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(Masonite)
What is it?

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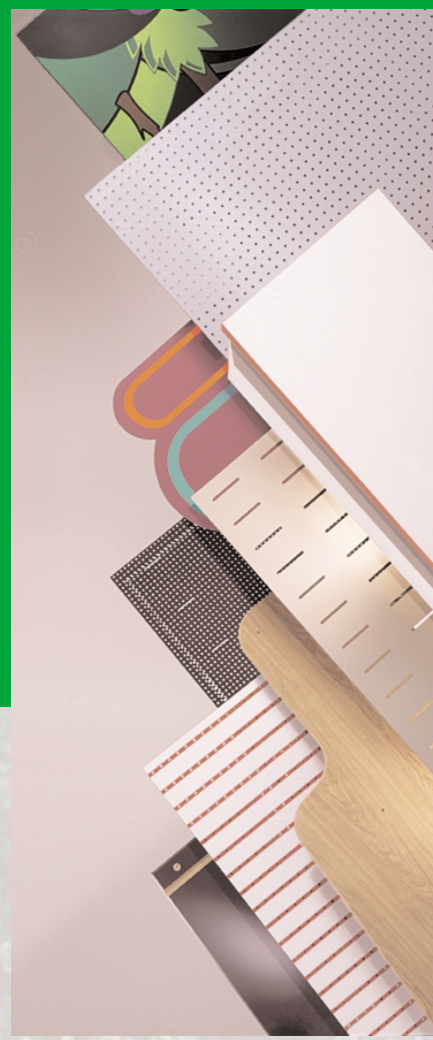

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HARDBOARD
(Masonite) What is it?

by R.M. Granum and O. B. Eustis

Hardboard is often referred to as “masonite” because Masonite Corporation was the first and for many years the only major producer of this product. Today there are 28 plants in the U.S. and many others throughout the world which manufacture products similar to the “hardboard” invented by William H. Mason in 1924.

In a most real sense “hardboard” is *hard board*. It is made in sheets in a wide variety of thicknesses but most commonly 1/8” to 1/4”. It is made from wood but is more dense. Placed in water many hardboard products will sink or barely float. It is hard on saws; major users find it economical to use carbide-toothed blades.

Beyond this simple explanation, hardboard is a very complex commodity. Average characteristics of hardboard produced by one plant often are vastly different from those produced by another. These characteristics often can’t be described as “good” or “poor”. A “good” property for one application may be “poor” for another. Sometimes a sacrifice in one desirable quality is necessary to improve another.

In this article we will try to describe in simple terms how hardboard is made, and how this might influence a buyer in his selection of hardboard for a particular application.

No single type of hardboard is best for all applications.

No two pieces of hardboard are exactly alike.

HARDBOARD’S RAW MATERIAL

Like every living organism, each tree is unique. There are hundreds of different tree species, and individual trees within a species vary widely, depending on age and the amount of water, food, and sunlight during growth. Even within one tree there are many variables; knots, sap, heart wood, etc. Wood as a raw material is infinitely variable.

Hardboard is a manufactured product made from wood. Ideally each piece should be perfectly uniform. Of course, perfect uniformity is never attained but the degree to which it is approached is one of the most important factors in determining the utility of particular types of hardboard. Certainly the over-riding quality control consideration in every hard-board plant is making a uniform product from an infinitely variable raw material.

Hardboard manufacture consists of breaking down wood into its basic fibers then putting the wood back together with the fibers rearranged to form hard panels which have their own set of separate and distinct characteristics.

The wood in each species of tree develops its own characteristics as it grows; when broken down into fibers the individual fibers are more alike than different. Thus the basic step of separating the wood into fibers eliminates many of its variables. For example, there are no knots or grain in hardboard.

Individual mills further refine this "uniforming" process by separating and blending species and or providing large reservoirs during the fiberizing process to buffer the hour to hour variables in the raw material flow.

Wood fibers are made of 2 main ingredients: cellulose and lignin. Cellulose gives wood its strength; lignin is the natural binder which cements the fibers together and makes wood solid. Hardboard is unique among manufactured wood products in that it uses the lignin to reconstitute and bind the fibers into their new form. Other board products use various synthetic binders.

