

Plywood and Wood Bending

Jesse - Kalob - Evan

Content

Plywood and Wood bending

History

Concepts

Techniques

- Laminated
- steam

2-sided forms (industrial process) vs 1-sided forms (vacuum forming)

History all over the World

Used in different parts of the world differently and similarly.

- Native Indian of the **Americas** bends wood to make snowshoes, sledges, and canoes.



In Northeast **Japan**

- Old community makes traditional snowshoes called as “Kanjiki.”

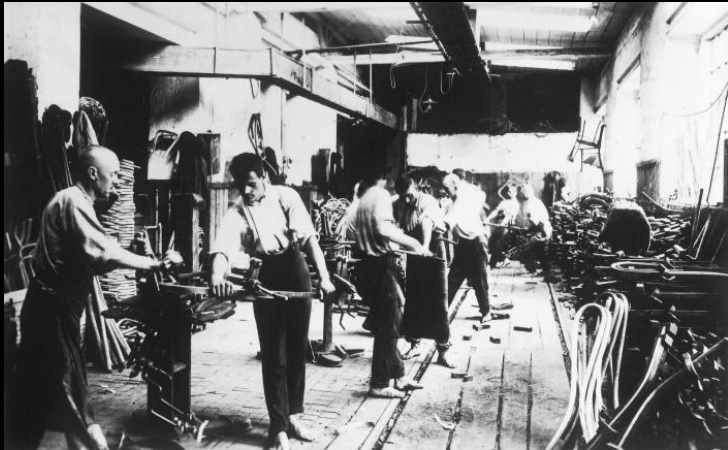


Bending Method

- bends wood on the pot
- covered and steam
- pressed to desired shape

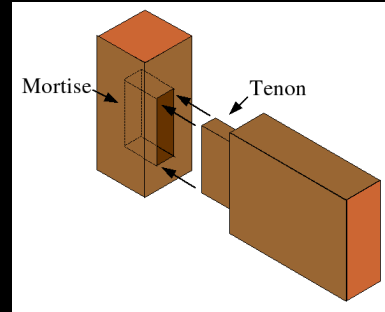
Michael Thonet (1796 - 1871)

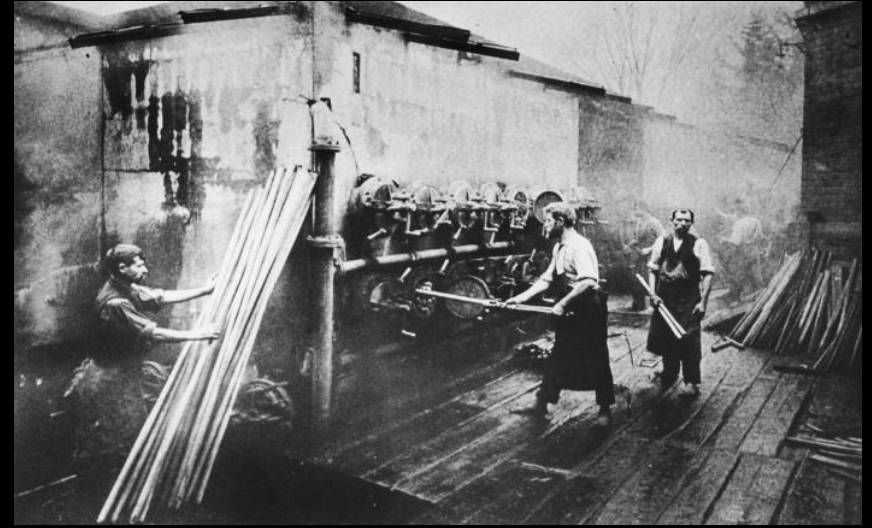
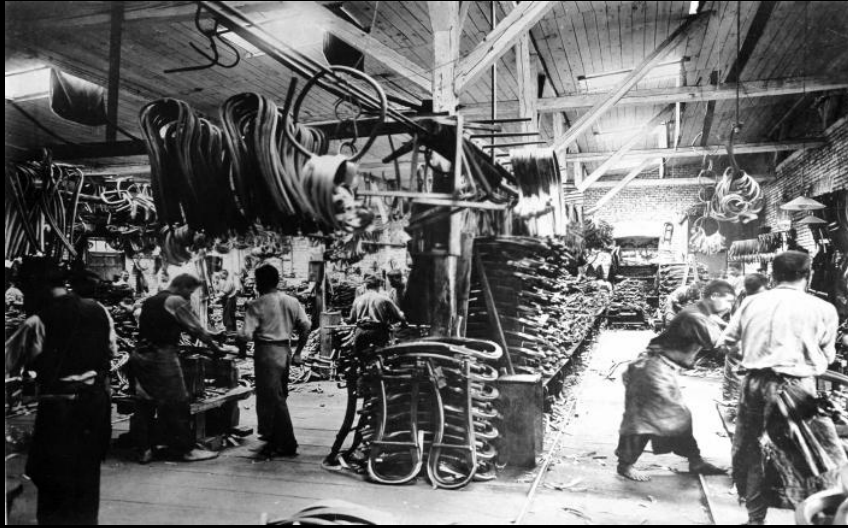
- Carpenter, inventor, and furniture designer
- Bentwood Furniture Factory in Hostynem, Czech Republic, 1861
- 1830s began producing laminated and steam-bent chairs in **Europe**
- technique used for a long time such as the slat back chair and the ladder back chair (already existed in the middle ages 1100-1450)



