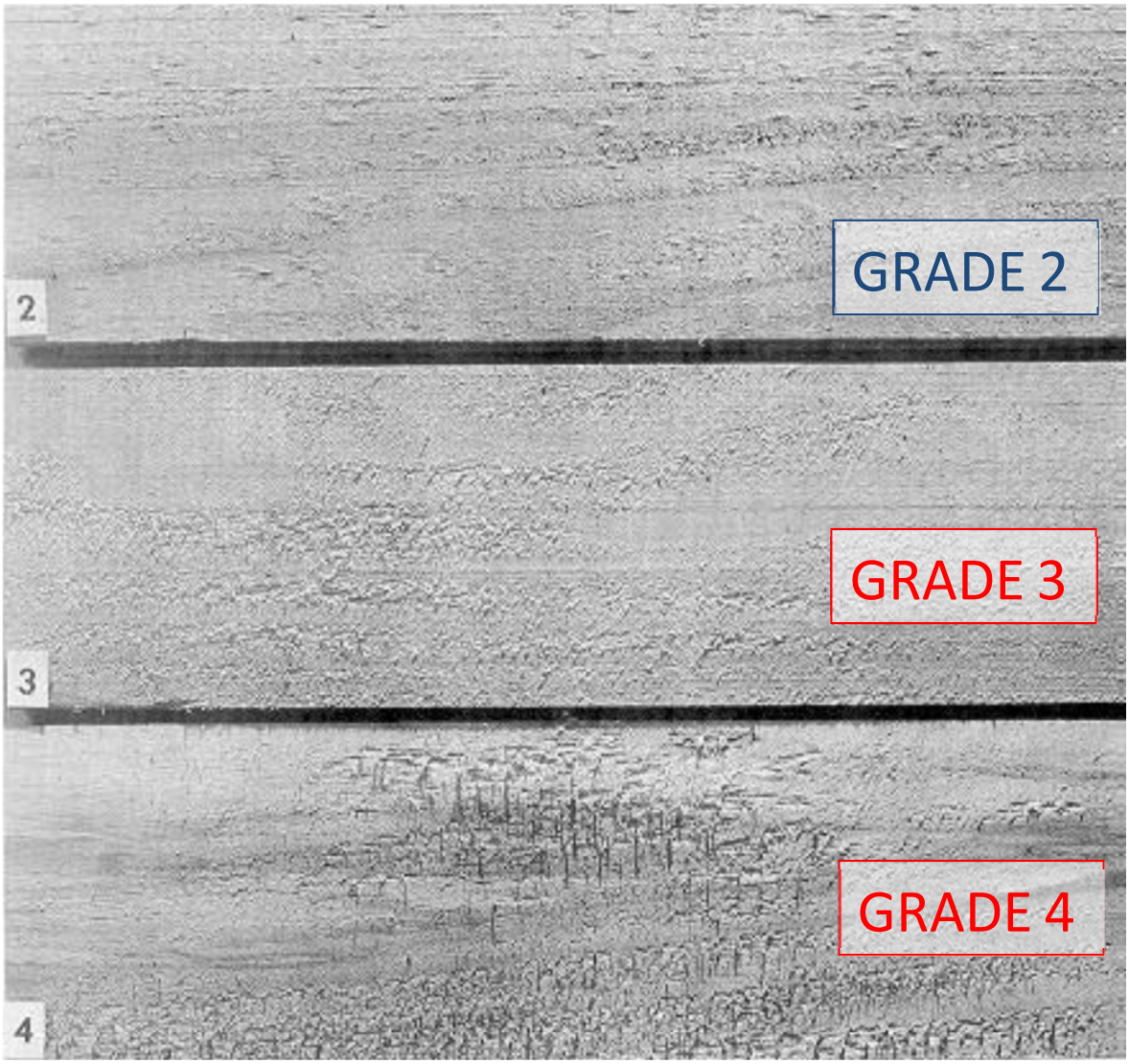
Different degrees of raised grain illustrated by soft elm [Davis 1962].