Most hardboards have a small amount of chemicals added to enhance certain properties such as flexibility, strength or water resistance, but the main consolidating binder is the natural lignin.

MANUFACTURING PROCESSES

Fiberizing of the wood is accomplished by a variety of methods but basically they consist of steaming chips to soften them followed by grinding between abrading discs to tear the fibers apart.

Green wood is about 50% water. This water plus any added in the process must be removed before hardboard manufacture is complete. The method and time of water removal is what distinguishes the various hardboard manufacturing processes.

• WET PROCESS MANUFACTURE •

The wet process was the one first invented by Mason. In it water is added during the fiberizing process to make a pumpable slurry of wood fiber. This slurry is delivered to a screen where water is drained from the fiber leaving a soft mushy mat. More water is removed by vacuum and pressing between rolls. The wet mat, now able to support it-self, is cut to length and placed on another screen which carries it into a hot press. These hot presses usually have 20 or more "decks" or openings. They are capable of applying several thousand tons of pressure to the wet mats while heating it to a temperature of 35O°F or more.

When fully loaded the press is closed and quickly brought to high pressure, A torrent of water is squeezed out of the mat thru the carrying screens and cascades over the edge of the platens. In a few seconds, water remaining in the mat is heated to steam. Press pressure is reduced and held for several minutes while the rest of the water is evaporated, the board is reduced to the desired thickness, and the chemical reaction to reconstitute the lignin bond is completed. The press is unloaded, the screens peeled off and we have S1S (smooth one side) hardboard, or traditional "Masonite': smooth on the face with a screen pattern on the back. Additional operations are necessary to make it practically usable, but the process of "making hardboard" is complete at this point.

• WET-DRY PROCESS MANUFACTURE •

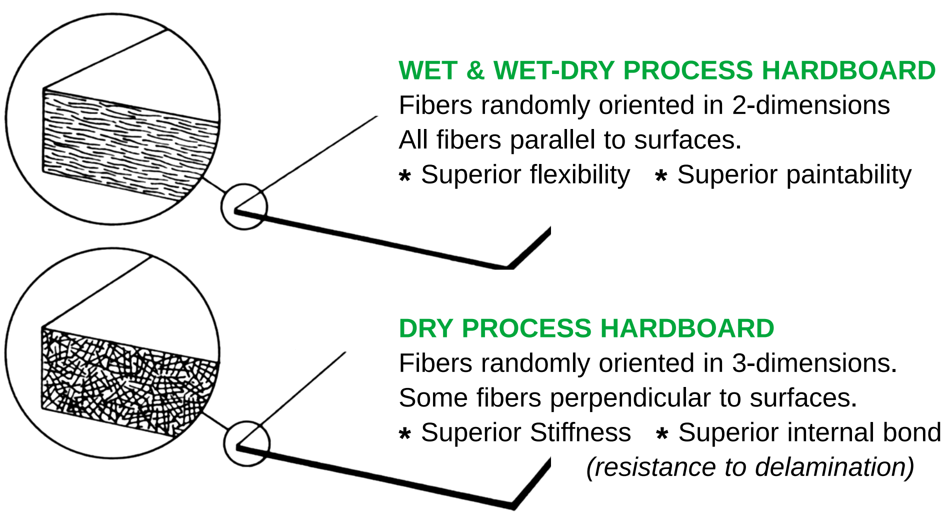
Wet-dry hardboard was invented also by Mason, a few years after the wet process. Fiberizing and mat formation is essentially the same as in the wet process. However, water in the wet mat is evaporated in a tunnel dryer before the mat is delivered to the hot press. Since no water is squeezed out in the hot press, the board may be pressed between 2 smooth plates giving a smooth 2 side (S2S) board. Pressing time is much shorter than for wet-process SIS board. Pressing temperatures are much higher, well over 400ºF.

