

MSC 124 - INDUSTRIAL SKILLS MATERIALS & INDUSTRIAL STANDARDS

What is a Technician?

According to *Webster's New World Dictionary* a technician "is a person who has great technical skill or knowledge." A technical education has to do with the "applied sciences or the practical, industrial, or mechanical arts."

As a Marine Technician entering the job market you must not only have a strong background in nautical and marine sciences, but you must understand a great variety of industrial materials and applications. Cape Fear Community College will provide the foundation for a successful career as a marine technician, however, work related experiences, inquisitiveness and sound work ethics will ultimately provide you with the technical expertise that will make you a valued employee. An integral part of your marine related employment may revolve around the acquisition and use of a variety of generalized tools, construction materials, fasteners, and general hardware, as well as the use and acquisition of highly specialized marine instrumentation. One of the intents of this class, is to provide you with a rudimentary background for estimating the cost and/or ordering a variety of stock materials. Obviously, it would be impossible to cover every aspect or type of supply item you might need during your career, so this class will concentrate on the basic standards of wood, metal and pipe, as well as some generalized fasteners. With a solid understanding of the industrial applications and sizing requirements of the aforementioned materials, plus an ability to apply the various dimensional and volumetric formulas discussed in the previous handout (*Measurement Systems & Industrial Applications*), I am convinced, a dedicated and resourceful marine technician will be able to locate, price and utilize the appropriate material for any task expected of them.

Wood Products

Wood is one of the most versatile and useful materials that nature has produced and it is generally one of the most widely used materials for a variety of construction needs. Wood is selected for many products because of its advantages. It is well known for beauty and high strength. Wooden parts are made easily with hand tools or woodworking machinery. These shaped pieces then can be quickly joined with fasteners such as screws or adhesives. Properly finished wood products are durable and will give many years of service. In addition to traditional construction applications, industrial uses for wood include decks, ladders, stairs, scaffolding, cabinets, bins, boxes and shipping crates. Quite often, marine grade hardwoods are used on vessels purely for their aesthetic qualities in a variety of trim and storage applications.

Trees commonly cut into lumber and timber products are divided into two broad groups: *hardwood* and *softwood*. The term softwood, as used in the lumber trade, does not necessarily mean a tree produces wood which is soft, nor does hardwood always indicate one whose wood is hard. In fact, no definite degree of hardness divides the two groups. The custom has developed of calling the coniferous trees softwood, and broad-leaved trees hardwood. In general, the woods in the hardwood group are harder than those in the softwood group. However, a few of the softwoods are harder than many hardwoods. Southern or yellow pine is an example of a hard softwood. Some hardwoods, on the other hand, are among our softest woods, an example being basswood. Although a variety of woods may be found in generalized industrial settings, the woods you would expect to find in the marine industry are white cedar and/or juniper, cypress, and pines which are all classified as *softwoods* and white oak, mahogany and teak which are *hardwoods*. Quite often, marine grade hardwoods are referred to as exotic woods because of their countries of origin (mainly tropical).

Purchasing lumber can be very confusing. Lumber is available in a wide selection in many different grades. The various defects and blemishes found in lumber necessitate the establishment of certain classification and grading rules. To insure uniform grading throughout the country, the National Bureau of Standards defines separate standards for both softwoods and hardwoods. When working with wood, you should take the time to learn the major grades of lumber to help you determine wood quality and provide an accurate basis for estimating the cost of a project.

Softwood lumber is normally classified in three different ways: *by use, by method of manufacture, and by size.*

Use Classifications

Use classification for softwood lumber is broken down into three principal categories: *yard lumber, structural lumber, and factory and shop lumber.* Yard lumber is less than 5 inches in thickness and is intended for ordinary construction and general building purposes. Yard lumber is graded into *select lumber*, which is lumber of good appearance and finishing qualities, and *common lumber*, which is suitable for general construction and utility purposes. **Structural lumber** is 2 inches or more in both thickness and width and it is used where working stresses are required. It is graded according to its strength and to the use which is to be made of an entire piece. Such lumber is used principally for bridge or trestle timbers, car and ship timbers, for decking on docks and piers, and for framing of buildings. Some of the structural timber used today is formed of glued laminated members or high strength plastics. **Factory and shop lumber** is graded with reference to its use for doors and window sashes, or on the basis of characteristics affecting its use for general cutup procedures. Such lumber is used in different types of millwork and/or in furniture factories.

