WOOD BENDING

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Wood Bending

- Wood bending is an ancient craft that is of key importance in many industries today,
- Of the several methods commonly used to produce curved parts of wood, bending is the most economical of material
Wood Bending

- Wood bending is one of the techniques used in the wood processing from a long time ago

- boat, barrel, violin, Applied Mechanics in Wheel-Making
In Europe, this technique already been used for a long time in the making of chair such as the slat back chair and the ladder back chair that already existed in the middle ages (1100-1450) and often could be seen in their wood block print and the copperplate print.
Their method of bending the wood is to place the material directly on the pot, put a cover on it, and after steaming it for a while they just press it to the desired shape.
Yet commercial operations often sustain serious losses because of breakage during the bending operation or the fixing process that follows.

There is a longfelt need for more reliable knowledge about: (1) **Criteria** for selection of bending stock (2) more efficient **machines** for the bending operation (3) techniques for **drying** and fixing the bent part to the **desired shape**
Michael Tohnet

- The person that responsible to transfer bending technique so that it could be used in the mass production was an Austrian Michael Tohnet (1796-1871).
Tohnet's bending method

- Applying a heat to get a ductility - general technique of bending.

- Tohnet's method uses a pure material, where using a heat to ductile the material, then bending is done using a **bending strap** and a **former**.
Fig. 110 Simple wood bending bench jig showing blocks and wedges to righthand side

Fig. 111 A simple wood bending jig with wood end-stops and wedges
A male and female mould typically used for production of larger quantities of laminated or formed-plywood parts.
- **steel band former** mould [3] is less costly to produce than male and female moulds and can apply considerable pressure to the glue line.
His bent wood chair was very epoch-making, not only in the aspect of making method but also in the aspect of design. This is because, his chair was completely different compare to the others, very light, strong, the components were assembled using a screw that was also made from a wood, make it lot easier to fix it when the chair is broken.

Moreover, there were no excessive decoration, with most of the components in its structure took a curve shape that make it looks simple and couldn't be found in other chairs at that time, its functions that closed to the daily life and the practicality it has, all these things had made it to become the forerunner for the modern chair. After that, his chair received lots of recognition in the expo and exhibition, made his light and modern bent wood chair to become
Title: Folding Chair
Designer: Thonet
Manufacturer: Thonet, Vienna
Date: c 1910
Title: Armchair
Designer: Luis Feduchi Ruiz
Manufacturer: Lledó, Valencia
Date: c 1933
Title: Armchair
Designer: Alvar Aalto
Manufacturer: Huonekalu-ja Rakennostyötendas, Turku, Finland
Date: 1931-1932
- **Title**: Ant Chair
- **Designer**: Arne Jacobsen
- **Manufacturer**: Fritz Hansen
- **Date**: 1952
- **Title:** Butterfly Stool  
- **Designer:** Sori Yanagi  
- **Manufacturer:** Tendo Co., Ltd., Tokyo  
- **Date:** c 1956
- **Title:** Stool
- **Designer:** Reiko Tanabe
- **Manufacturer:** Tendo Mokko Inc., Yamagata-Ken
- **Date:** 1961
**Title:** Twins Tables  
**Designer:** Gary Van Broekhoven  
**Manufacturer:** Midform/GVB  
**Design Date:** 2004
Title: Eco-Eden
Designer: Peter Danko
Manufacturer: Peter Danko Design Inc.
Date: current
Clifton Monteith

Clifton Monteith, Carlton Chair, 2010, willow aspen and gold leaf, 41 x 34 x 74”
Matthias Pliessnig

Left: Matthias Pliessnig, Thonet No. 18, 2007, steam bent white oak, Thonet café chair, 27 x 22 x 42”
Right: IN PROCESS, Matthias, Pliessnig, Pinch, 2012, steam bent white oak, 50 x 30 x 27”

http://www.youtube.com/watch?v=Cz_sMRWRE94
Matthias Pliessnig

- A Deviated Path, 2006, ash, 168 x 27 x 23 inches.
Matthias Pliessnig
Michael Cooper, Big Bang Theory, various hardwoods, steel, aluminum, 2010, 65 x 53 x 37”
Thonet Bike by Andy Martin
Pure Timber
Cold-Bend™ hardwood undergoes extreme physical, longitudinal thermo-mechanical compression. There is no chemical treatment, or glues used in the process. Cold-Bend™ hardwood is solid hardwood that has been selected and milled to yield clear lumber. It is carefully controlled for moisture content. Cold-Bend™ hardwood is not modified in any way except for the extreme compression and the careful quality selection and moisture control required for its extreme bending qualities.
Pure Timber Designs

- Cherner Chair
Pure Timber Designs

- Damian Barton
- Brian Buchik
Bending Forms

The Beginning..
Design a Piece of Furniture
Creating your Form

Step 1
Start by drawing your form on a piece of paper...

This particular example uses laminated wood pieces.
Types of Bending Forms

One-Part Form

Two-Part Form
Ideal Form Setup

1. Draw part to full scale.

2. Divide female part of form into sections 4 in. to 6 in. in length.

3. Use your clamps to determine block widths.

4. Make marks for clamp holes.
Drawing the Form

1. Initial drawing
2. Detailing the form
3. Using clamps to secure
4. Final adjustments
Production

1.) Transfer initial drawing to MDF

2.) Cut Multiple pieces to stack on top of one another
Assembly

1.) Apply Glue to Each Layer
2.) Screw Layers together
3.) Attach Guide Blocks
4.) Drill Socket Holes
5.) Cover Every Piece of Form Work with Cellophane Tampe
Cutting Laminates
Determining the Thickness

To Thick

Just Right
Understanding Springback

Predicting springback

Y = springback
X = rise (in inches)
N = number of laminates
Y = X/N^2

N=12

X= 6 in.