• DRY-PROCESS MANUFACTURE •

Dry process hardboard was first manufactured in out the addition of water. The fiber is conveyed by air instead of in water slurry. Water is evaporated by heating the air and/or tumbling the fluffy fiber in a rotating drum dryer. The fiber is then blown to the “former” which is basically a large box for distributing the fiber, floored by a traveling screen thru which the air passes. Several farmers may be used in sequence so that a board can be built up in layers. Total mat thickness may be several inches to produce a finished hardboard 118” thick. The mat travels thru prepress conveyors, belts backed up by press rolls, and is then cut to length for the press. Some dry processes deliver the board to the press at moisture content of about 35%. These are called “semi-dry” and the board is carried into the press on screens making S1S board. Others dry the fibers to below 10% and press the board between 2 smooth plates making S2S Board. The hot presses are about the same as for the other hardboard processes except for wider openings to accommodate the soft thick mat.

Air formation into a thick fluffy mat results in the fibers being randomly oriented in 3 dimensions. This gives dry-process board distinctly different characteristics from wet formed board. Water formation lays all the fibers parallel to the board surface with random orientation in only 2 dimensions. The degree of “randomness” in any process may vary substantially from mill to mill.

Figure 1



The “Tempering” Process

After pressing any type hardboard may be “tempered”. Unfortunately, this term has often been misused and abused. Some manufacturers quite properly refer to a product of theirs as “tempered” even though it doesn’t conform to Class I of the Commercial Standard (**See Table 1**). Other manufacturers produce board which meets the physical property specifications of Class I but can’t be properly described as “tempered”. Terms such as “treated”, “chest-tempered”, “vat-tempered”, “core-tempered” and “heat-tempered” have contributed to misunderstanding and confusion, even though used in good faith effort to describe a particular process.

In the most commonly accepted “tempering” process, both surfaces of the hardboard are flooded with a drying oil shortly after emerging from the hot-press. Linseed oil is most commonly used. Excess oil is squeezed off and the board is then heat treated in a circulating hot-air oven for several hours to cure the oil. The oil does not saturate the board. It only penetrates a little way below the surface.

Tempering gives a harder, more paintable surface, greater strenth and more resistance to liquid water.

A "heat-tempered" hardboard is not bathed in oil after coming from the press but is simply baked in a circulating hot-air oven for several hours. This gives a substantial improvement in some physical properties, but it does not give the paint hold out, scratch resistance and liquid water resistance of oil impregnated boards.

It should be noted here that tempering improves some characteristics of any hardboard but that the basic characteristics of the hardboard remain unchanged. Therefore an untempered board produced at one plant can and often does have qualities which are superior to those of a tempered board produced at another plant.

The Humidifying Process

After pressing or heat treating all hardboard is bone dry. At this point moisture must be forced into the board to bring it to a level approaching that at which the board will stabilize when exposed to normal relative humidity. This is usually accomplished by passing the board through an oven where warm moist air (relative humidity 65 - 7O%) is circulated over it for several hours.

A recent development in the board field eliminates humidification by delivering a board from the hot press at 4 - 6% moisture. This product, medium density fiberboard (MDF) utilizes the dry process and synthetic resin to hold the board together because press temperatures are not high enough to reactivate the lignin. MDF is most economical in the production of thick boards, 1/2" and up, but thicknesses and densities overlap the hardboards.

MEDIUM DENSITY FIBERBOARD (MDF) may be considered the same as hardboard, even though it does not conform to the technical definition. For many uses they are equally suitable.

WHAT DIFFERENCE DOES THE PROCESS MAKE?

The astute buyer will want to examine the properties which emphasize the differences between hardboards to buy the one best suited to each specific use.

The Commercial Standard classifies hardboard by surface finish, thickness, and physical properties into 5 different classes. (See Table 1). All 3 processes (**wet**, **wet-dry**, and **dry**) manufacture boards which fall into all 5 classes. One would think that to find a board suitable for a particular use you need only select the class which seems to fill your needs and purchase it from any mill that produces it. Nothing could be further from the truth.

In the first place the Commercial Standard lists minimum physical properties. All hardboard plants do not produce all 5 classes but average properties from all plants exceed these minimums for the classes they produce, in some cases by a substantial amount.

