LECTERN BOOK CASE DESIGN

Case Layout Diagram (Full Size At Link)

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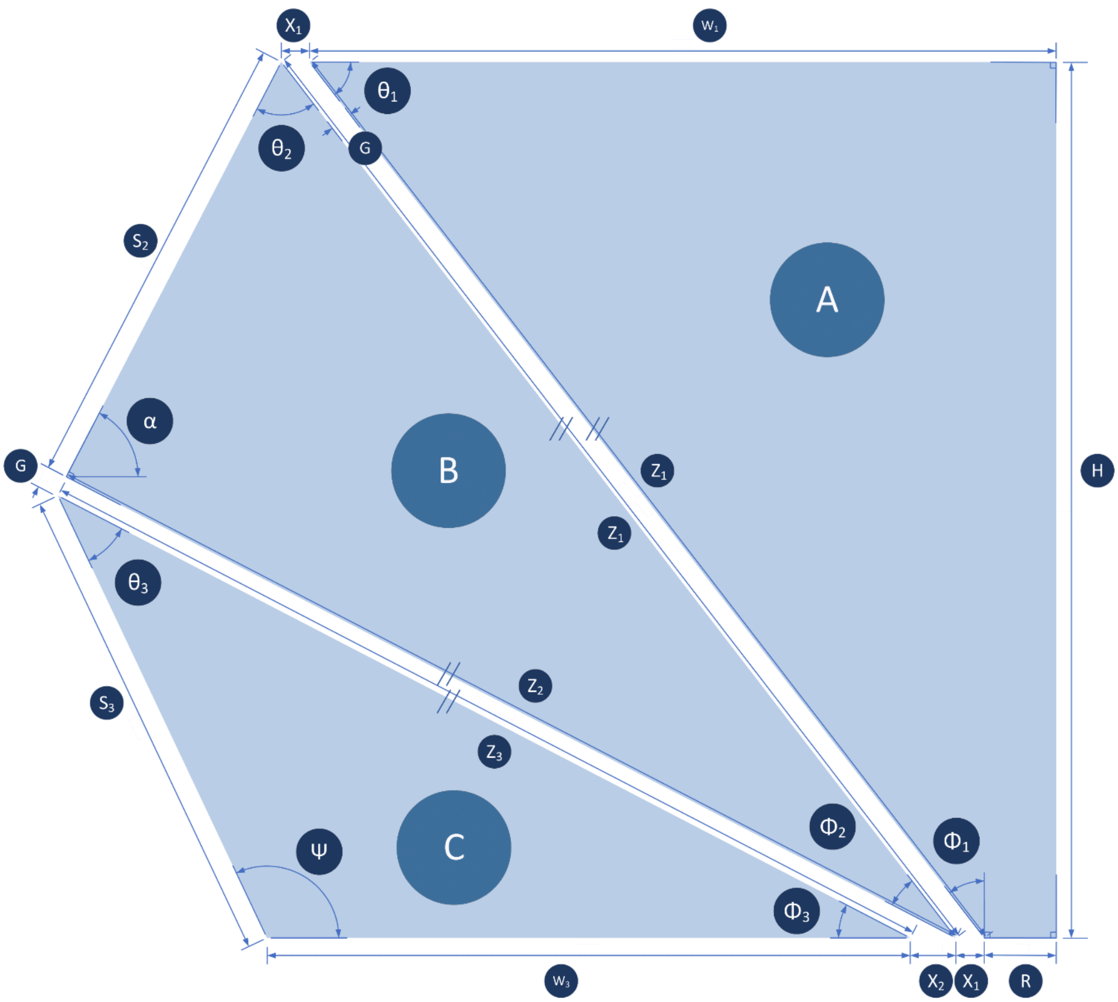

