

# THE CHLOE ROCKER

## KEVIN MCELROY



# INSPIRATION + OBSERVATION + WORKSHOPS

I flipped through a lot of books and sat in/measured/looked at a lot of chairs. In the end I decided to build this chair for Chloe to be cozy in but everyone who sat in it said it was super comfortable. I was building an heirloom chair, for Chloe to sit in with are soon-to-be-born son or daughter, a chair for me to grow old in, a chair to pass on one day. Are you building a chair for yourself, for someone else, or for everybody?

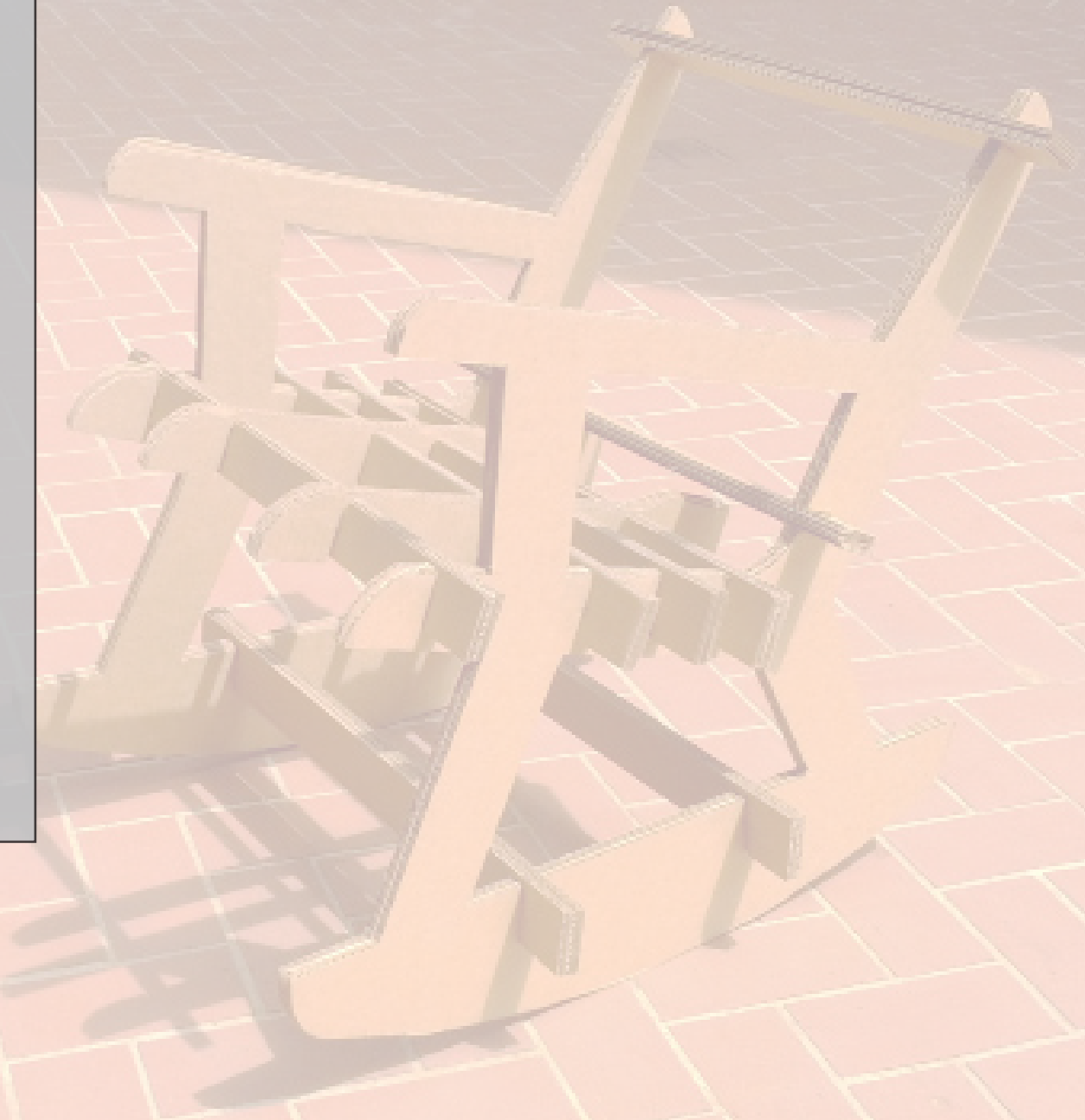
Craig Milroy (PRL) and Dan Tiffany (Sculpture Lab) organized a few hands-on workshops for us. I attended the fiberglass, steam-bending, and bent lamination workshops. Seeing all the fiberglass, plastic, and epoxy solidified my feelings about how nasty the fiberglass and bent-plywood processes are so I committed to wood. I originally intended to steam-bend a solid piece of walnut for each rocker, but was talked out of it. It would be difficult to get two identical rockers and a bent lamination will be more stable over time.