Examples of Fuzzy grain



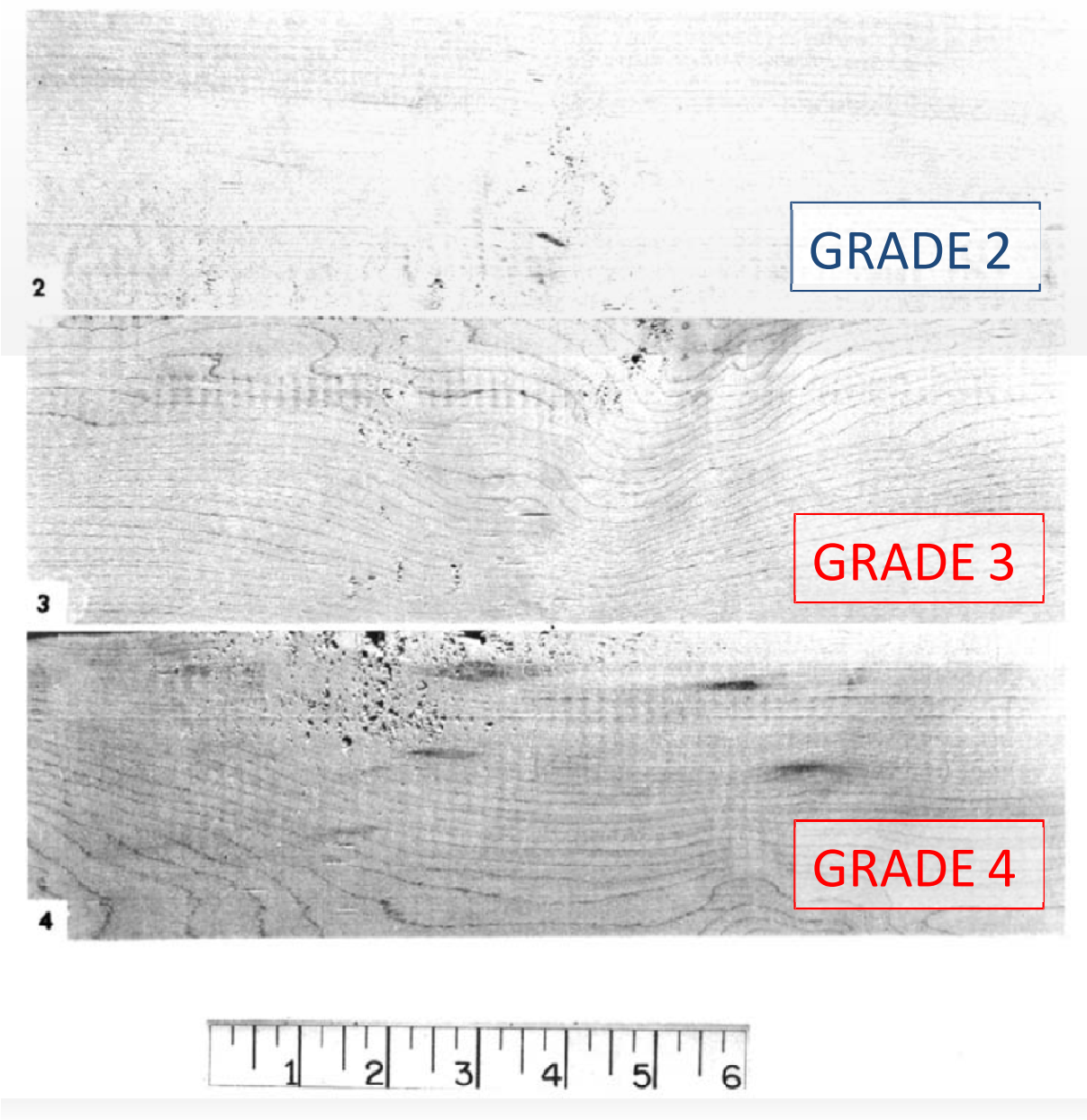
Fuzzy Grain (small particles or groups of fibres that did not sever clearly in machining but stand up above the general level of the surface) in Engelmann Spruce, Grades Nos. 2, 3, and 4 [11].

Examples of Fuzzy grain



Different degrees of fuzzy grain illustrated by willow [Davis 1962].

Examples of Torn or Chipped grain



Torn or chipped grain in Hard Maple, Grades Nos. 2, 3, and 4 [11].