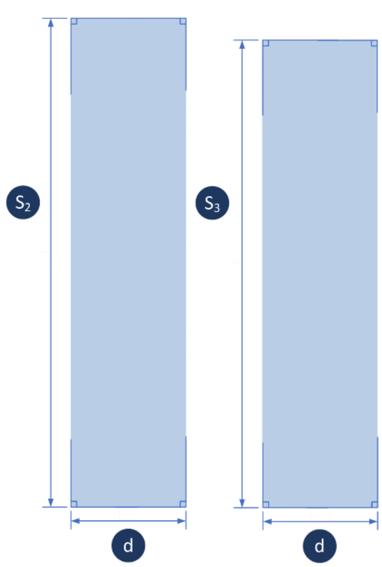

Cover Dimensions - Inputs/Constraints

- W_1: Width of case
  - The final width of the case will be slightly more than this, mostly driven by X_1. However, the geometry for the size of the book square is complex, and I don't have a formula for how it works out in practice rather than pure theory, and my test books have not gotten results perfectly in line with the pure theory. It may be best to avoid adding much margin to the book width before some experiments to see how your casing-in process absorbs or adds to any margin.
- H: Height of case
- R: Recession of conjunction point
- G: Hinge gap
- Φ_2: Desired viewing angle

Board A

- $\Phi_1 = \tan^{-1}\left(\frac{W_1 - R}{H}\right)$
- $\theta_1 = 90^\circ - \Phi_1$
- $Z_1 = \sqrt{(W_1 - R)^2 + H^2}$

A-B Gap

- $\theta_2 = 90^\circ - \Phi_2$
- $X_1 = \frac{G}{\sin(\theta_1)} = \frac{G}{\cos(\theta_2)}$

Board B

- $S_2 = Z_1 * \sin(\Phi_2) = Z_1 * \cos(\theta_2)$
- $Z_2 = Z_1 * \cos(\Phi_2) = Z_1 * \sin(\theta_2)$

B-C Gap

- $\Phi_3 = 90^\circ - \Phi_1 - \Phi_2$
- $X_2 = \frac{G}{\sin(\Phi_2)}$
- $Z_G = X_2 * \cos(\Phi_3)$

Board C

- $Z_3 = Z_2 - Z_G$
- $W_3 = W_1 - R - X_2$
- $S_3 = \sqrt{{Z_3}^2 + {W_3}^2 - 2 * Z_3 * W_3 * \cos(\Phi_3)}$
  - Law of cosines: $c^2=a^2+b^2-2ab*\cos(C)$
- $\theta_3 = \sin^{-1}\left(\frac{W_3 * \sin(\Phi_3)}{S_3}\right)$
  - Law of sines: a/sin(A)=b/sin(B)=c/sin(C)
- $\Psi = 180^\circ - \theta_3 - \Phi_3$

Spine

- Upper spine: rectangle, height of S_2, width of text block
- Lower spine: rectangle, height of S_3, width of text block

Assumptions

1. The conjunction point of the diagonal hinges will be recessed from the tip of the corner (marked R) for greater structural integrity and ease of covering the book
    a. Part A is therefore a trapezoid with two right angles corresponding to the top and bottom of the book fore edge
2. The hinge gaps will be a uniform width, regardless of what angle the hinge lies at
    a. The geometry for horizontal displacement of boards will therefore become tricky, which is what the below equations are designed to address
3. The upper tip (angle marked θ_2) of the triangle for Board B will align with the upper edge (marked W_1) of Board A. The lowest tip (marked Φ_2) of Board B will align with the lower edge (marked R) of Board A. The lower edge (marked W_3) of the triangle for Board C will align with the lower edge (marked R) of Board A.
4. The lower edge (marked W_3) of the triangle for Board C will align with the lower edge (marked R) of Board A. The upper tip (marked θ_3) of Board C will align with the spine-side edge (marked S_2) of Board B.
5. All angles used in the equations are provided in degrees – if trigonometric operations are applied to these numbers and the calculator decides that either inputs or outputs are in radians, the results will get weird.