## PROTOTYPE IN CARDBOARD

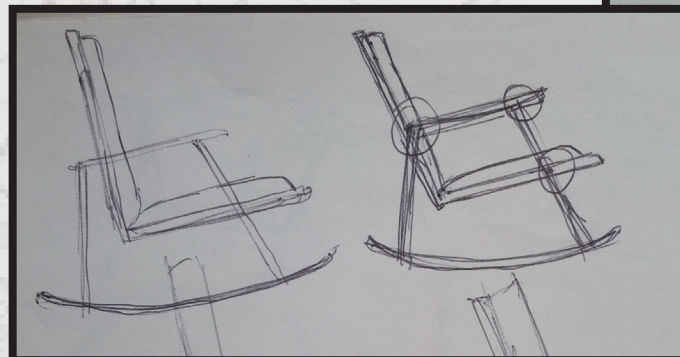
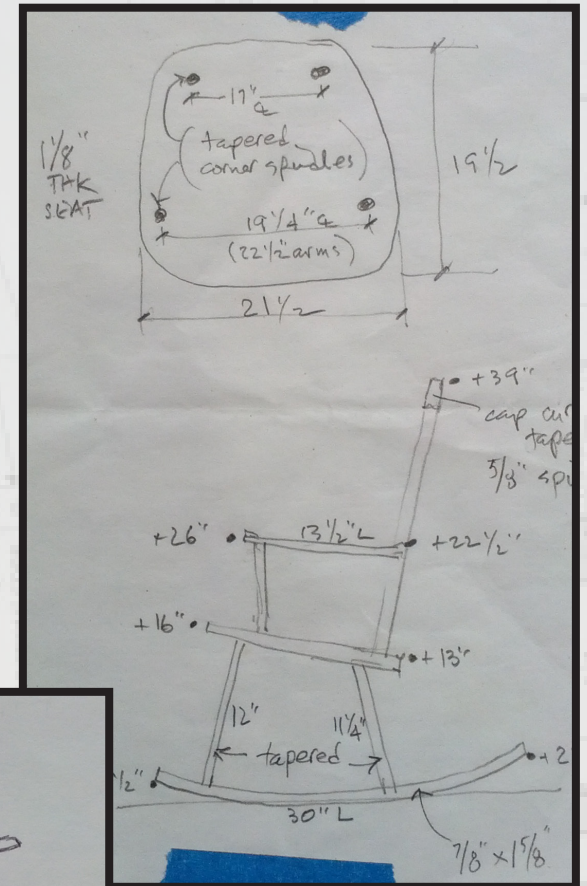
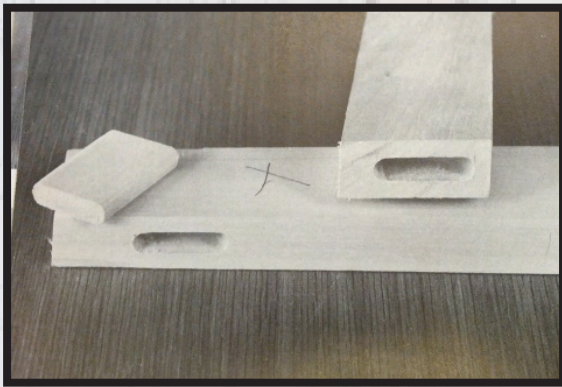
The assignment given the first week of class was to design and build a working chair from cardboard. I decided to build a cardboard rocking chair.

I'm not sure how helpful this exercise was. Since we were in the very beginning stages of our design exploration, it was a bit of a sidetrack to jump right in to building something. And learning the properties of cardboard didn't help at all with my final product. That said, it was cool to see what the rest of us came up with. The designs were all over the place and some of them even held weight. My advice to you, young chair designer, is to use this as an opportunity to explore some aspect of an idea for a chair that you are considering. There are a lot of cardboard chairs on the internet, make a better one!



# SKETCH & OBSERVE + ERGONOMICS STUDY

This is when I started to get excited about wood joinery and I knew my chair would go in that direction. I started looking at rocking chairs and taking measurements. There are a couple good books about wood joinery in the PRL wood shop. The Measure of Man and Woman by Alvin Tilley and Henry Dreyfuss Associates gives some good information for seat heights, angles, widths, etc. I based my measurements heavily on a drawing my Dad made of his rocking chair (a gift from my mom's mom), which I like, then made a few adjustments for Chloe.



## PROTOTYPE IN WOOD

I designed a plywood and maple box, fully upholstered, sandwiched by two walnut arms/legs/rockers. I liked not having any cross-pieces below the chair to connect the legs.

I built a full-scale prototype using scavenged 2x2s, 2x4s, and 3/4" plywood. I cannot stress enough how much this helped me figure out the ergonomics of a rocking chair:

Craig Milroy sent me an article about rocking chairs and I grabbed a couple juicy bits: "Old chairs are the best teachers." A good rocker has a radius of 42" (diameter 84"). Only about 8" of a rocker contacts the ground and the rest is aesthetic.

To create the arm/leg/rocker profile I sketched out a full-size drawing on butcher paper, doing plenty of editing until I had the dimensions and the rough look I wanted. Then I transferred this to plywood.

The router table is your new friend. Practice using a straight flush-trim bit. I grabbed a section of a 42" radius circle in Illustrator and laser cut it in 1/4" duron, then traced the arc to a piece of 3/4" MDF. Rough-cut the MDF as close to the line as possible without going over. Attach the duron pattern to the MDF using machinist's (double-sided) tape (PRL), or screw it on (when you use your final wood, you won't be screwing on your pattern since you won't want holes in your \$50 piece of walnut. So get used to using double-sided tape). Note that the router bit will chew up the edge of the Duron with even slight pressure, so be gentle. Transfer your duron pattern to 3/4" MDF immediately, then use that as your pattern.

**IMPORTANT:** Securely affix your pattern to your wood so it doesn't slip. The router is probably the most dangerous tool in the wood shop, make sure you know what you're doing before setting it up and operating it. Ask a TA or Craig Milroy.