Secondly the Commercial Standard does not list physical properties which are critical to many end uses. It lists only properties which emphasize the similarities of all hardboards.

Let's examine those differences.

All *wet process* hardboards are S1S. The screen back on these boards tends to shed dust in handling. This may be infinitesimal but where high gloss finishes are being applied dust contamination can cause downgrade. S1S boards are generally well consolidated, trim and perforate without flaking,

Manufacturing efficiency favors a coarse fiber which gives the products of some mills a fibrous surface which does not paint well. However, many S1S boards have excellent paintability.

S1S boards have superior impact resistance and greater flexibility compared to hardboards of the same class made by other processes.

Wet fiberizing removes some hemicellulose from the wood. This reduces the affinity of wet and wet-dry hardboard to water vapor and also makes them less attractive to termites and dry rot.

All *wet-dry process* hardboards are S2S. Wet formation deposits coarser fiber on the back than on the face side of the mat.

The two surfaces of wet-dry process S2S board are not identical.

The top surface will always be slightly more paintable and free from manufacturing defects. Wet-dry boards are pressed at much higher temperatures. They are various shades of dark brown in color. Most boards from the other processes are blond. These boards have two hard well consolidated surfaces and a slightly softer core. This gives greater stiffness and superior paintability but requires more care in trimming and perforating to avoid flaking. For all around 2 surface finishing the best of these boards are unbeatable.

Dry process hardboard may be S1S or S2S. S1S dry process board is very similar to S1S wet. Very little of it is now manufactured.

Dry process S2S board generally has poor paintability.

At some plants, precure of the surfaces of the soft fluffy mat before compression is so severe that paint will literally disappear into the board. This same problem also makes tempering less effective on dry process board. Some mills overcome this by sanding off the precured surfaces and this board can be very paintable; however the infinitesimal striations from sanding will show on high gloss, or if print patterns are made crossways of the board. Sanded boards have much less thickness variation than unsanded hardboard.

Since dry process can be formed in layers it is possible to have equally fine fibers on both surfaces.

Both surfaces of a "dry" S2S board may be practically identical.

The 3-dimensional fiber orientation of dry process board gives it greater stiffness and greater resistance to pulling apart when exposed to vertical stress. This makes it particularly suitable for laminated operations. Three-dimensional fiber orientation causes a slight increase in linear expansion compared to wet formed boards.

The most serious weakness in dry process manufacture is the difficulty in reducing the variables from the wood furnish. Wet process plants store the fiber slurry in large tanks with constant in and out flows, which buffers short term variables from the wood furnish so that many are eliminated or reduced. Dry plants have no such tanks. Every variable that enters with the wood furnish goes directly to the forming machine. The best of the dry plants exercise extreme control measures on the wood supply to make an acceptable product. With poor control the board becomes so variable as to be totally useless for any critical application.

Plant to Plant Variations

There are more property variations between boards from different mills than from different processes. The most important factors are the source of the raw materials and the primary market or markets for which the mill manufactures.

Mills using the same process may produce boards having vastly different characteristics, often even greater than those from mills with different processes. Besides the design of individual mills, the most important factors are source and species of wood supply and the primary markets which the mill intends to serve. Source and species determines the number of variables introduced to the plant. Primary markets determine the degree to which management must eliminate these variables. For instance, a mill using all sorts of saw mill waste, chips, shavings and sawdust will have many more variables to deal with than one using only one species of round pulpwood. By the same token a mill selling much of its production for “hidden” applications such as case backs, dust stops and furniture drawer bottoms will have much less expertise and necessity for producing a more uniform a product such as would be made at a plant supplying manufacturers of high quality wall paneling.

Large mills with several production lines may supply different markets from different lines. In such cases the careful buyer may want to specify the line from which his board will come. The same board class (per Table 1) made on different lines may have quite different characteristics.

CLASS VARIATIONS

The classes of hardboard (Commercial Standard Table 1) generally go down in density and price progressively from Class #1 to Class #5. Density measures only the weight per cubic foot.

Density does not necessarily determine the suitability of a board for any end use.