Process

1. Begin by determining the five input values listed below. Height and width of the case are determined by the book that's supposed to fill the space. The recession of the conjunction point is down to better judgment, but for a half-letter book, 25mm worked well for me. Hinge gap is also a personal call, but 5mm has worked well for me. I recommend experimenting with a protractor and a board to determine an optimal viewing angle (Φ_2). Most of my experiments have been in the 20-30 degree range. Use caution in going higher, because a higher viewing angle will place the case under greater stress and lead to a less stable configuration (because the base will shrink).
2. Use the calculations to determine the dimensions of Board A, and cut two of this piece.
3. I have had the best luck using a sheet of cardstock to align my board pieces and measure and pencil in my desired hinge gaps rather than immediately gluing my boards to my bookcloth. Images are included to describe what I mean by this. If you want to live dangerously, go for it.
4. Calculate dimensions and cut two of Board B.
5. Glue this to the paper and sketch out your second hinge gap as well, if you swing that way.
6. Calculate dimensions and cut two of Board C. This will be more difficult than the other two boards, which are both based on right angles, while Board C is an irregular triangle. I achieved greatest accuracy by measuring the edge marked W_3 (the bottom edge) along a straight line from a corner of my board, then measuring angle Φ_3, and then the diagonal marked Z_3. Finally, connect the terminus of Z_3 to the end of edge W_3. Attempting to measure angle Ψ often introduced a very slight error, and measuring Z_3 was more true to the desired dimensions.
7. Glue board C to the paper along with the other two. If this was done correctly, its lower edge should form a straight line with the lower edge of Board A. If it doesn't but it's close, hey, go ahead and soldier on anyways, the best way to figure out the mechanics of this is to make it.
8. If you did use backing paper, trim it down to the edges of the assembled boards.
9. Cut two spine pieces, one with height S2, one with height S3.
10. Glue these to spine bookcloth, with a hinge gap of the same size as the other pieces in between them.

11. Take cover assemblies, and align the free edge of Board B (marked S2) to spine piece of height S2, separated by the usual hinge gap. If backing paper was used, it should face the inside of the case (facing upward from working surface). Glue boards in this position.
12. Congratulations, you're almost there, but it's time for weird fabric shenanigans. I'm going to talk math and get back to this later.

I'VE ADDED A SPREADSHEET

https://docs.google.com/spreadsheets/d/1PFM0_2MO8sdEdhnGPkXDAPa1aaKNirPT_5B0FR0ajUQ/edit?usp=sharing

Make a personal copy and enter your values as desired. I haven't tested this yet! I just finished it, draw your board outlines and see if they make sense before you cut them

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Board A

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- $\theta_1 = 90^o - \Phi_1$
- $Z_1 = \sqrt{\left(W_1 - R\right)^2 + H^2}$

A-B Gap

- $\theta_2 = 90^o - \Phi_2$
- $X_1 = \frac{G}{\sin\left(\theta_1\right)} = \frac{G}{\cos\left(\theta_2\right)}$

Board B

- $S_2 = Z_1 * \sin\left(\Phi_2\right) = Z_1 * \cos\left(\theta_2\right)$
- $Z_2 = \left(\Phi_2\right) = \left(\theta_2\right)$