Before Thonet, and afterward

- Samuel Gragg (1772 - 1855) patented his “elastic chair,” in 1808.
- First piece of **American** Furniture to feature a bentwood, cantilever back.
- Steam bent hickory, assembled with mortise and tenon.

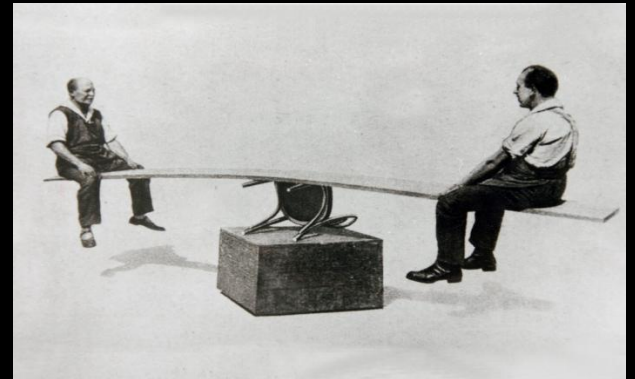




TON Factory (150+ years)

Factory chairs successfully passed more than a century without stopping production and today TON is an important European center of production quality of bentwood furniture.

Today, the company TON with Czech and international designers such as Tom Kelley, Mojmír Ranný, design studio Olgoj Chorchoj and a number of young designers. For bentwood chairs acquire these designers prizes and awards at world exhibitions seating.



The concept of wood bending

Manipulating the material that is typically rectilinear to attain a desired curved form



Plywood laminating

- Using individual strips that are thin enough to allow for a bend in the wood, due to the nature of the material, and gluing these together to dry in the curvature desired



Wood

- Adding moisture and or heat to the wood causing the wood to become malleable enough to bend as desired
- Cutting a series of kerfs into one side or in an offset pattern of the wood which allows it to bend in one or two directions and gluing it to hold its form (Because of the cutting away of the material, it loses a lot of strength)

Laminating Technique

Start by drawing a template for the form of the curve

- pencil drawing will allow for easy adjusting as you design the template

-Cutting individual pieces of laminate

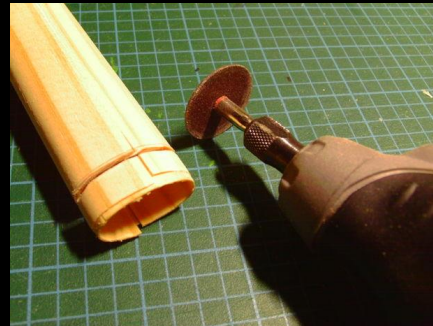
- the pieces should be thin enough to bend around the form with minimal pressure applied

- the thickness necessary will depend on the type of wood and the length of the pieces

- springback is the main concern here

-Gluing these pieces together, apply it liberally and using tape to hold in place

-The bent wood should now be left to dry and after can be trimmed and sanded to remove excess glue and assure the pieces are flush to one another



Laminating technique continued

- Making forms that can be one or two sided and applying even pressure to them using clamps or vacuum method if available

 - Two sided forms contain a male and female side, where the female side is convex and is typically cut into sections

 - If the form will be used a lot, MDF would not be recommended as it will wear out quickly, if not MDF will be suitable

- dry clamping is an important process to test the wood before applying glue

- glue that requires mixing is recommended to prevent glue creep from occurring.