Manufacturing Classifications

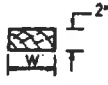

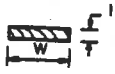


Manufacturing classifications for softwood lumber are broken down into three categories: *rough lumber, dressed lumber, and worked lumber.* **Rough lumber** is lumber that has not been dressed (surfaced) but which has been sawed, edged, and trimmed at least to the extent of showing saw marks in the wood on the four longitudinal surfaces of each piece for its entire length. **Dressed or surfaced lumber** is lumber that has been dressed by a planing machine for purposes of attaining smoothness of surface and uniformity of sizes on one side(S1S), two sides(S2S), one edge(S1E), two edges(S2E), or most commonly a combination of all sides and edges. **Worked lumber** is lumber which in addition to being dressed has been matched, shiplapped, or patterned. Tongue and grooved boards are an example of matched lumber, whereas, moldings and other trim material is an example of patterned lumber. Shiplapped lumber has been worked or rabbeted on both edges of each piece to provide a close lapped joint by fitting two pieces together. (note table of standard sizes of lumber)

Size Classifications

There are two basic sizes of softwood lumber: *nominal or rough size and actual or dressed size.* Nominal ("not real or actual") refers to the rough size of a board as compared to the finished, actual size. The standard or "nominal" sizes of lumber, such as 1 x 6, 2 x 4, or 4 x 4, refer to the nominal thickness and width (in inches) of a board before it is dressed and dried. In other words, nominal sizes are the dimensions of rough lumber. Lumber length is always stated separately, normally in feet. Note the differences between the nominal size and actual sizes of lumber in the *Table of Standard Sizes of Lumber.* Normal or "standard" size softwood lumber are classified as *boards, dimension lumber, and timber.* **Boards** are less than 2 inches in nominal thickness and more than 2 inches in nominal width. **Dimension lumber** is at least 2 inches in nominal thickness but not more than 5 inches thick and 2 or more inches in nominal width. **Timbers** are comprised of lumber which is 5 or more inches in thickness and width. Timbers may be classified as beams, stringers, posts, caps, sills, girders, etc. **Standard lengths of lumber** generally are 6 feet and longer in multiples of 2 feet. (ie. 6',8',10',12',14',16', longer lengths are available as special orders, most lumber yards do not carry 6 foot lengths, 2x4's classified as studs are 93 inches long)

Hardwood grading standards are different from those for softwood. First of all, the grading system for hardwood is simpler. Second, while softwood is graded by the best side of the board, hardwood is graded by the worst side. Hardwood is graded by three basic marketing categories: *factory lumber, dimension parts, and finished market products.* Both factory lumber and dimension parts serve industrial uses. The **factory lumber grades** reflect the proportion of a piece that can be cut into useful smaller pieces, while the **dimension grades** are based on the entire piece. **Finished market products** are graded for their end use with little or no remanufacture-for example, molding, flooring, etc. While softwood lumber is sold by standard nominal sizes, hardwood lumber is sold by random widths and lengths (RWL). Because hardwood is more valuable, the boards are left as large as possible when cut at the sawmill.

STANDARD SIZES OF LUMBER

TYPE	NOMINAL SIZE		ACTUAL SIZE	
	Thickness	Width	Thickness	Width
Standard Stock Sizes Dimension 	2 in.	2 in. 4 in. 6 in. 8 in. 10 in. 12 in.	1 1/2 in.	1 1/2 in. 3 1/2 in. 5 1/2 in. 7 1/4 in. 9 1/4 in. 11 1/4 in.
Timbers 4", 6", 8" 	4 in. 5 in. 6 in. 8 in.	4 in. 5 in. 6 in. 8 in. 10 in.	3 1/2 in.	3 1/2 in. 4 1/2 in. 5 1/2 in. 7 1/2 in. 9 1/2 in. 7 1/2 in. 9 1/2 in.
Common Boards 	1 in.	2 in. 4 in. 6 in. 8 in. 10 in. 12 in.	3/4 in. or 25/32"	1 1/2 in. 3 1/2 in. 5 1/2 in. 7 1/4 in. 9 1/4 in. 11 1/4 in.
Shiplap Boards 	1 in.	4 in. 6 in. 8 in. 10 in. 12 in.	3/4 in. or 25/32"	3 1/8 in. Face Width 5 1/8 in. Face Width 7 1/8 in. Face Width 9 1/8 in. Face Width 11 1/8 in. Face Width
Tongue & Groove Boards 	1 in.	4 in. 6 in. 8 in. 10 in. 12 in.	3/4 in. or 25/32"	3 1/4 in. Face Width 5 1/4 in. Face Width 7 1/4 in. Face Width 9 1/4 in. Face Width 11 1/4 in. Face Width