B-C Gap

- $\Phi_3 = 90^o - \Phi_1 - \Phi_2$
- $X_2 = \frac{G}{\sin\left(\Phi_2\right)}$

- $Z_G = X_2 * \cos\left(\Phi_3\right)$

Board C

- $Z_3 = Z_2 - Z_G$
- $W_3 = W_1 - R - X_2$
- $S_3 = \sqrt{Z_3^{\ 2} + W_3^{\ 2} - 2 * Z_3 * W_3 * \cos cos\left(\Phi_3\right)}$
    - Law of cosines: $c^2=a^2+b^2-2ab*\cos(C)$
- $\theta_3 = \left(\frac{W_3 * \sin\left(\Phi_3\right)}{S_3}\right)$
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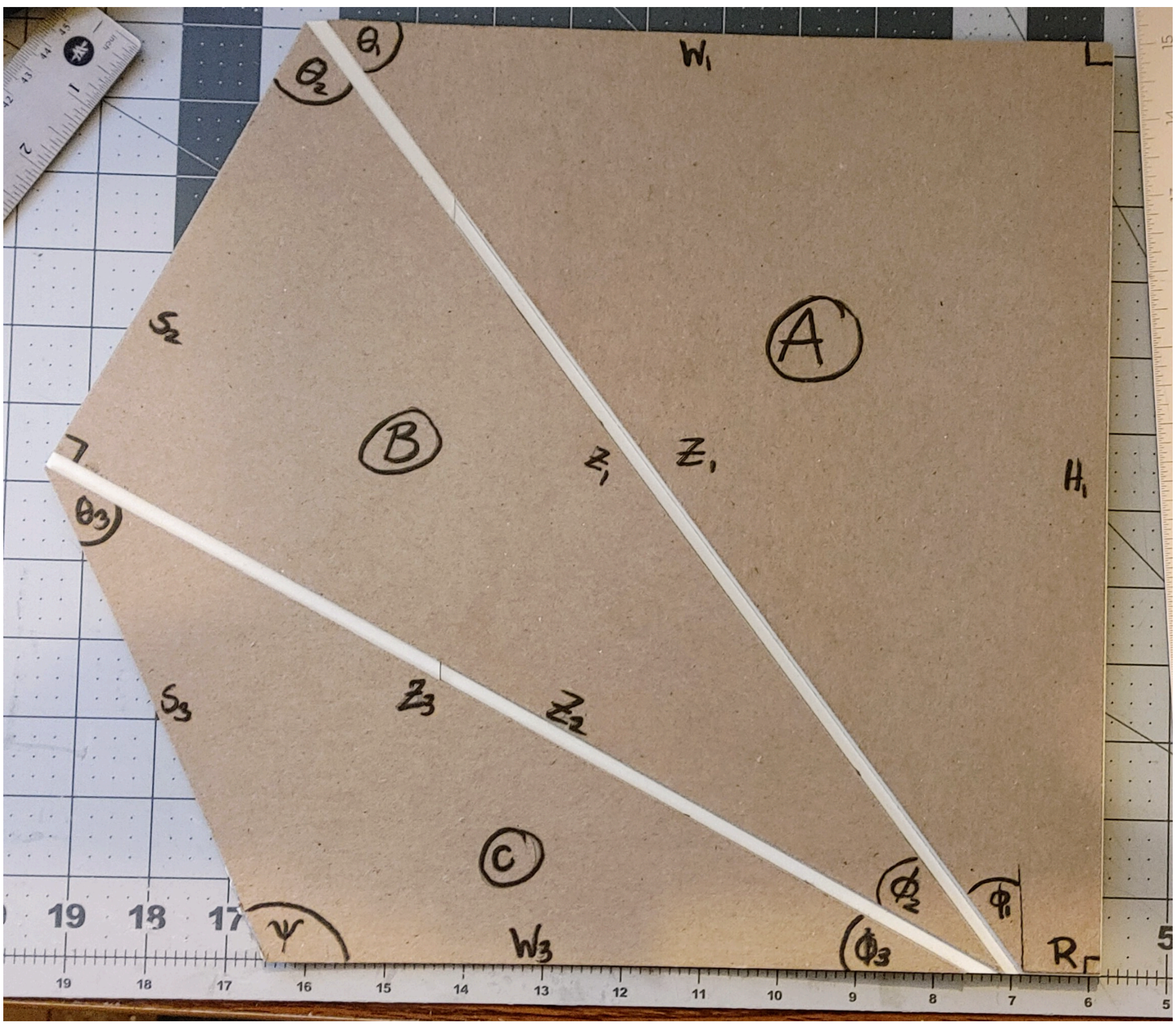