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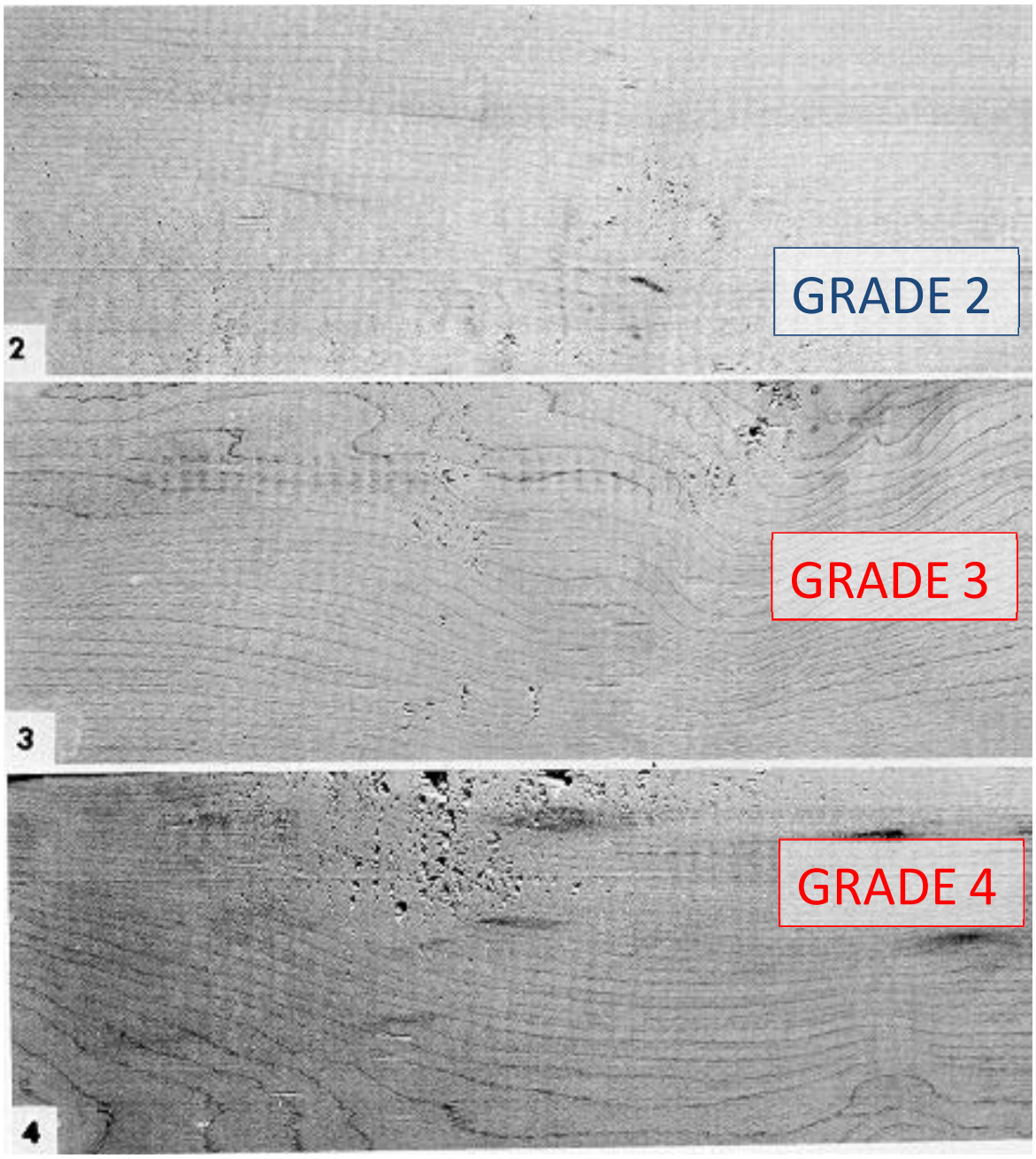
Examples of Torn or Chipped grain



Different degrees of torn or chipped grain in hard maple [Davis 1962].