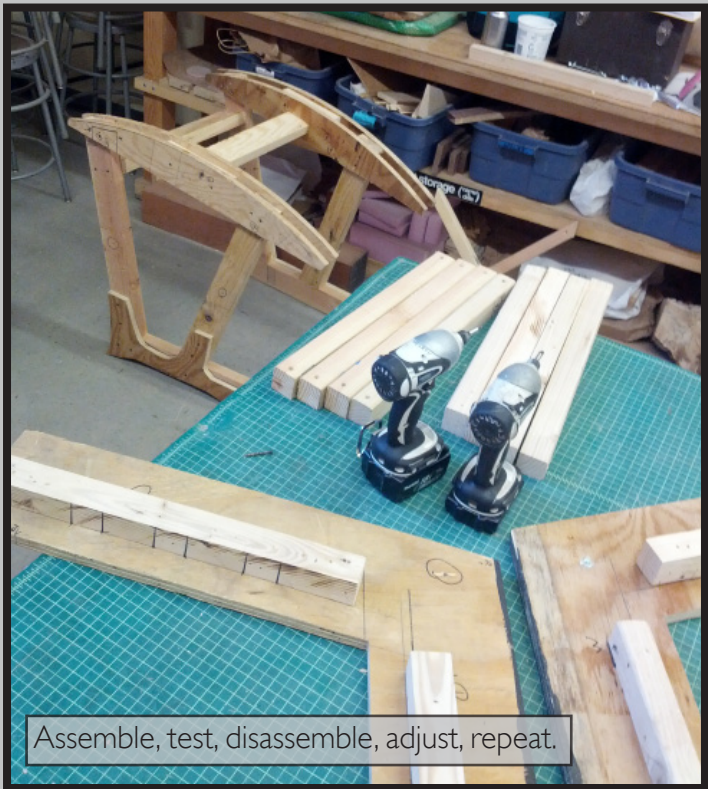


This is what happens when you push Duron too hard against a flush-trim router bit.

## MORE ON THE WOOD PROTOTYPE

I built the prototype to be adjustable and easy to tweak. At one point I took it completely apart, hacked it up to change almost every dimension, and screwed it back together. Only took an hour or so.

It also just felt nice to have a working prototype that was sort of comfortable and rocked like a dream (especially after I had failed the cardboard challenge).



## UPHOLSTERY AND FOAM

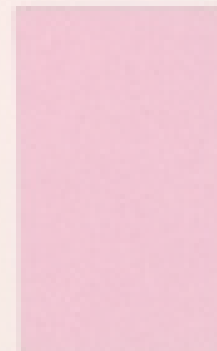
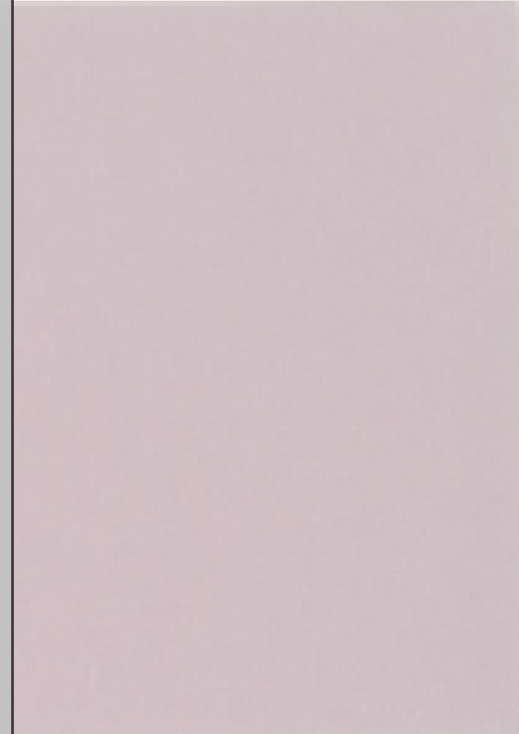
A former student recommended Jeanne Henzel of Joona Creates in Oakland to do my upholstery. The quality of her work is tops but if you want to hear why I won't work with her again please contact me, I won't go into it here. Basically there are cheaper and closer options out there. My project was big but it wasn't complex enough to warrant the inconvenience of traveling to Oakland to pay her price. She would be worth the money if your piece is super complex or massive.

That said, I wouldn't have been able to do this myself so I am grateful for her good work. I am happy with the seams and how the fabric sits on the foam. The seat is a little bulkier than I imagined it would be but that is my error in not designing it better or communicating my needs to Jeanne. She installed springs under the seat foam and webbing behind the back foam.

Knoll has a showroom in San Francisco where you can see all of their fabrics but unfortunately they are closed on weekends. Design Just Out of Reach has a book of Knoll fabrics at their Palo Alto store. You can order complimentary 10" square samples from [knoll.com](http://knoll.com), delivered for free in 2 days. The catch is you can only order 5 per day so I ordered 15 over 3 days, I wish I had done it sooner. I chose a 100% wool because I don't dig synthetic fibers and Jeanne told me she can use tailor's tricks to steam wool to get it to cooperate around tough corners without bunching.

Per Jeanne's advice I ordered my 3" foam from [foamorder.com](http://foamorder.com). They are a San Francisco company so I picked up my two custom cut 3" thick pieces of latex foam at their SOMA warehouse and delivered them with my chair to Jeanne. I chose a medium-firm density (N45) for the seat and a soft density (N25) for the back. Apparently it's easy to make the seat back too firm. It was my choice to spend a little more money to go for a natural latex foam, rather than a cheaper nastier variety.