Okay But How Do I Finish That Spine

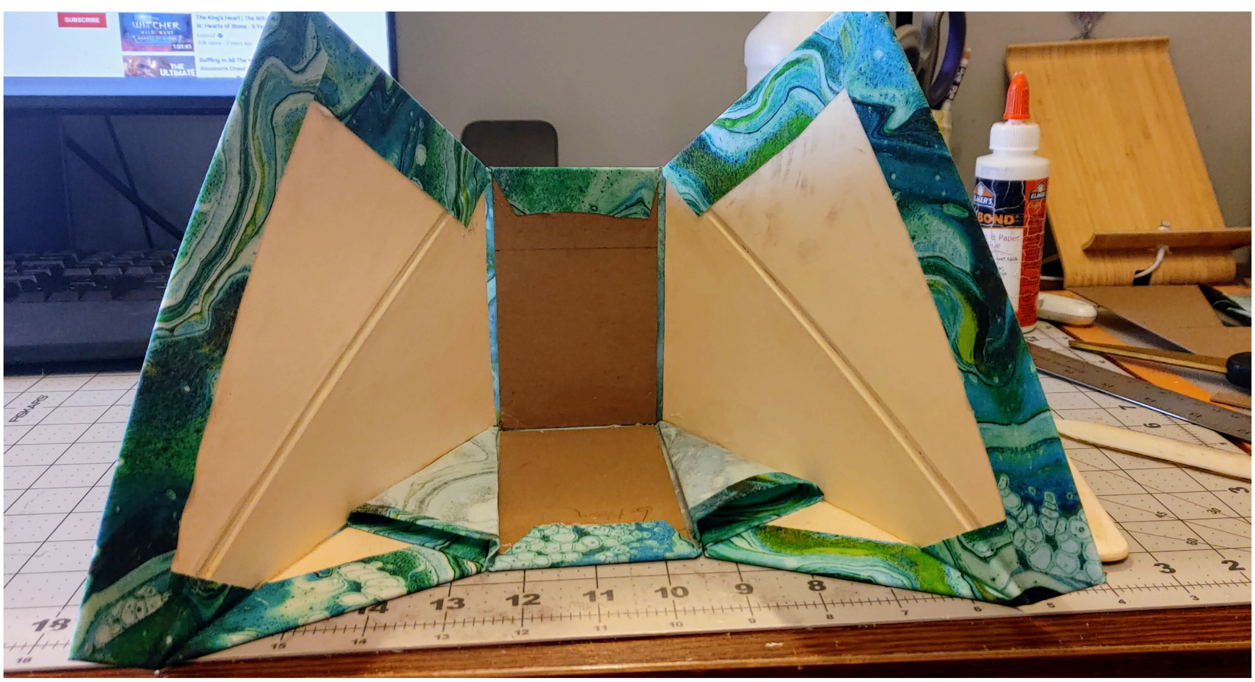
So, you want Board C to be a hinge gap's distance from Board B. You also want it to be that far from the lower spine piece. If you try to arrange this yourself, you will find that this isn't possible to do flat. I'm not writing a full in-depth tutorial for this piece, but don't panic!

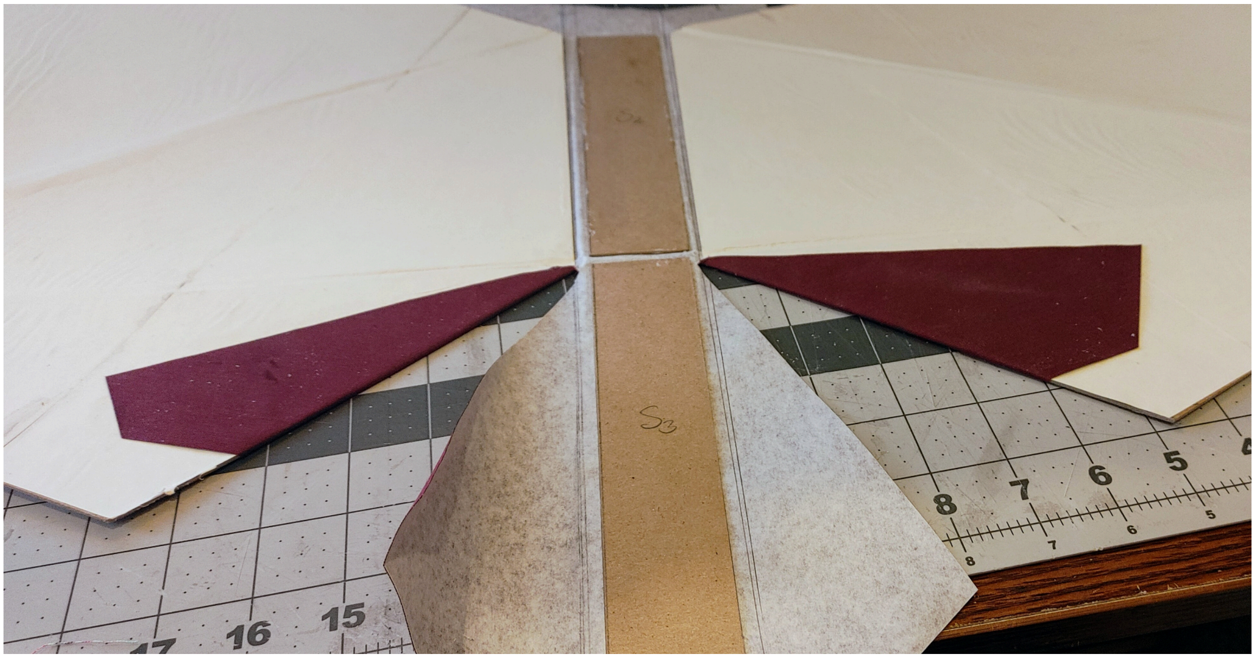
Glue your Board C (x2) down next to the appropriate Board B pieces. Trim your bookcloth for turn-ins the way you would for a rectangular case, and start doing the turn-ins, but don't touch that awkward webbing between Board C and the spine just yet. Once you address that, your case will stop lying flat, and you need to be prepared to pin your case in place with awkward geometries to help let your adhesive dry. For the other parts, work carefully to address the way the board edges intersect at weird angles, and take the time to press your cloth down around the corners well.