 - glue should be rigid after drying and not allow a lot of movement when curing

- clamps should be first applied at the curves and then at the ends loosely and then tightened down from one end to the other to allow access glue to be pushed out and wiped off

 - clamps should be perpendicular to curve



Steam Bending Technique

When heated, wood fibers are said to become slightly plasticised, that is to say they can be bent to some extent because they become softer

When the combination of water and heat is added this effect is increased

-there are a number of ways in which to add water and heat to the wood including:

heat blankets, soaking in water, steaming, microwaves, etc

-Again the amount that the wood will bend depends on the species of wood being used, but each piece will vary slightly

-there are charts available that list which woods will bend better

If using a steamer:

keep the internal temperature of a steamer at 212 F

-Rule of thumb: one hour of steaming per inch of wood thickness

-**Compression straps** are used when removing the wood from the water or heat source and allow the wood to be compressed into the bent form using bolts and wood blocks to hold the bent wood in place

-Clamps can also be used to hold the wood in place while it cures

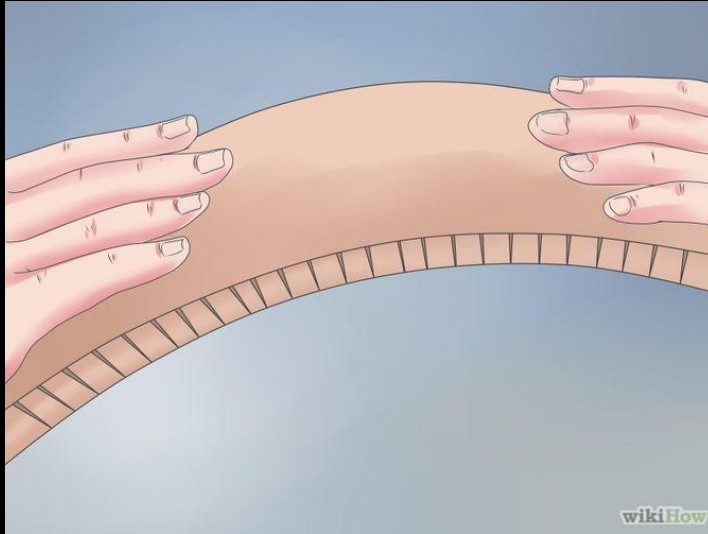
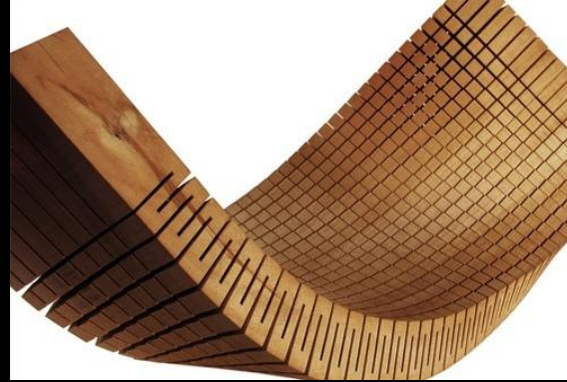
-Gradually apply pressure to the wood testing that it is not beginning to crack as pressure is applied until curve is reach

-wood should cure for at least 24 hours to retain its form

Species	Unusable Bends	Marginal Bends	Good Bends
Alder	7	3	0
Ash	0	2	8
Domestic Cherry	3	4	3
Hard Maple	3	3	4
Hickory (Pecan)	0	2	8
"Honduran" Mahogany	8	2	0
Pine	9	1	0
Red Oak	0	1	9
Soft Maple	3	2	5
White Oak	0	2	8

Kerf Bending technique

Kerf refers to the cut of the width of the wood.



-By making a series of these cuts the wood bend into the space cut out but careful cuts must be made to not cut too far through the wood.

-if using cuts on both sides, stagger the cut line to increase the strength and prevent tearing (same way bricks are staggered)

-This process inevitably causes the wood to lose strength because the material will be cut very thin in some places

One sided vs. Two sided forming

Industrial, vacuum, and other.