KnollTextiles



K120718 Grey

K120719 Tangerine

K120717 Purple

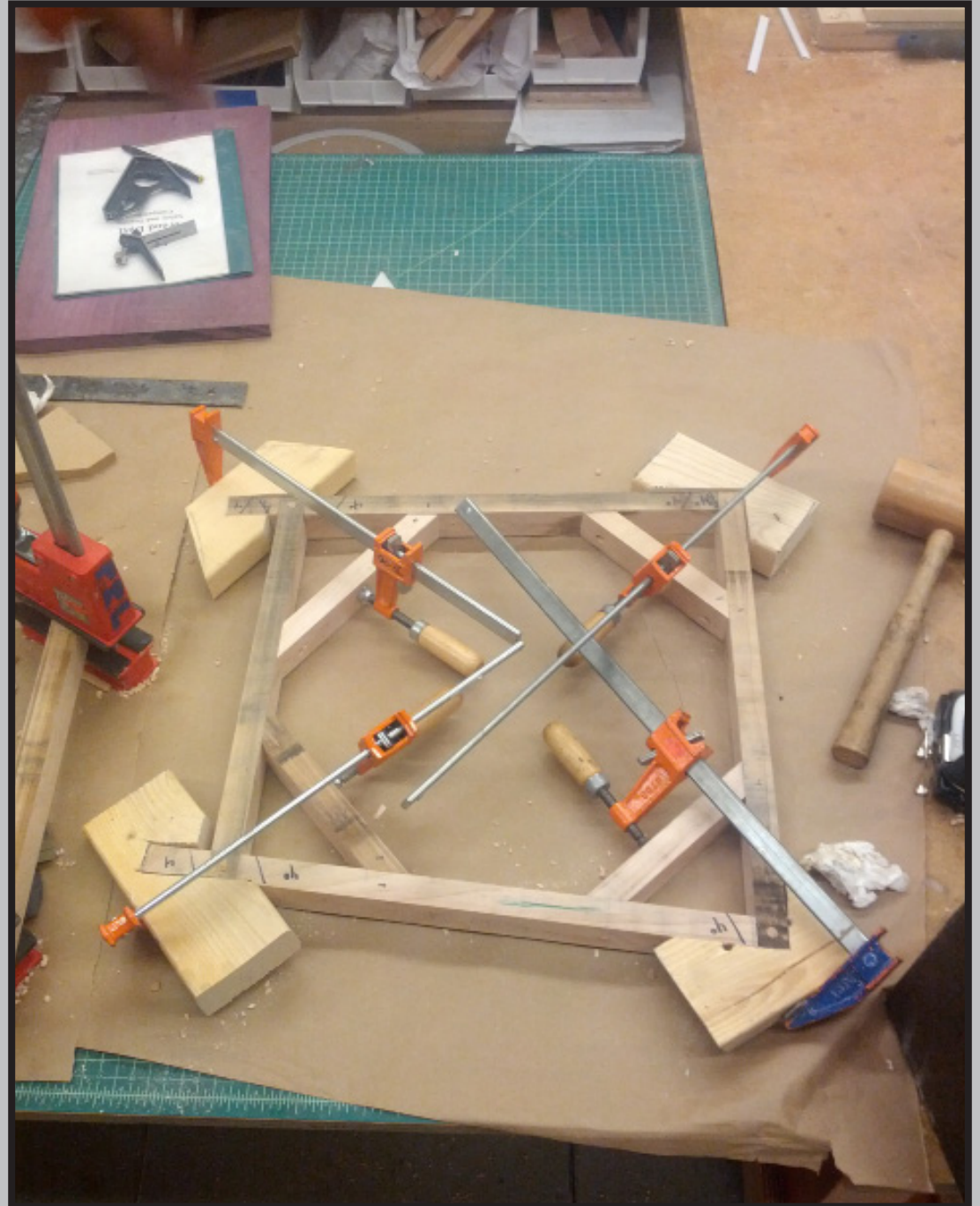
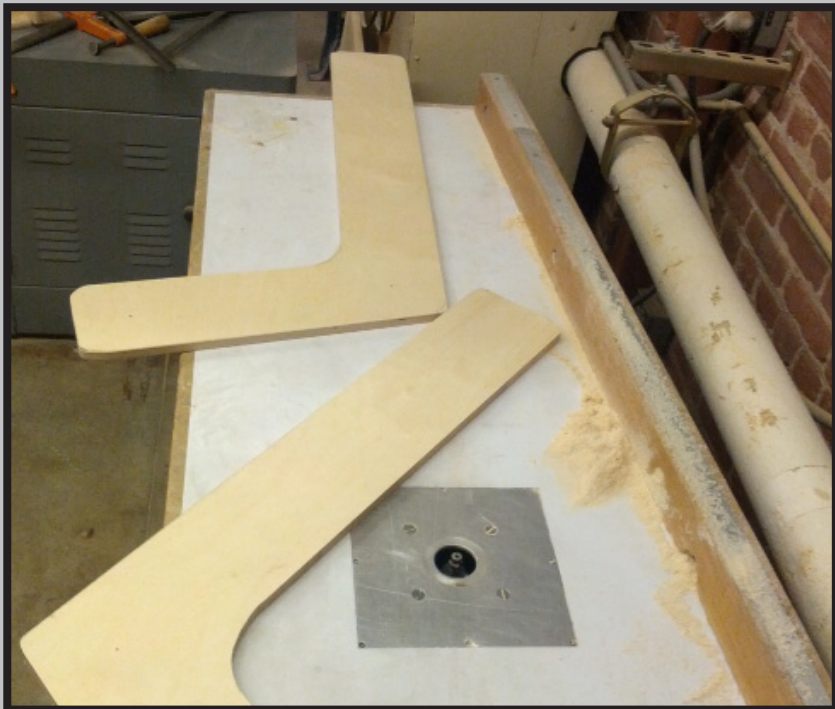
K120718 Pink