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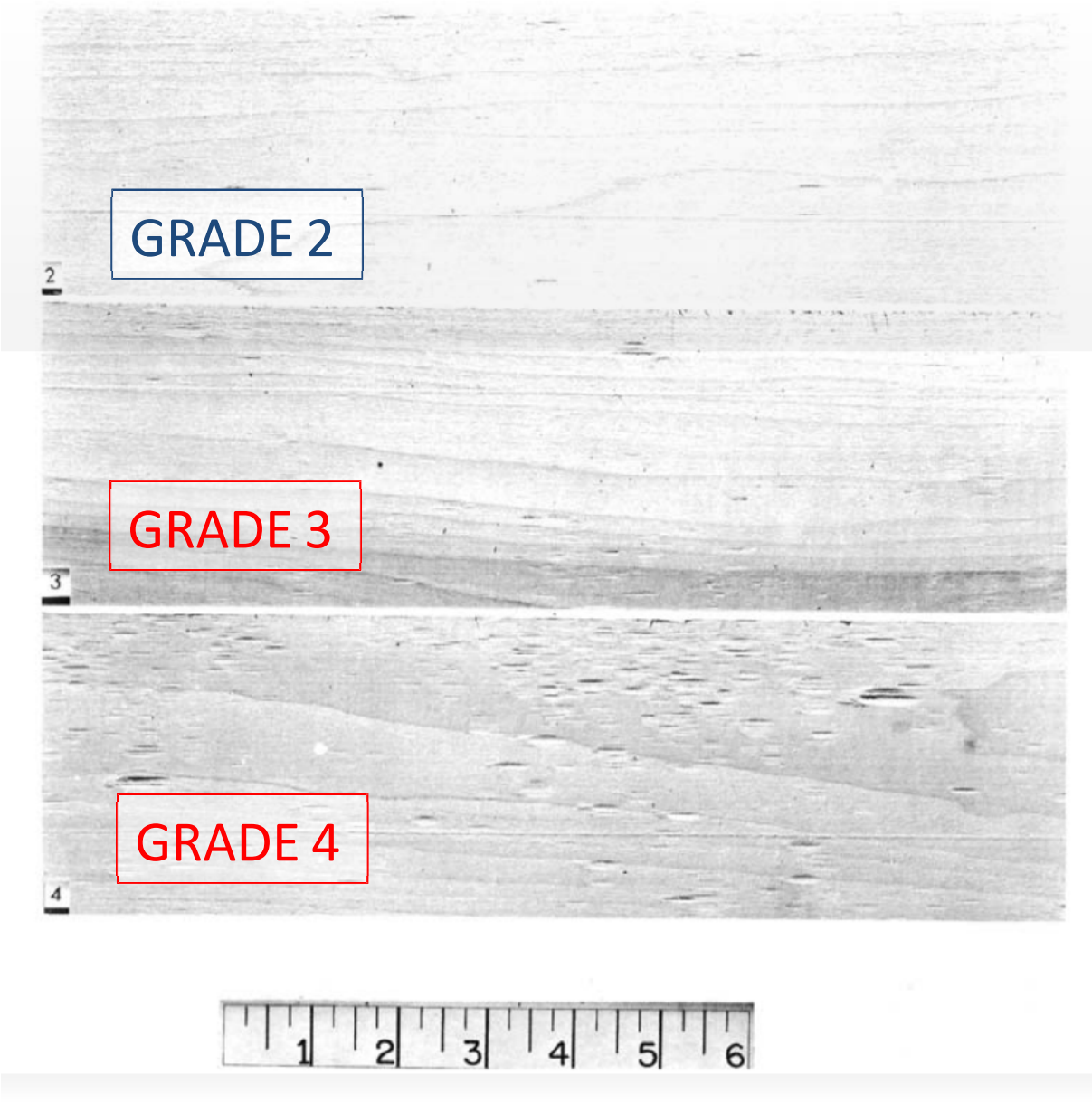
Examples of Chip marks



Chip marks in the surface (caused by shavings that have clung to the knives instead of passing off in the exhaust as intended) in Yellow-Polar, Grades Nos. 2, 3, and 4 [11].

