

Laser Box - Minnehaha Falls

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1 Summary

No matter what season it is, Minnehaha Falls in Minneapolis, Minnesota is enchanting. From magical frozen waterfalls and secret ice caves in the winter to wading down the entire river in the summer, it's always the place I bring friends to just relax and have a good time. For this reason it was my inspiration for the laser box design project. With the titular waterfall, bridge, cave, and ice flow I once fell through, it was great to relive my memories while making it.



The actual Minnehaha Falls in both summer and winter. Photos taken by me.

Depicting one of the many bridges, secret cave, and of course the waterfall it is named after, the box utilizes a number of joints and fasteners to capture the essence one of my favorite places in the world.

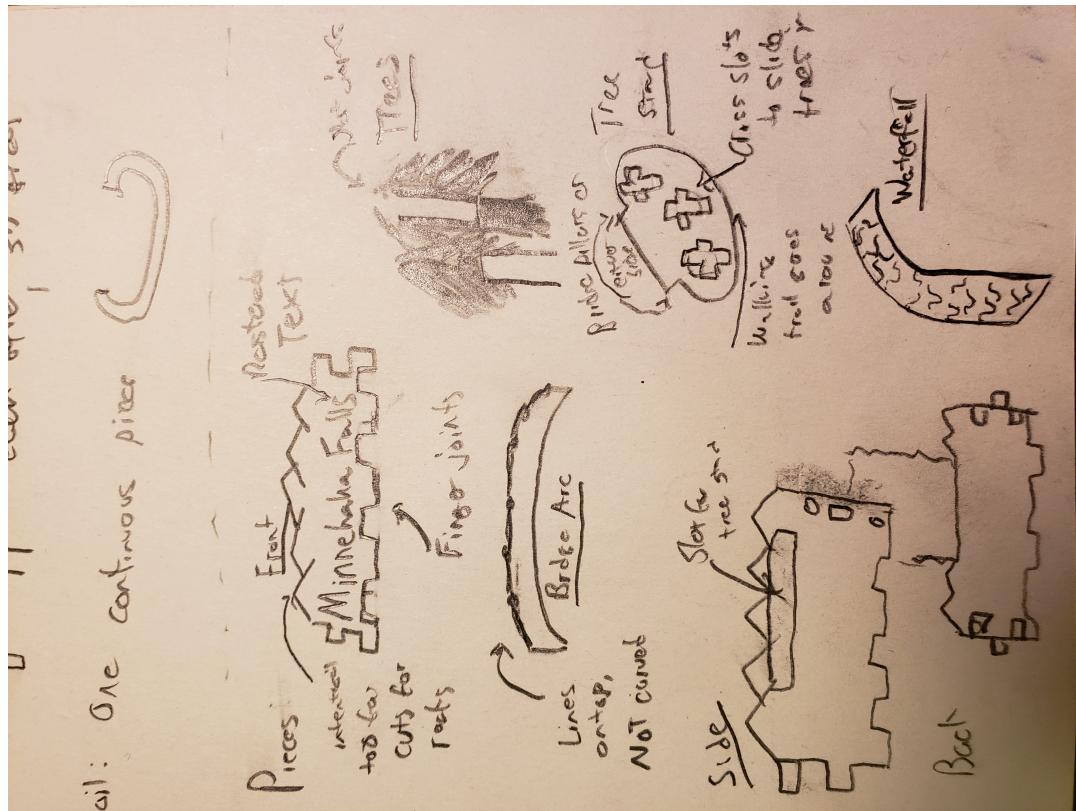
Joints used include:

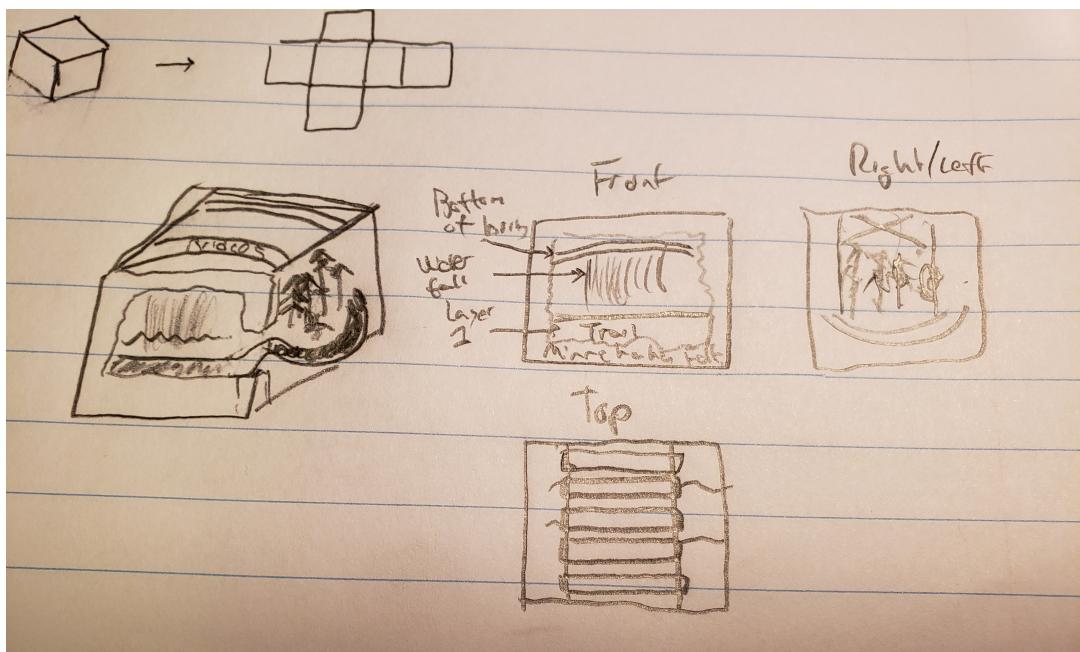
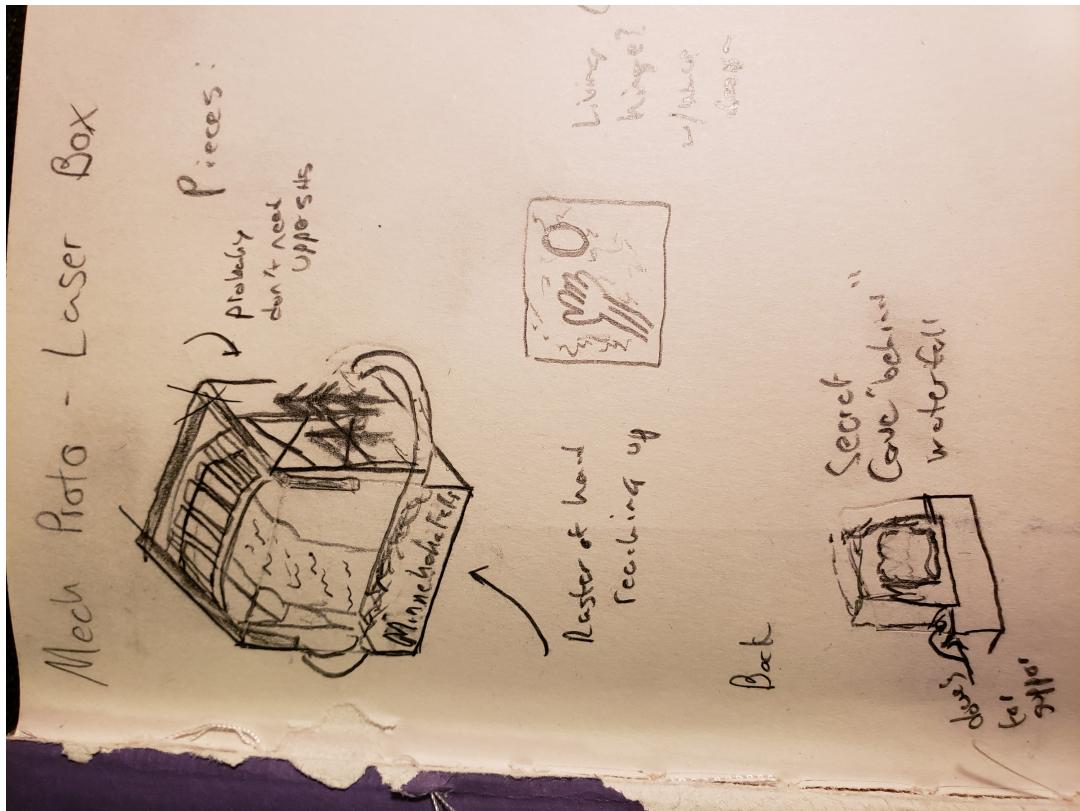
- Finger Joints - Used for the base of the box. These were useful because it allowed for easy joining of large pieces with simple geometry and minimal work needed to be done in CAD. Having 3 different planes in contact with each other full constrains the three pieces.
- Living Hinge - Used for the waterfall. I specifically used and tested out the wave pattern provided by the Obrary Design Library to have a hinge that both looks like water and has the bending properties (90 degree bend over a maximum of 5 inches) to mimic the fall of the water.
- Butt Joint - Used for the bridge cross beams. Because some of the cross bracing was directly between the bridge supports and the supports were already rather thin and tall, I used butt joints for the cross braces to keep them from bowing inwards as well as provide a defined wall looking plane. When used in conjunction with glue, they also were useful for joining pieces with large faces coincident to each other.
- Rabbit Joint - Used in connecting the beams holding the back of the bridge to the back arc of the bridge. Provided a way to more securely hold the beam in place while allowing the stronger, non-burnt side to be on a different plane than the arc's non-burnt side.
- Modified Dove Tail - Used in the lower snowflake pattern to make a co-planar locking pattern. They served to make an interesting bottom pattern that was easy to put back together while also allowing for the locking in of other parts like the waterfall living hinge or the beams of the bridge.