Plywood

One sided forms

Uses a basic form on one sided of the material, with layers of wood glued together and then clamped, or vacuum formed.

Two sided forms

A primarily industrial process used for producing larger quantities of furniture. A two piece mold presses the layers of wood and glue together from both sides. These molds use high pressure and often times heat as well.

Wood

Usually bent and fit to a form using steam and heat, and then kiln dried to help hold the shape.

Cold bending is also possible using wood with a higher moisture content, letting it dry, and then finishing in a kiln.

Straps are often used instead of a two sided form, holding the wood to the form using tension.

<https://www.youtube.com/watch?v=VCzNJgYPftc>



Industrial radio frequency two-sided wood press

Others

-Other concepts, techniques and products in wood bending.

Woodskin

A wood and textile composite that creates a flexible piece of wood with triangular panels.



Wood Vacuum Test



Procedure

Ribbed form

- from Rhino to CNC mill to woodshop
- two different curves

Sheets

- cut into 7inches wide sheets for layering

Layering

- glued both sides of the sheet for maximum attachment

Form + Layered sheets

- taped the sheets onto the form to be intact

Vacuum sealed

- turn on machine until all air are vacuumed
- keep inside the bag for several hours



Links

<http://parametricwood2011.wordpress.com/page/14/>

<http://www.fastcodesign.com/1669956/watch-the-handmade-process-behind-your-eames-chair#1>

<https://www.youtube.com/watch?v=TXAeLwJ8fcw>

<http://www.joewoodworker.com/>

<http://www.joewoodworker.com/veneering/vacuumforming.htm>

<http://www.joewoodworker.com/veneering/getting-started.htm>

http://www.bendywood.info/index.php?option=com_frontpage&Itemid=1

<http://www.upmgrada.com/>

<http://www.wikihow.com/Bend-Plywood>

<http://www.finewoodworking.com/how-to/video/free-form-steam-bending-technique.aspx> (video steam bending)

<https://www.youtube.com/watch?v=TXAeLwJ8fcw> (video plywood laminating)

<http://www.ces.ncsu.edu/nreos/wood/Under%20Utilized%20Species%20Project/workshop%20pdfs/session%20%20frame%20workshop%2008.pdf>

<http://www.fpl.fs.fed.us/documnts/usda/ah125.pdf>

[http://www.tai-workshop.com/english/tech-2\(b\)-e.html](http://www.tai-workshop.com/english/tech-2(b)-e.html)

<http://www.tai-workshop.com/english/tech-2%28b%29-e.html>

<http://www.furniturelink.ca/bentwood.htm>

<http://www.atan.cz/tonetky/>

<http://www.tomraffield.com/about/steam-bending.php> <http://books.google.com/books?>

[id=VrENESuik3cC&pg=PA61&lpg=PA61&dq=wood+bending++history&source=bl&ots=nRCgXXyll2&sig=SFG9-nN3vcvJW69xx66dOMlwKs&hl=en&sa=X&ei=oxIPVMiVK8_BggSXIYGoDg&ved=0CB0Q6AEwADgK#v=onepage&q=wood%20bending%2020history&f=false](http://books.google.com/books?id=VrENESuik3cC&pg=PA61&lpg=PA61&dq=wood+bending++history&source=bl&ots=nRCgXXyll2&sig=SFG9-nN3vcvJW69xx66dOMlwKs&hl=en&sa=X&ei=oxIPVMiVK8_BggSXIYGoDg&ved=0CB0Q6AEwADgK#v=onepage&q=wood%20bending%2020history&f=false)

[nN3vcvJW69xx66dOMlwKs&hl=en&sa=X&ei=oxIPVMiVK8_BggSXIYGoDg&ved=0CB0Q6AEwADgK#v=onepage&q=wood%20bending%2020history&f=false](http://books.google.com/books?id=VrENESuik3cC&pg=PA61&lpg=PA61&dq=wood+bending++history&source=bl&ots=nRCgXXyll2&sig=SFG9-nN3vcvJW69xx66dOMlwKs&hl=en&sa=X&ei=oxIPVMiVK8_BggSXIYGoDg&ved=0CB0Q6AEwADgK#v=onepage&q=wood%20bending%2020history&f=false)