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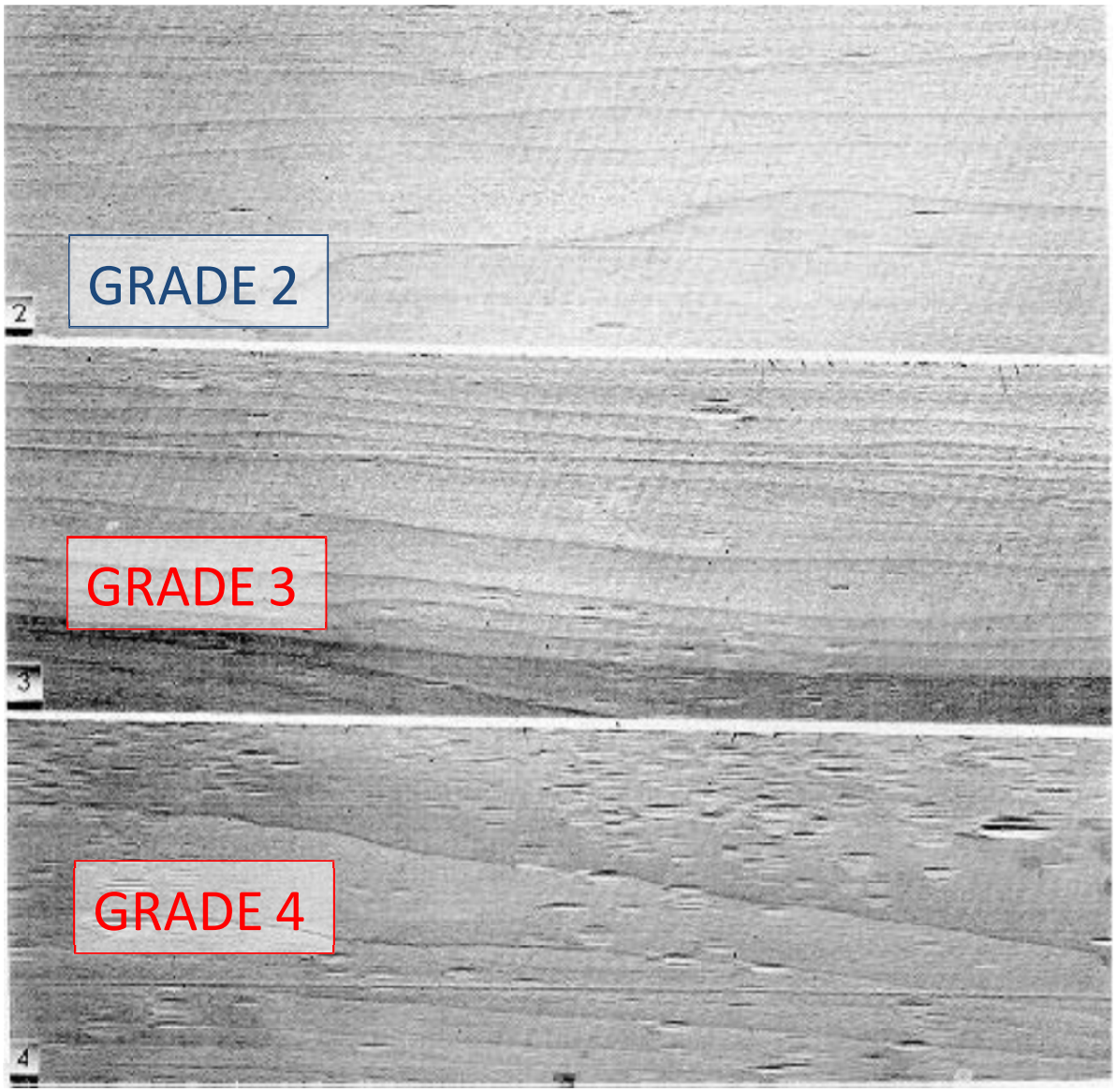
Examples of Chip marks



Different degrees of chip marks in yellow-poplar [Davis 1962].