Y=0.04 in.

Bending form
Cutting Laminates - Drawbacks

**Tablesaw**
- 2 ½ Inch Limit
- Glazing or Burn Marks

**Bandsaw**
- Material Waste due to nature of the Machine
Physically Cutting on TS v.s BS
Dry-Clamping and Choosing Glue
Why Dry-Clamp?

Measure Twice, Cut once…same idea as dry-clamping
Bar Clamps
Glue? What not to use

Glue Creep or Cold Creep
Ideal Glue
Preparing the Glue
Gluing Up & Clamping
Gluing
Clamping
Improper Clamping
Milling the bent lamination
Shaving Excess Glue

- During this process, wood may shift
- Clamps are removed to reveal bent lamination
- Remove excess glue with a hook scraper
Always wear appropriate safety gear

3 things to remember while using a hook scraper

1. requires two hands
2. work slow
3. always have a sharpened scraper
To me, the best option to use for the laminated edges is the belt sander with a 120 grit belt.

Milling the edge of a piece of bent lamination is very similar to milling the edge of a piece of plywood.
Sanding

The inside part of the wood is more difficult to sand.

Use an insert to sand a gradual radius.

Made of thin wood, this piece fits under the belt of the sander.
Milling the bent lamination

Steps:

- 1. Scrape the glue
- 2. Lightly sand the edges
- 3. Feed the bent lamination
- 4. Sand the face
- 5. Place an insert
Sanding Continued

- The wooden insert makes the surface of the belt curved or *convex* to allow for easy sanding of the inner surface or *concave*.
- After using a belt sander, it is recommended to sand by hand to eliminate as much glue as possible.
Setting Up for Steam-bending
Steam-bending

Success factors:

1. wood species
2. straightness of the grain
3. steam box temperature
4. steaming duration
5. applying enough end pressure

- The process of using steam heat to make wood flexible enough to bend
- Steam bending is extremely difficult and there are many ways to ruin the wood
- The materials for this process are readily available and are not expensive
Creating a Steambox

- Exterior plywood or solid pine are appropriate types of wood for the box.
- Use coated deck screws, regular steel can be bad for the woods appearance.
- Use shelves within the box to allow better airflow around the wood being bent.
- Conducting and venting the steam.
- Too much steam in the box can cause an explosion.
- Not enough steam will obscure the way the wood bends.
- It has to be perfect.
How to Generate Steam:

- PVC pipe can also connect to a steambox
- There is a relationship between the size of the box and the size of the boiler. The box has to be at a minimum of 200 degrees Fahrenheit.
- Steam Kettle
- Large, homemade boiler
- Turkey fryer
Steam bending is very similar to bent lamination.

These two processes differ in terms of shape and strength.

Springback will always occur during steam bending.

Assume that the wood will spring back 15 to 20% after steam bending.

Trial bending on practice wood can help an individual prepare for the actual bending of the final project.

People have to experiment with different wood types to understand how wood bends.

http://www.youtube.com/watch?v=YjQOuKLow3w
Make the bend

- Test different pieces of wood and see how well they can bend.
- The best wood for your project is some that does not break too easily.
- How does the wood react to the steam?
- Directly after the wood has been steamed, it should be brought over to the bending form.
- The bending form must be clamped to something so that it does not move around.
- If the wood is thicker than ½ inch it will need a compression strap.
- With the correct amount of pressure bend the wood over the form.
Making the Bend

Steps:

1. Set the piece
2. Clamp the piece of wood
3. Start bending the piece
4. Use clamps and clamping blocks
5. Leave alone
6. Undo clamp and place on cooling form

http://www.youtube.com/watch?v=nwTFw8Ol2o4
Why Do Bends fail?

- A. The outside or *convex* part of the wood can be stretched too much
- B. Species selection
- C. Flaws in the wood such as knots
- D. Grain run out, this flaw is very noticeable
- E. Insufficient heat or too much heat
A Compression Strap
Steam bending using a Compression Strap

- It is very difficult to bend wood
- A compression strap can make bending wood possible
- Compression works in many ways
  - With any object, bending requires that something gets shorter, in this case the concave or the convex
- Breakage mostly occurs on the outside of the bend
- You have to limit the amount a piece of wood can stretch or it will break
- The key to bending successfully is to get the inside concave face of the wood to compress. The back board of a chair is a good example
- Compression strap is a flexible metal strap with fixed blocks at each end
- The strap stays in place on the convex face of the piece during the bending
- As the piece bends, the end blocks apply pressure and as the outside attempts to stretch it is restricted by the strap
How to make a Compression Strap

- A compression strap can be made in many different ways
- 1. Use metal strapping - readily available, last for only a few bends, cheap
- 2. Make the end block - make it fit the part your bending
- 3. Extend the handle - helps to keep the end block in line
- 4. Drill through the handle, end block and strap
- 5. Bolt the other end in place
Bending with a Heating Blanket
Bending with a heating blanket

- Old techniques involved hot stovepipes to bend wood
- Technological advances makes it easier
- Electric heating pads, heat guns and hot pipe setups
- Heat the wood, bend slowly and repeat as necessary
- Bending solid wood with a heating blanket is possible
- An example is done on a ½ inch piece of red oak. This is a potential back chair board
Steps for Using a Heating Blanket

1. Preheat the piece
2. Turn on the heating blanket
3. Place the heating blanket
4. Allow the piece to bend on its own