K120719 Rouge

## FABRICATE THE SEAT AND BACK

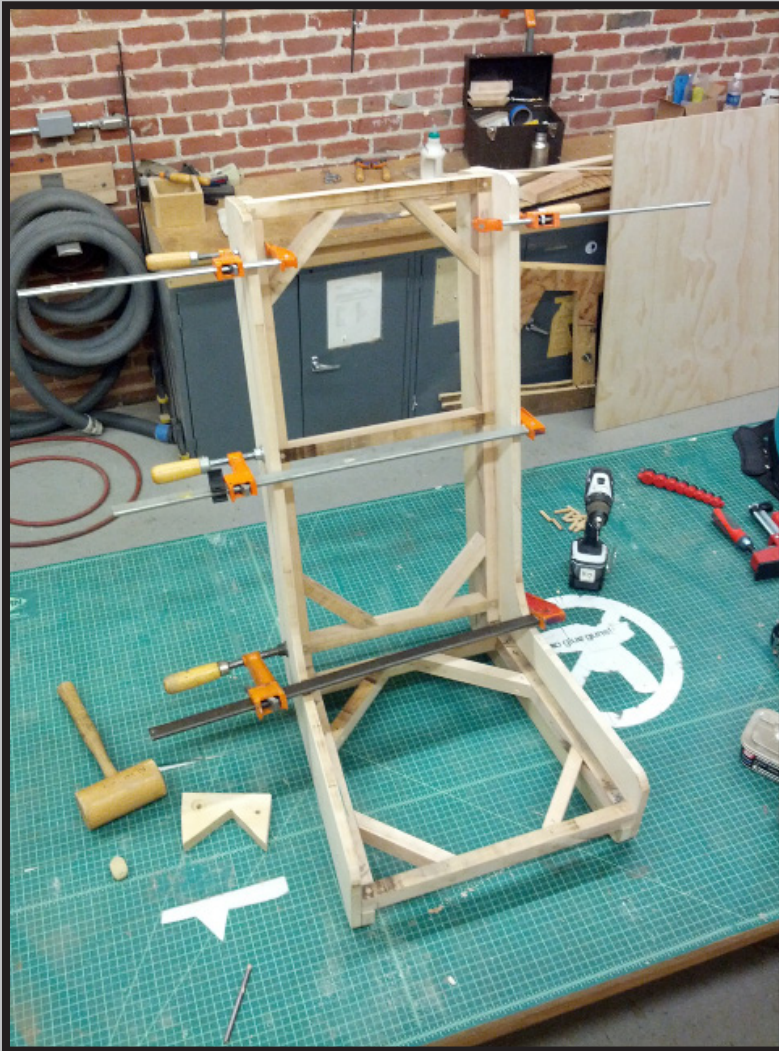
I built the seat and back from 3/4" Baltic Birch plywood and soft maple. My upholsterer recommended using dowel construction as it will last longer and the dowels (if built properly) won't back out over time like screws could. Also, I reckon they won't squeak like screws might. I used a flush-trim roundover bit on the router to knock down the plywood's sharp edges.

Maple: finally...hard wood. Such a nice change of pace from the 2x4s and plywood. It machines better, doesn't chip as easily, holds an edge.





## FABRICATE THE SEAT AND BACK

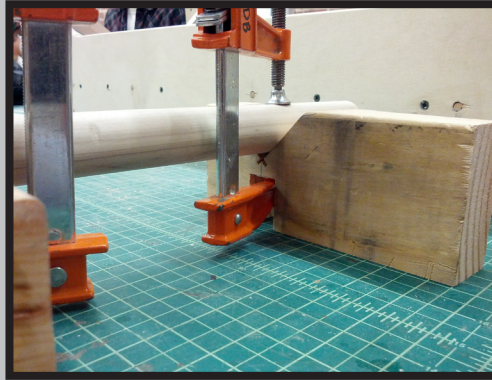


I built the chair to be robust. Joints were tight (usually) and everything was kept square where it needed to be. I used dowels and wood glue at all the connections and even threw in a few wood screws for good measure. I tapered the chair so it was wider in the front and snug in the rear.

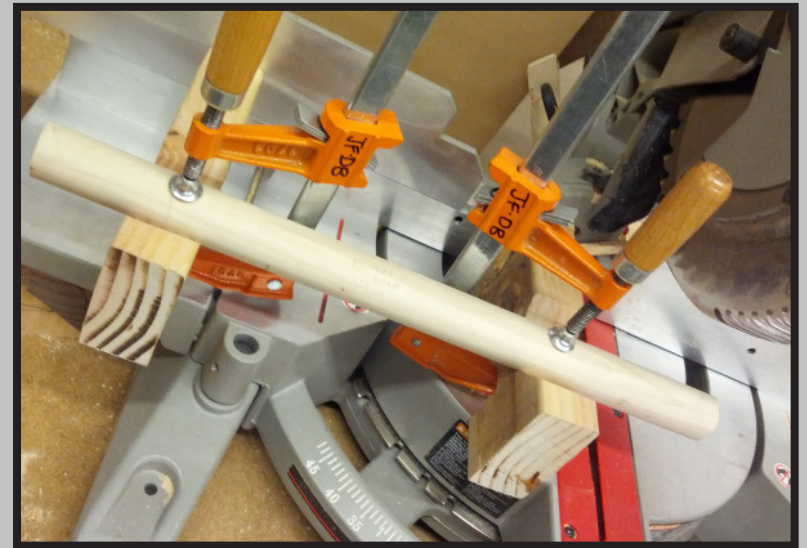
I added 1.5" dowels on the top back, bottom back, and bottom front of the chair so Jeanne could wrap the fabric around and put some tension on it. The seat and back structures were doweled + screwed on about 2.5" below the plywood edge so the foam + upholstery would end up just above it. In retrospect I wish I had trimmed the plywood sides a bit more because the whole thing looks a little bulky to me. It was hard for me to visualize what the foam and upholstery would look like.



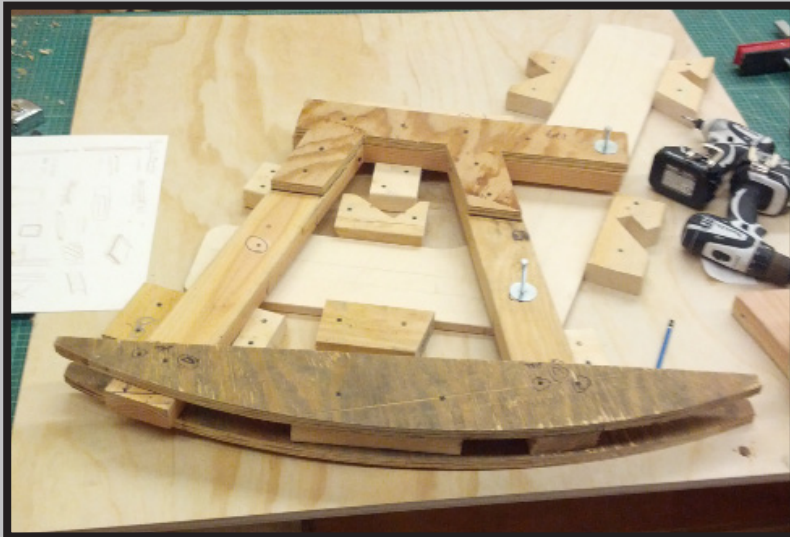
## FABRICATE THE SEAT + BACK: A FEW TRICKS