Lumber Measurements and Pricing

Lumber may be sold by the board foot, square foot or lineal foot, but the standard unit of measurement for solid lumber is the board foot. A board foot represents 144 cubic inches. Although you may receive a price per piece of standard lumber (ie. One 2"x4" by 8' = X dollars) or by the lineal or running foot (ie. One foot of clear 1"x4" = X cents), a board foot is the unit used in pricing solid lumber. Whenever you are ordering marine grade hardwoods or large quantities of softwoods you will receive a price per board foot. When calculating board feet always use the nominal size (ie. The size of the rough-sawed board). Sometimes the nominal sizes of hardwoods are given in quarters. Each quarter is 1/4 inch. For example, a 4/4 (four-quarter) board is 1 inch thick. An 8/4 (eight quarter) board is 2 inches thick, etc. A typical board foot is 1 inch thick and 12 inches square. A 1"x 12" board 5ft. long contains 5 board feet. A board 2"x 12"x 5' contains 10 board feet. Board feet can be calculated in several ways:

- Multiply the number of pieces by thickness(T) by width(W) by length(L) all in inches and divide by 144. The denominator is 144 because there are 144 cubic inches in one board foot.

Example: Four boards, 1" thick, 5" wide and 30" long:

$$\frac{\text{no. of pieces} \times T \times W \times L}{144} = \frac{4 \times 1" \times 5" \times 30"}{144} = 4.2 \text{ board feet (nearest tenth)}$$

- Multiply the number of pieces by thickness(T) by width(W) both in inches by length(L) in feet and divide by 12. The denominator is 12 because there are 12 inches in one foot. This is one of the exceptions to the rule of always using like units when performing calculations.

Example: Four boards, 1" thick, 5" wide and 2.5 feet long:

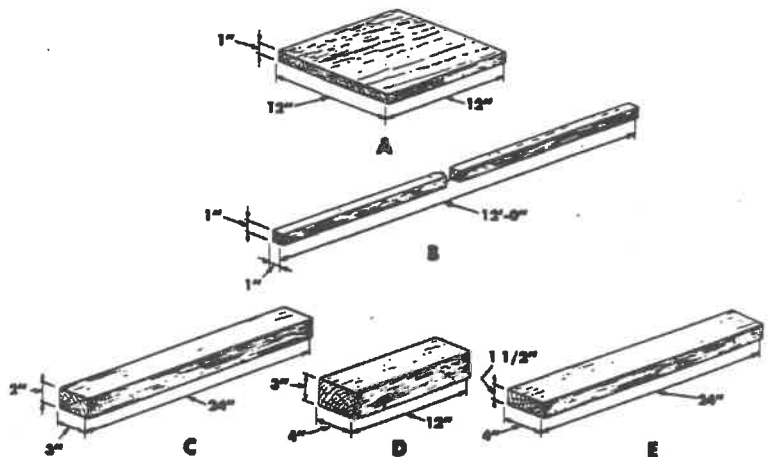
$$\frac{\text{no. of pieces} \times T \times W \times L}{12} = \frac{4 \times 1 \times 5 \times 2.5}{12} = 4.2 \text{ board feet} \quad (\text{nearest tenth})$$

- To convert board feet to lineal feet, simply reverse the multiple used to bring lineal feet to board feet; in other words, multiply board feet by 12 and divide by thickness(inches) by width(inches).