Fasteners used include:

- Glue - Used to further secure joints and when press fitting did not occur due to tolerances. Given how many large face to face parts there were (bridge arc to back, bridge front railing to bridge arc) this proved useful. Additionally because there were so many parts it made it easy to hold everything together without visually cluttering the piece with more conspicuous fasteners.
- Nails - Used in joining the beams to the sides of the box as well as the slats of the bridge to its support arc. The latter was also for aesthetic purposes, being a wood plank bridge.
- Screws - Used to better secure the front bridge railing to the bridge support arc which was important given how large the two pieces were. It also provided a convenient way to hang the "thin ice" sign.
- Bolts - Used to secure the cross braces of the bridge to one another. Sandwiching the cross braces in between the main beams to the inner most cross braces meant it was an additional constraint not allowing the brace to be pushed out of the vertical column of the bridge. It was also for aesthetic purposes to make it look more like bridge cross beams.
- String - Used to hang the "thin ice" sign. Allowed for freedom of motion and it makes the sign stand out.

2 Sketches

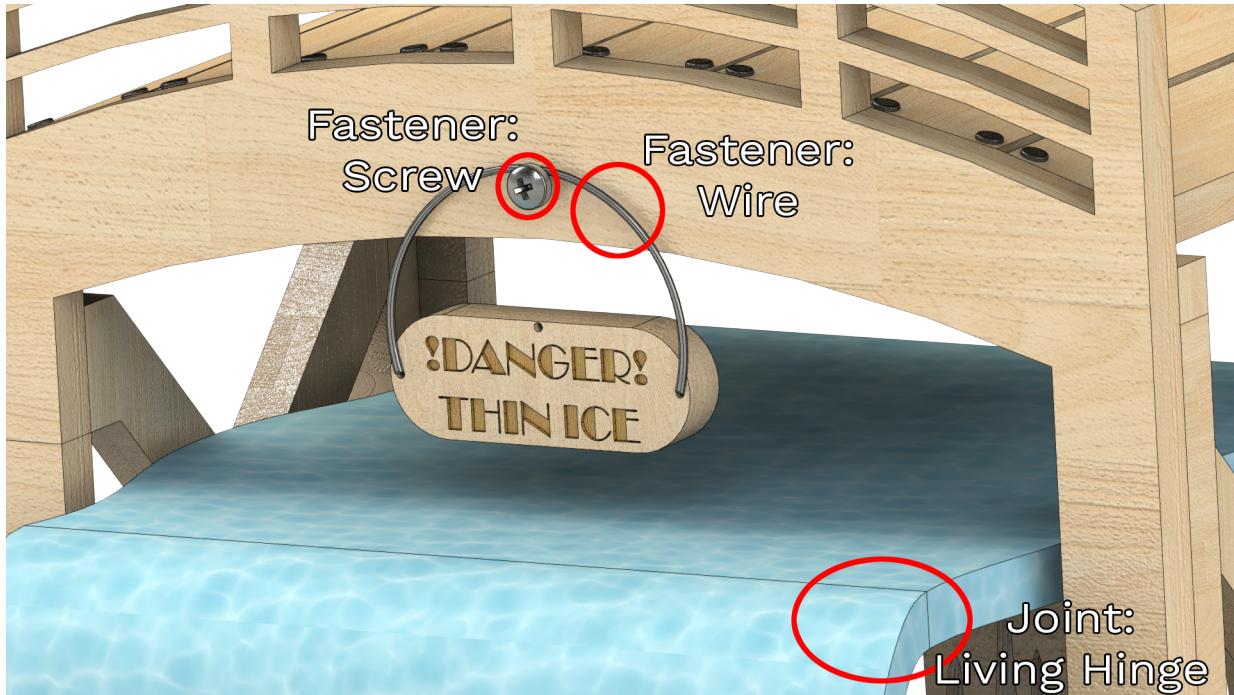