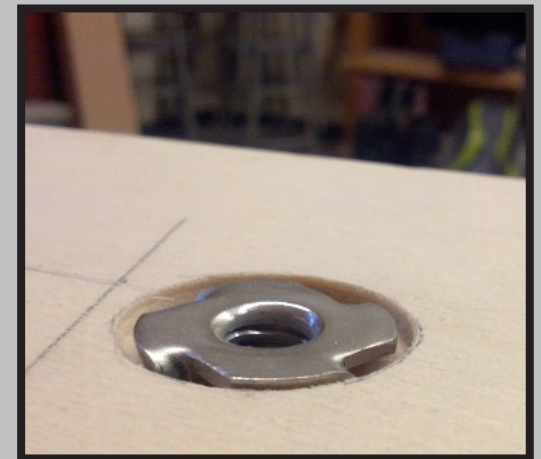
To get angled cuts on both sides of a dowel I built this jig so I could move it around the chop saw without unclamping it.



Full-scale chair jig with holes drilled for bolts. Since I shipped the seat/back to the upholsterer before even starting the arms/legs/rockers I needed to know where the holes should end up.



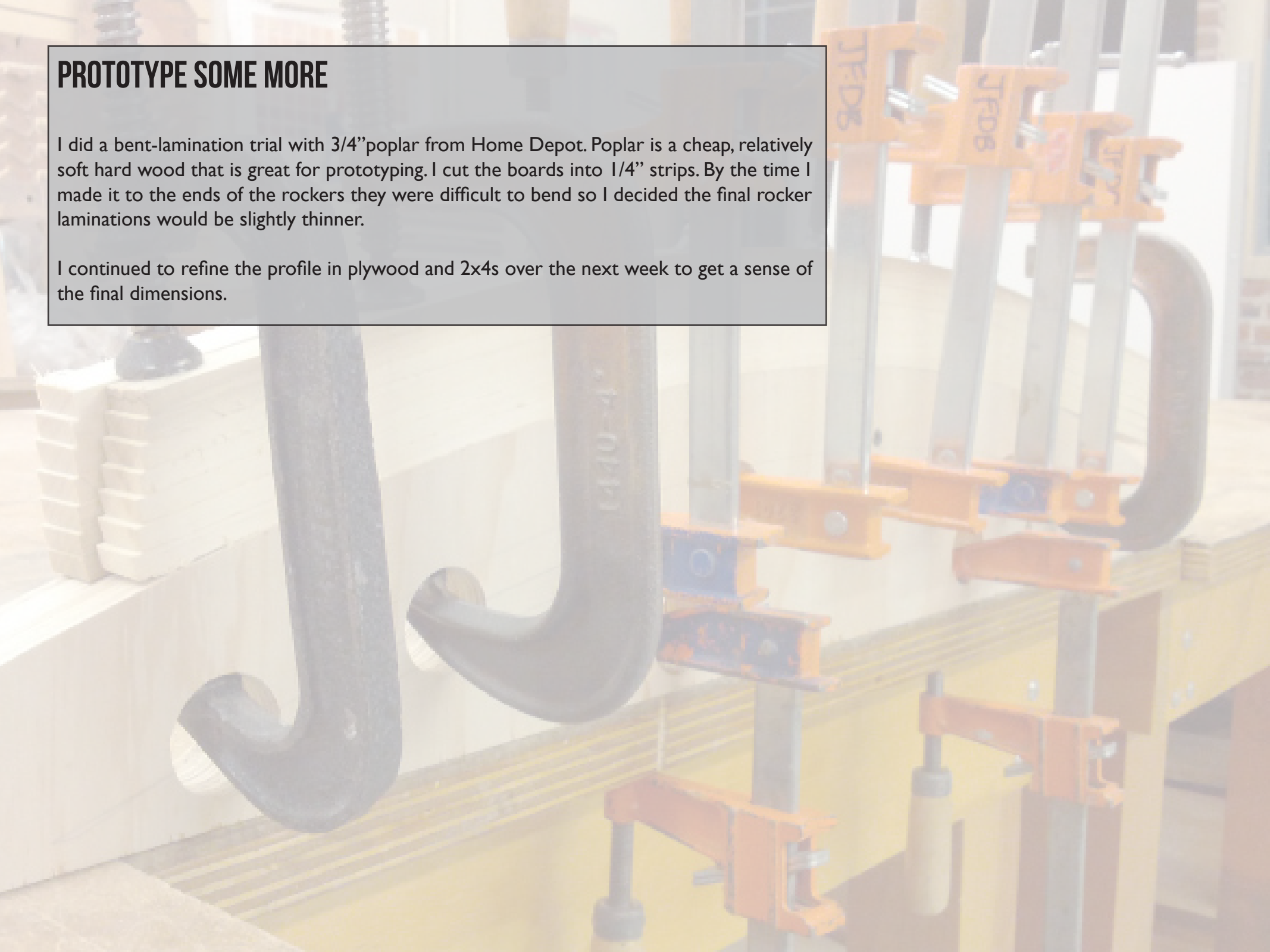
Want to be able to take apart your furniture and reassemble it? Use winged tee-nut inserts and some nice bolts. These I embedded in the plywood. Luckily they were still in there when I got it back from the upholsterer and the whole thing bolted together nicely.



## PROTOTYPE SOME MORE

I did a bent-lamination trial with 3/4" poplar from Home Depot. Poplar is a cheap, relatively soft hard wood that is great for prototyping. I cut the boards into 1/4" strips. By the time I made it to the ends of the rockers they were difficult to bend so I decided the final rocker laminations would be slightly thinner.

I continued to refine the profile in plywood and 2x4s over the next week to get a sense of the final dimensions.