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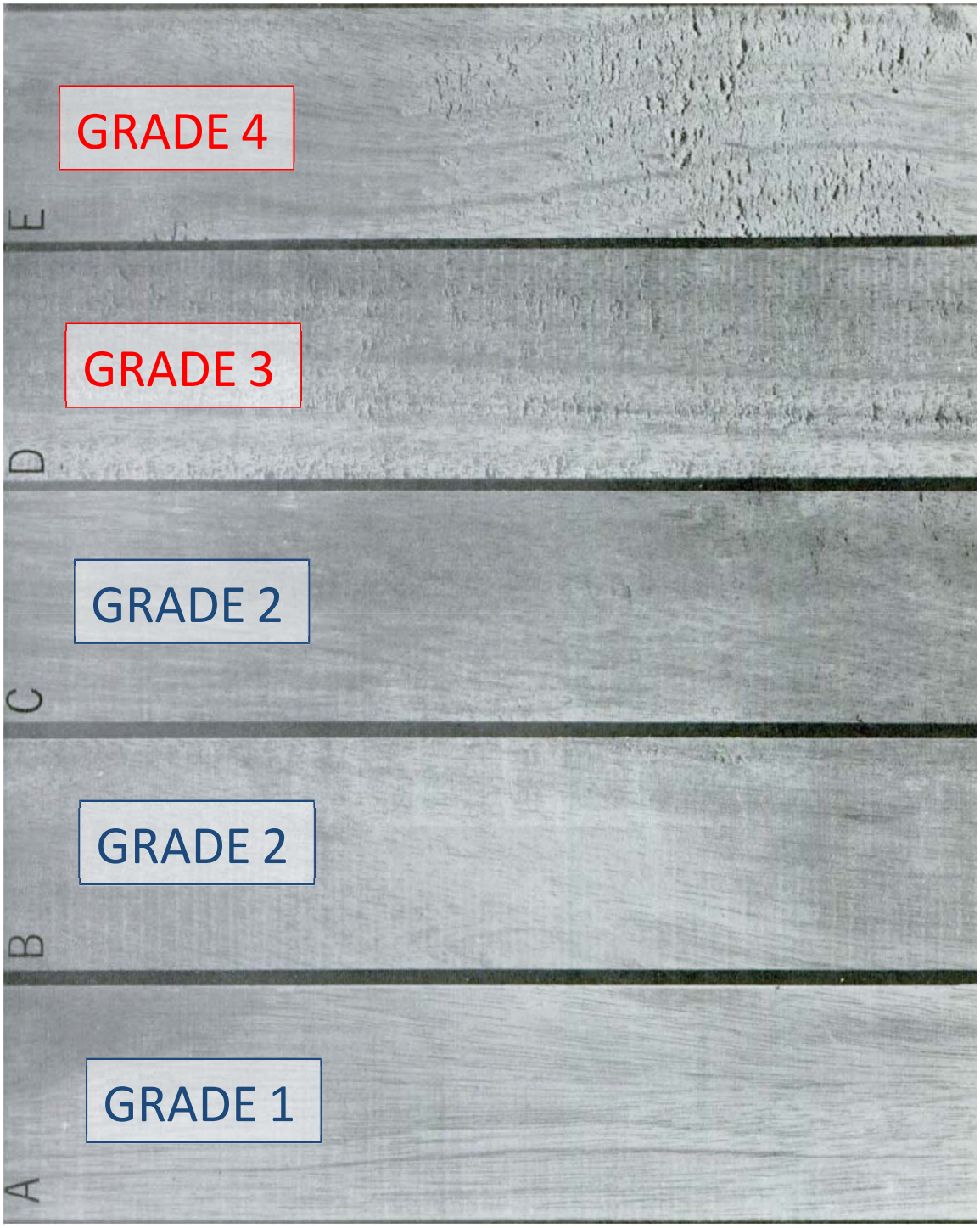
Examples of Fuzzy grain, Chipped grain, Torn grain



Boards of molucca albizzia: A Defect-free; B Grade 2 fuzzy grain; C Grade 2 chipped grain; D Grade 3 chipped or torn grain; E grade 4 torn grain [Peters and Lutz 1966].

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Examples of Torn grain, Chipped grain

Boards of Nepal alder: A grade 3 torn grain; B Grade 2 chipped grain; C Defect-free [Peters and Lutz 1966].

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Example of Quality Control Form

Machining operation: Planing
Date: 3/11/2014
Species: teak
Feeding speed: 8800 mm per minute
Speed r.p.m.: 3600
Number of knives in head: 2
Cutting angle: 20°
Moisture content: 10-12%
Quality controller: Douangta Chitdavong

Sample Number	Defect-free	Raised grain	Fuzzy grain	Torn grain	Chip marks	Comment	Acceptable? (Y/N)
1		4	4	3	4		No
2		2	2	2	2		Yes
3	☒						Yes
4		1	1	1	3		No
5		2	3	2	2		No
6		1	1	1	3		No
7	☒						Yes

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Machining operation:
Date:
Species:
Feeding speed:
Speed r.p.m.:
Number of knives in head:
Cutting angle:
Moisture content:
Quality controller:

Sample Number	Defect-free	Raised grain	Fuzzy grain	Torn grain	Chip marks	Comment	Acceptable? (Y/N)
1							
2							
3							
4							
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Comment(s):

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References

ASTM D1666 (2011) Standard methods for conducting machining tests of wood and wood base materials. American Society for Testing and Materials. Philadelphia, PA, USA.

Davis, E.M. (1962) Machining and related characteristics of United States hardwoods. USDA, Forest Service, Technical Bulletin No. 1267. 70 p.

Peters, C.C., Lutz, J.F. (1966) Some machining properties of two wood species grown in Hawaii – Molucca albizza and Nepal alder. USDA, US Forest Service Research Note, FPL-0117. 25 p.