(I will also say that I do full cloth cases, and I have not finished a prototype yet with a cloth-paper combo. With that kind of material, it may not be possible to do all your turn-ins before addressing the weird geometry. But since it's outside my wheelhouse, I'm having trouble visualizing it, and don't want to pretend to be an expert. Sorry about that! Good luck!)

So you've done your turn-ins and you have two awkward triangles of cloth left hanging in the breeze. You want your hinges to eat that excess. In testing your case, it's as easy as pulling the fabric up into the holes as the book closes, but once you introduce glue, it gets messy fast. I like to fold over my raw edges once so the final product looks a little more polished (you can see that in below), and then, without trimming, I start doing a turn-in around the bottom of Board C. That's what I took a picture of, in my attachments.

I didn't stop quite there, though. I glued down the fabric until it wanted to overlap into my hinge. That wasn't ideal, I want my hinges to be free to move. So I awkwardly cut a line down the fabric just shy of that point. My one triangle of fabric was split into two flaps, one of which was glued down. But I didn't want to wrap the spine fabric around the spine piece, then my case wouldn't hold together. So I pressed together my spine board and Board C so they had the desired separation and their corners aligned, and I glued the remaining fabric to my Board C turn-in. I still had to trim a bit of excess fabric to protect my hinges, but I left as much as I could. And then I did the same on the other side.





It's one of the more awkward bookbinding things I've ever tried to do! It will be difficult with a thin book, because you are going to be working in the space between the two covers and (I assume) trying not to get the right side of your cloth all gluey and messy. I found that letting my book lie on one cover, with the inside stuffed with books of the right thickness and some more books pinning the top down to the book stack, worked best. It's not yet an elegant solution. But it's enough for people to start with.

And then, casing in was also REMARKABLY weird. Hold your text block in the position you want, and note where it falls along the edges of the case. Then, I set the text block aside, and covered Board A *only* in adhesive, within my guesstimated bounds. You do not want to let the endpapers adhere to Board B, and ESPECIALLY not to Board C. There might be a way to make weird endpapers that work well with Board B, but the breakaway spine is different dimensions than your book, and going across the hinges risks tearing your book, and you really don't want to deal with that at this point. Your spine breaks away from the spine along more than one axis, and your paper won't want to do that. Unless I'm wrong! There's only so many prototypes I can make before I lose patience and get distracted by something shiny, I can only speak to my personal construction and process.

Okay there we go I'm really tired now that's the end, good luck, witnessed, etc etc etc.

(scroll to final page for redundant notes and diagrams dissecting the math)

Bonus Notes

Here's my scribble sheet where you can trace the math I did to get to the equations described above. It reads great to ME, but I know better than to assume it's very legible to anyone else, haha