Example: How many lineal feet are there in 1000 board feet of 2" x 8".

$$\frac{1000 \times 12}{2 \times 8} = 750 \text{ lineal feet}$$

The unit of measure for lumber is the board foot.
Each of the pieces shown to the right is one board foot.



SOFTWOOD LUMBER GRADES

SELECT-	Good appearance, grain, and finishing qualities
Grade A:	Practically flawless. Excellent appearance with natural finishes or stains.
Grade B:	A few small blemishes or flaws, still suitable for staining.
Grade C:	Some defects and flaws that can be easily covered with paint.
Grade D:	More defects than in grade C but still easily covered with paint.
COMMON-	Numerous defects, not for applications where appearance is important.
Number 1:	Utility lumber. Tight knots, limited blemishes. No warp, splits, checks, or decay.
Number 2:	Sound lumber with some loose knots and checks. No warp or damaging splits.
Number 3:	Construction lumber-medium quality. Some waste expected because of more severe defects.
Number 4:	Low-quality construction lumber. Plan for considerable waste.
Number 5:	Essentially waste lumber.

Plywood

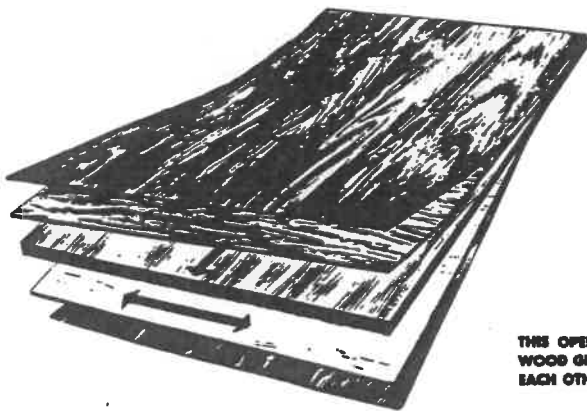
When plywood was introduced in the 1930s, most woodworkers considered it a cheap substitute for other woods. Since that time plywood has proved superior to many wood products. Today plywood is used in construction, cabinets, furniture and boats. Plywood is a panel that has layers, or plies, of wood veneer. The grains of the layers are at right angles to one another. Plywood panels contain an odd number of layers-3,5,7 or more. The layers are glued together. The two outermost layers are called the face and the back. The face, since it is often visible, is commonly of a quality wood selected for its beauty or strength. There are two major kinds of plywood. **Softwood plywood** is the most common. It is used mostly in building construction. **Hardwood plywood** usually is chosen for its fine appearance. Cabinets, furniture and boat interiors often have hardwood plywood in their construction. Each kind of plywood has a number of grades. The edge or the back of each sheet of a softwood plywood has a grade stamp to help a customer. Each ply, or veneer, that makes up a sheet of softwood plywood is graded N, A, B, C, C plugged or D. (See standard veneer grades) The panel's face and back are graded. They do not always get the same grade. If a grading stamp has "interior" printed on it, the plywood's core contains veneers of D grade and better. Interior plywood is bonded with moisture resistant glue, but the bonding material is not permanently waterproof. If a stamp has "exterior" on it, the core has veneers of C and better. "Exterior glue" indicates that the veneer is bonded with waterproof glue and is designed for an outdoor applications or where service conditions include repeated exposure to weather and moisture. **Marine plywood** has no voids in its core and is made to withstand continuous exposure to water such as in boat hulls or other submerged applications. Because **hardwood plywood** is used for its appearance, its grading is concerned with only the face and the back. In order of quality, grades are premium, good, sound, utility and backing. Grades are usually abbreviated, G1S/Snd tells you that the face of the panel is a good grade and the back is a sound grade. A listing of only one grade refers to the face. Hardwood is also specified by the type of adhesive it has and the quality of its core. **Type I** has exterior glue and is full-waterproof bond. **Type II** has interior glue and accounts for 95% of all domestic hardwood plywood. When you need a core without any voids or holes, you can buy a "solid core." Plywood has many advantages. It has a smooth, continuous surface that makes a joint-free panel. It is one of the strongest manufactured wood products. It is equally strong with and across the grain because of its construction.