## BUY THE WALNUT

This was one of the best days of the project. I went to MacBeath with Ravi and Cam to pick out our wood.

I had visited two hardwood vendors, MacBeath in San Francisco and Southern Lumber in San Jose. Southern is more expensive but their wood is better organized and planed down, so you will spend less time looking and machining your wood but more cabbage. I think the wood at MacBeath is better quality (just a gut feeling, really) and cheaper, but you will spend more time machining it. I personally prefer MacBeath. The people there really know what they are talking about, whereas at Southern I asked a few people a question about a router bit and nobody knew the answer. It sort of feels like the Hardwood Home Depot. Southern had a better selection of router bits. MacBeath gave us a student discount.

Do not underestimate how long it will take you to choose your wood (especially at MacBeath where you will have to dig through piles). Ravi and I looked at every single piece of walnut in stock and we were there for a few hours. Since the wood at MacBeath is rough, it's hard to get a sense of the grain underneath the grime. For a chair, you want the legs to have nice tight straight grain. For any kind of bending (steam or bent lamination) you want grain that doesn't run off the side. Lighter-colored wood (sap wood) won't be as strong as the darker stuff (heart wood).

$4/4 =$  one inch;  $6/4 =$  1.5 inches;  $8/4 =$  2 inches, and so on.

A board foot is a piece with dimensions 1" x 12" x 12", a.k.a.  $4/4 \times 12" \times 12"$ .

A board foot is a piece with dimensions  $6/4 \times 8" \times 12"$  or  $8/4 \times 6" \times 12"$ .

Get it?

Know what you want before you go: lengths, widths, thicknesses. And remember, just because you want a 6" wide piece of  $6/4$  walnut doesn't mean they will have it; they might have 8" widths and 10" widths. Be prepared to improvise and calculate on the fly. Also, if you go to MacBeath bring a flashlight as it's dark where the wood is stored.

## MILL THE WALNUT

Use the Sculpture Lab planer, jointer, and band saw because at the time of this writing those PRL facilities are lame. Everything else you need you can do in the PRL, if you don't mind occasionally waiting 20 minutes to make one cut on the table saw while someone figures out how to slice the ends off their cutting board. Though the PRL is convenient if you live in the Loft like I do, the Sculpture Lab is a quiet and well-maintained shop to work in. Dan runs a tight ship. Ask Ravi, he worked there a lot. The bummer is their wood shop is only open Monday to Friday 9am-5pm so get to work on Dan to let you in after hours.

First I jointed and planed all my walnut down to square. Then I rough cut my arms using the plywood template. This was all done at the Sculpture Lab then I brought everything back to the PRL for the rest.

I transferred my arm pattern to the walnut using the 2" flush trim bit. The bit was expensive (\$50 at Southern) but so valuable. Ravi and I both used it a lot and it never failed us.



## LAMINATE THE ROCKERS

I cut the strips for the laminations 3/16" thick. For my poplar prototype I used 1/4" laminations but they were a little difficult to bend at the ends. I didn't want to have that much trouble with my final piece. In retrospect I might have gone even thinner, down to 1/8". You have to realize that for each 1/8" lamination you cut on the table saw, you lose 1/8" to the blade. I'm too cheap for that and I don't like to waste wood, so I went for 3/16". Ask me in 30 years if the rockers are still together and I might have an opinion about 1/8" vs. 3/16".

When you cut your laminations keep them true to the original piece of wood--if you do it right the seams will all but disappear. When designing your buck think about the length of your laminations and cut holes in your buck that will allow you to evenly space your clamps (every 5" for me) all the way down from the middle to the ends. My final holes were a little too far over and clamping the ends of my laminations was difficult. You want a nice easy clamping experience.

I used Titebond III wood glue for all of my laminations. Lay a nice thin coat on both sides of each lamination and clamp them in a hurry. I used a variety of blocks to try to keep everything square and to apply even pressure on the top. Use blue tape between any wood-to-wood connections that you don't want stuck to your final product: blocks, the buck itself, etc. Once you have your laminations glued up in a stack, put a couple pieces of clear packing tape to keep the bundle (mostly) together before you transfer it to the buck.

Get another pair of hands for the lamination process. Have everything ready and do a dry-run (without glue) to make sure you have enough clamps in the right size. With everything ready to go (laminations in their proper order, buck clamped to the table, clamps ready to go, glue, paper towels, old chisel), go for it. You don't want any delays as the glue is unforgiving once it starts to cure.

The book to read is Wood Bending Made Simple by Lon Schleining.

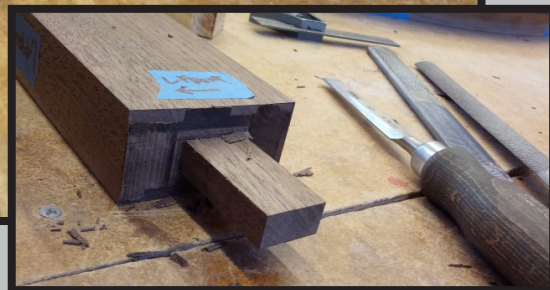


# JOINERY

It wasn't until this point that I really started to enjoy myself. I had never done mortise and tenon joints or worked with a sharp chisel before. It is so satisfying for a joint to snap together snugly.

I used floating tenons for the arm/leg joints and mortise and tenon construction for the leg/rocker joints. These should all fit snugly but you shouldn't need a mallet to put them together; leave room for glue and for the wood to expand/contract over time. I tried a variety of techniques to get nice tight joints and it just depends on your comfort level with certain tools. Cam Bennet went really deep into using the table saw and sharp chisels. I used a combination of table saw, band saw, disc sander, and chisel. I used leftover walnut for the floating tenon (the one below on the left looks so blonde but it is indeed leftover sap wood from my walnut planks). Make sure the grain of your tenon runs vertically down from your arm; otherwise it will split.