High density boards are generally stronger but may have poorer dimensional stability or be deficient in some other attribute such as paintability or fabricating quality. The Commercial Standard emphasizes strength measurements of “modulus of rupture”and “tensile strength”. However, for many applications the total load the board will carry, as measured by its “transverse strength”, may be more important. That is, a slightly thicker board may be stronger even though it has a lower “modulus of rupture”.

Similarly, tempering does not necessarily make hardboard better for all applications. For pre-

• **TABLE I** •

CLASSIFICATION OF HARDBOARD BY SURFACE FINISH, THICKNESS AND PHYSICAL PROPERTIES

Class	Surface	Nominal Thickness	Water resistance Water absorption based on weight		(max av per panel) Thickness swelling		Modulus of rupture (max av per panel)	Tensil strength (min av per panel)	
			S1S	S2S	S1S	S2S		parellel to surface	perpendicular to surface
		inch	percent	percent	percent	percent	psi	psi	psi
1 Tempered	S1S and S2S	1/12	30	–	25	-	7000	3500	150
		1/10	20	25	16	20			
		1/8	15	20	11	16			
		3/16	12	18	10	15			
		1/4	10	12	8	11			
		5/16	8	11	8	10			
		3/8	8	10	8	9			
2 Standard	S1S and S2S	1/12	40	40	30	30	5000	2500	100
		1/10	25	30	22	25			
		1/8	20	25	16	18			
		3/16	18	25	14	18			
		1/4	16	20	12	14			
		5/16	14	15	10	12			
		3/8	12	12	10	10			
	S1S and S2S	1/8	20	25	15	22	4500	2000	100
		3/16	18	20	13	18			
		1/4	15	20	13	14			
		3/8	14	18	11	14			
4 Service	S1S and S2S	1/8	30	30	25	25	3000	1500	75
		3/16	25	27	15	22			
		1/4	25	27	15	22			
		3/8	25	27	15	22			
		7/16	25	27	15	22			
		1/2	25	18	15	14			
	S2S	5/8	–	15	–	12			
		11/16	–	15	–	12			
		3/4	–	12	–	9			
		13/16	–	12	–	9			
		7/8	–	12	–	9			
		1	–	12	–	9			
		1-1/8	–	12	–	9			
5 Industrialite	S1S and S2S	3/8	25	25	20	20	2000	1000	35
		7/16	25	25	20	20			
		1/2	25	25	20	20			
	S2S	5/8	–	22	–	18			
		11/16	–	22	–	18			
		3/4	–	20	–	16			
		13/16	–	20	–	16			
		7/8	–	20	–	16			
		1	–	20	–	16			
		1-1/8	–	20	–	16			

finished uses subject to severe wear and tear it generally offers an advantage in scratch resistance of paint coatings. It sheds liquid water better than untempered board but tempering does not improve dimensional stability. Extra strength alone usually does not justify the price of tempered board. Adequate strength can generally be found in other classes or from other manufacturers. Color also does not indicate the suitability of hardboard for any particular end use.

Dark boards are not necessarily or even commonly stronger than light colored boards.

In summary, despite their complexity, hardboards are really not a jungle of confusion. This article has stressed the variables in hardboard process and properties. These differences are, in reality, benefits to the knowledgeable buyer, for they mean that in them there is a hardboard just right for most every use.

The searcher should ask:

By what process was it made?
What class is it?
What plant and production line manufactured it?
Know the properties which are meaningful to your particular use and keep an open mind.

About The Authors

R. M. "Bob" Granum, Founder and present Senior Chairman of Panel Processing, Inc., has been involved in the hardboard industry since 1957, holding positions in research and production as will as in top management. He is one of the nation’s leading experts on the types of hardboard manufactured worldwide. During early years of the Company’s existence he authored and co-authored a series of articles aimed at correcting misconceptions and answering commonly asked questions regarding hardboard. Although some of the references he made in composing these articles have become outdated, the basic information presented continues to be a valuable source of reference for industrial consumers.

O.B. Eustis has been involved in building products manufacture, reasearch and development for 43 years, most of the time as an executive of major hardboard producers. After retirement, O.B. remained active as a consultant to the industry."