Sizes and Cost Estimates

A major advantage of plywood is its variety of sizes. Common thicknesses are 1/8", 1/4", 3/8", 1/2", 5/8", 3/4", and 1" (3,6,10,13,16,19, and 25 millimeters). Although plywood is manufactured in many widths and lengths, 4 ft. by 8 ft.(1219 x 2438 mm) is the most common. Special order lengths of 10 ft., 12 ft. and 16 ft. are available. Although you will generally be quoted a price per sheet of plywood (ie. One 4' x 8' sheet of 1/2" A/C exterior grade plywood = X dollars), all plywood or other sheet material is based on the cost per square foot. A piece of 1/2" x 4' x 8' plywood has 32 sq. ft.

- Measure sheet stock, such as plywood, in square feet. Figure square feet by multiplying the width by the length(both should be in either inches or feet). If multiplying by inches divide by 144 to determine square feet. 144 square inches = 1 square foot.

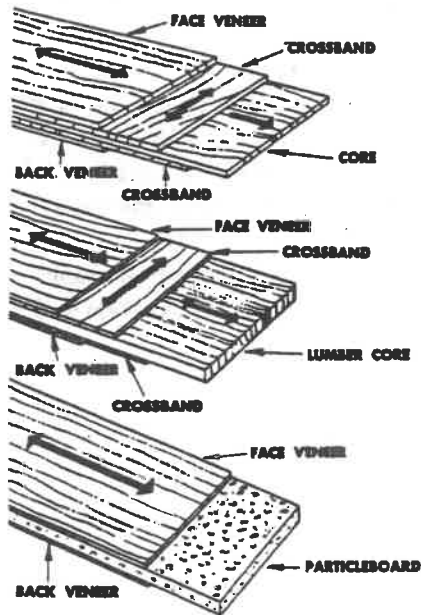
$$\frac{W \times L}{144} \text{ or } \frac{W' \times L'}{1} = \text{Square Feet}$$



THIS OPENED VIEW OF A PLYWOOD PANEL SHOWS HOW THE WOOD GRAIN OF THE PLYS RUNS IN OPPOSING DIRECTIONS TO EACH OTHER TO COUNTERACT WEAKNESS WITH THE GRAIN.

STANDARD VENEER GRADES

N	Smooth surface "natural finish" veneer Select, all heartwood or all sapwood. Free of open defects. Allows not more than 6 repairs, wood only, per 4' x 8' panel, made parallel to grain and well matched for grain and color.
A	Smooth paintable. Not more than 18 neatly made repairs, boat, sled, or router type, and parallel to grain, permitted. May be used for natural finish in less demanding applications.
B	Solid surface. Shims, circular repair plugs and tight knots to 1 inch across grain permitted. Some minor splits permitted.
C	Improved C veneer with splits limited to 1/8 inch width and knotholes and borer holes limited to 1/4 x 1/2 Plugged inch. Admits some broken grain. Synthetic repairs permitted.
C	Tight knots to 1 1/2 inch. Knotholes to 1 inch across grain and some to 1 1/2 inch if total width of knots and knotholes is within specified limits. Synthetic or wood repairs. Discoloration and sanding defects that do not impair strength permitted. Limited splits allowed. Stitching permitted.
D	Knots and knotholes to 2 1/2 inch width across grain and 1/2 inch larger within specified limits. Limited splits are permitted. Stitching permitted. Limited to Interior grades of plywood.



VENEER CORE: THE MOST COMMON PLYWOOD USES AN ALL VENEER CORE. THE NUMBER OF PLYS DEPENDS ON THE USE. THE MORE PLYS THE GREATER THE STRENGTH.

LUMBER CORE: THE CORE CONSISTS OF LUMBER STRIPS, ONE TO FOUR INCHES WIDE, EDGE GLUED TOGETHER. LUMBER CORES WITH FACE WOOD ON ALL FOUR EDGES MAY BE ORDERED.

PARTICLEBOARD CORE: THE CORE IS MADE OF WOOD FLAKES AND CHIPS BONDED TOGETHER WITH RESIN TO FORM A MAT. THREE TO FIVE PLY PANELS, ONE-FOURTH INCH OR MORE IN THICKNESS, ARE COMMON.