I generally use the rule of thirds: the tenon should take up the middle third of the width of each piece. In this case, my arms and legs were about 1.5" wide so the tenons were 0.5" wide. I made each about 1.5" tall. Scroll a couple pages down for details on the rocker mortises. For a great primer on different joinery techniques see [Tage Frid Teaches Woodworking -- Book 1: Joinery](#). Craig keeps a copy in the PRL.



This is after sanding.

## TAKE FIVE

I got extremely frustrated at (more than) one point when I was making the joints. So I did the smart thing and went to get a frozen yogurt. It is important to remind yourself that doing something for the first time will always be challenging. When the going gets tough, take a break and get some fresh air.

Observe in the photo that the chocolate yogurt matched the walnut perfectly--a coincidence but I took it to be a sign that I was back on track.





## SAND AND MACHINE THE LAMINATIONS

I lucked out, my laminations were just long enough to fit on the belt sander. I hit the bottom and sides with this tool and hand-sanded the tops (they didn't need much).

Once I had the legs, arms, and rockers laid out on the table I marked the locations for the rocker's through mortises. I built a jig with a 42" radius (laser cut in duron and transferred to 3/4" MDF with the router) to support the rocker and used the mortising machine to cut the 1/2" slots in the rockers. Be sure to test cut the mortise on a piece of scrap to get it square, I used my poplar lamination prototypes.



Mortising the rockers with a custom MDF jig.

Rockers on the belt sander: don't try to take off too much on one pass as you will just end up digging into one spot. Go light, switch your hand positioning, take off a little more, repeat.

# ASSEMBLE

Once everything fits snugly do a dry fit without glue to be sure you have your technique down and all the right clamps you need. I always put a thin coat of glue on each surface and clamp everything snugly but not tightly. Have paper towels and an old chisel nearby to remove any extra glue before it dries (this will save you lots of time in cleanup). It helps to have another pair of hands here, particularly someone familiar with the process who can point out any flaws in your process. Once you are glued up triple check everything because wood glue is unforgiving.



## SAND AND FINISH

This was my favorite part of the whole process. I wish I had a few more days to really get into this. I plan to take everything apart this summer and continue to sand it down---good thing I used those winged tee-nuts so I can disassemble it.

I sanded everything down close to my final lines then re-attached my plywood form to use the router table to trim down parts that I thought were too bulky and to flush-cut the floating tenons.

Ravi got a mini spindle sander that attaches to a hand drill (right). This was the best tool for shaping. It has a tube where you sleeve the sandpaper tubes on, then you inflate it with a bike pump. I tried various files and rasps but they were too slow. When the shaping was done I used a sanding block and went through the grits: 80-120-180-220 and finally took off the edge on all the corners with 320.



## NEXT STEPS



I am not completely happy with the look of the arm/leg/rocker, so I left it without a coat of finish. I will continue to strip away material with the router until the chair is more stream-lined and curvaceous.

I will do trials with different finishes, leaning towards using a linseed oil and beeswax product called Tried & True. I have used it with success on a redwood piece, though never on walnut. I have also heard good things about Danish Oil.

Let the experimentation continue!

# SOME NUMBERS

overall	44" L x 24"W x 43" H	rocker length	37"
seat height	21" front / 16" back	rocker arc	42" radius bottom / 40 7/8" radius top
seat depth	18"	rocker width	1 7/8"
seat width	20" front / 18" back	rocker height	1 1/8"
back length	31"	arm width	1 7/8"
back width	18"	arm length	24"
seat angle	105 degrees	leg width	1 3/8"

<b>MATERIAL</b>	<b>QUANTITY</b>	<b>SOURCE</b>	<b>PRICE</b>
cardboard for prototype	(4) 4'x8' sheets	PRL-Room 36	\$20
Duron for laser cutting rocker patterns	(1) 1/4" 2'x3' sheet	PRL	8
poplar for prototyping joints	3/4" x 2 3/4" x 50'	Home Depot	40
scrap 2x2s, 2x4s, and 3/4" plywood for working prototype	misc.	Loft courtyard	0
winged tee-nut inserts, hex head bolts, washers for prototype	(6) 1/4"-20	Ace Palo Alto	17
Baltic Birch plywood for seat/back sides	(1) 3/4" 5'x5' sheet	MacBeath	60
MDF for lamination bucks	(1) 3/4" 4'x8' sheet	Home Depot	35
latex foam	(2) custom pieces	foamorder.com	240
flush trim router bit	2" height	Southern Lumber	50
maple for seat/back structure	6/4	MacBeath	15
walnut-rockers	8/4 x 6" x 4'	MacBeath	50
walnut - arms	8/4 x 6" x 4'	MacBeath	50
walnut - legs	6/4 x 6" x 6'	MacBeath	30
Titebond III wood glue for laminations	one quart	MacBeath	15
Hopsack 100% wool fabric + shipping	2.5 yards, gold	knoll.com	150
clamps for the lamination	(8) 12" / 24" bar clamps	Ace Palo Alto and Home Depot	100
winged tee-nut inserts	(6) 5/16"-18	McMaster-Carr	12
hex head machine bolts, black oxide	(6) 5/16"-18 x 2.5"	Bay Bolt	4
upholster's fee	(1) chair	Joona Creates	600
		Total	\$1496

# THANK YOU

John Edmark: Chair Guru.  
Anja Ulfeldt.  
Craig Milroy: PRL Overlord.  
Dan Tiffany: Sculpture Lab Shopkeeper.  
The PRL Shop TAs, in particular:  
Tom Cohlma,  
Andrew Evans,  
Julian Malinski,  
Kathy Spriggs,  
Eric Slesinger, and  
Alyson Yamada.  
Peter Miller:  
My Chair 2013 classmates, in particular:  
Raviraj Pare,  
Xander Bremer,  
Michael Beck,  
Cam Bennet, and  
Wei Li.  
And to Chloe Sladden:  
Without you I would still be adrift.  
I built this chair for you and Junior!