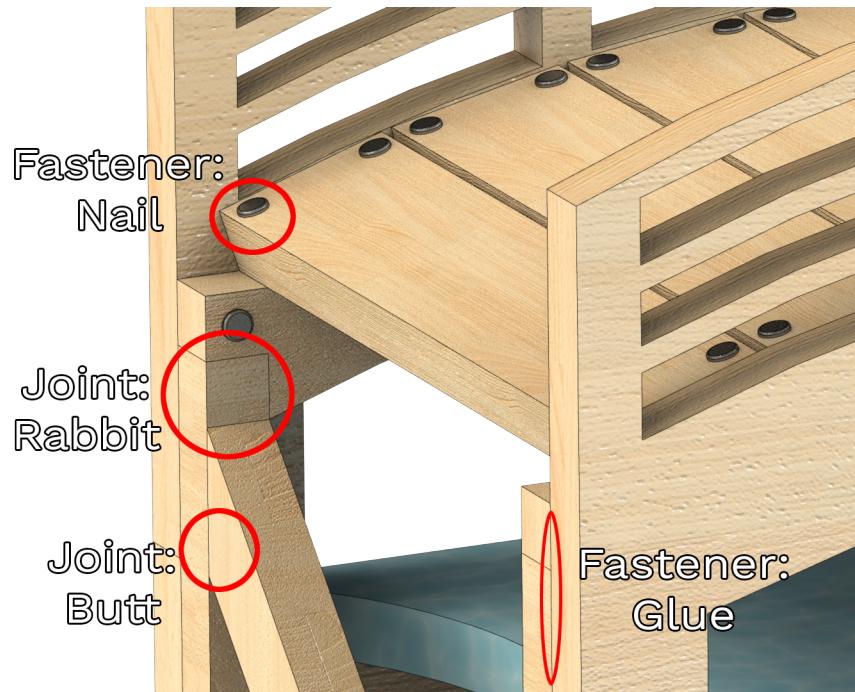
3 Renders



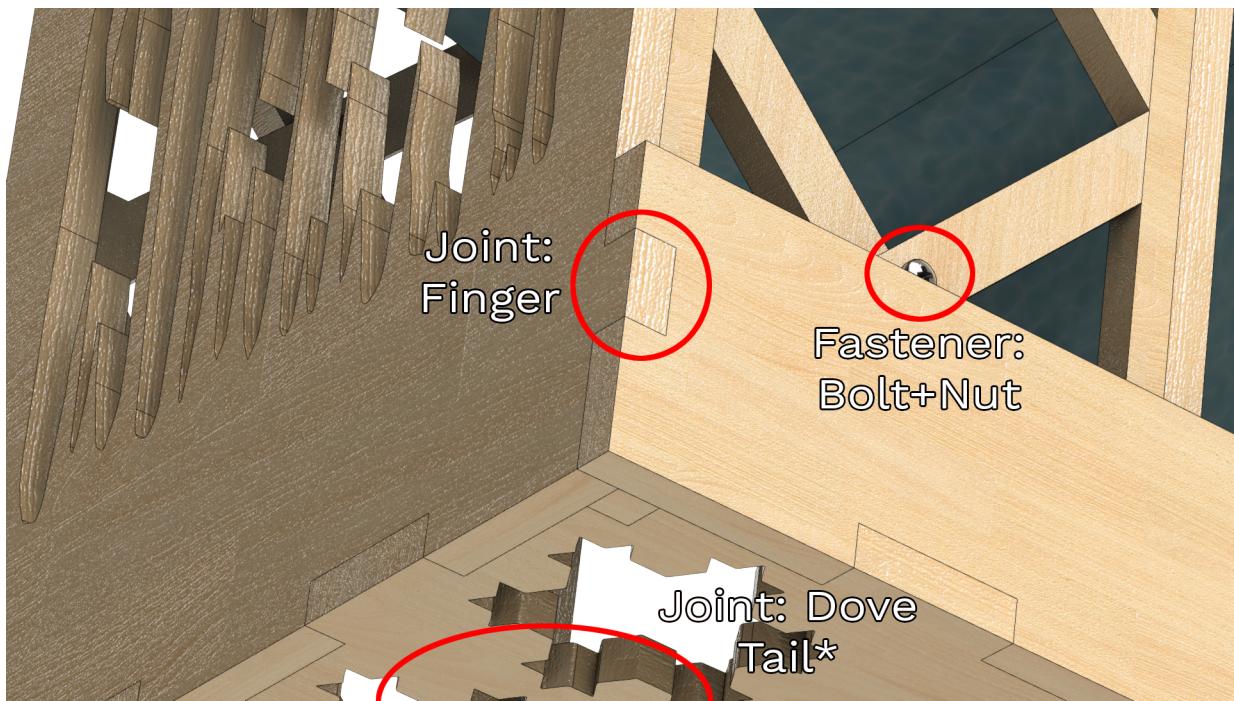
Final render with contours to show individual parts.



Close up of the sign. Note the living hinge for the waterfall, screw for holding the sign wire, and wire for holding the sign.



Close up of the side of the bridge. Note rabbit joint between arc and support beam, butt joint between cross brace and bridge beam, use of nails in bridge slates, and what would be some glue to secure the butt joint of the cross brace.



Close up of the bottom corner of the box. Notice the finger joints joining the side, back and bottom of the box, modified dove tail snowflake joints on the bottom, and bolt fastener through the cross bracing of the bridge.

4 Photos



5 Reflection

Overall the project went really well. I got to experiment with living hinges, worked at odd angles with the bridge, and get better at being able to efficiently and quickly reconstruct the mental image of a part in my head into a SolidWorks part. One thing I did wish was having more time to develop earlier ideas that can be seen in some of my earlier sketches. Having a week-long out-of-state competition and then playing catchup with all my classes definitely pulled my attention from this project more than I would have liked.

The largest lesson I learned from this project was actively thinking about dimensions and developing a better intuition for scale. Going in I didn't really have a sense of how big I wanted this to be and at first it was only the constraint of the one piece of 24"x18" MDF that directed me. While it certainly helped from making everything way too big, having it a bit on the larger side definitely helped when dealing with some of the smaller pieces and joint connections. Even once it was all in CAD, the sense of scale really only came to me once I started cutting. At all times I had a tape measure on me to get a feel for how big it would be.

Another skill I felt I developed was experimentation. Especially with the living hinge waterfall, I experimented with just about everything from width of the hinge lines, to hole size for nails and bolts. While it took more time in the beginning, it certainly paid off, with the waterfall coming out exactly how I had pictured it.

Finally going forward I want to be more careful with my glue usage. There are several points around the box where the presence of glue that flowed between seams is painfully obvious and detracts from the look of the project. As one of my goals of the class to make more professional looking boxes, I need to be more conscious and careful of this effect.