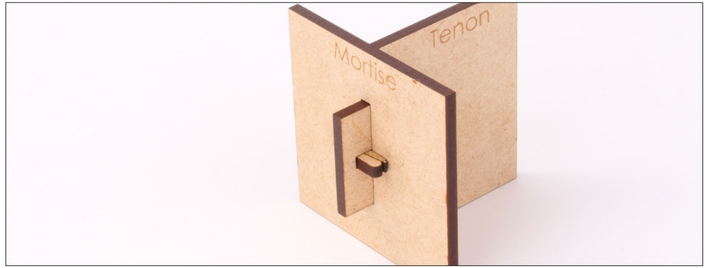
Keyed Mortise and Tenon Joint



A keyed mortise and tenon is a common variation on the mortise and tenon joint. Unlike the mortise and tenon joint, the tenon protrudes from the end and includes a slot for a wedge. The wedge makes the mortise and tenon joint stronger against tension and makes the use of glue unnecessary (though it is still recommended for increased strength).

Complexity

Materials

\+ *Increases the strength of the mortise and tenon joint in tension*

\+ *Only the tolerances of thickness of wedges need to be predicted*

Projects & Uses

The keyed mortise and tenon joint is used to form a T-orientation. Keyed mortise and tenon joints are used to re-enforce pieces that need to bear weight like for the bench in **1** *and the coffee table in* **2**. *This joint can varied in many ways like in* **3**, *so use your imagination.* **4** *is a common vaariation on the keyed mortise and tenon joint where the wedge is vertically through the tenon.*

http://hammerandhand.com/images/page-content/Field-notes/SS-2.png

http://www.stickley-furniture.co.uk/bilder/shop/Stickley-411-LT-Cocktail-Tabke-w.-Leather-Top-at-www.contaria.de.jpg

http://st.houzz.com/simgs/9801956l0ff-fa4da_4-3946/-dining-tables.jpg

http://www.freeportwoodworking.com/sites/default/files/details_13.jpg

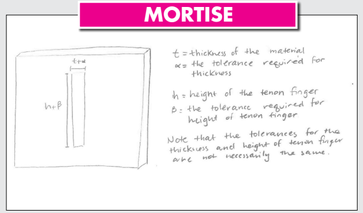
What can go wrong

Assuming you have the proper tolerances for the mortise and tenon parts, this joint will commonly fail in two ways during construction: 1) the wedge is too soft/long and the hammer bends it; or, 2) the tenon fails if the wegde is too close to the edge of the tenon or the wedge is pushed in too far.

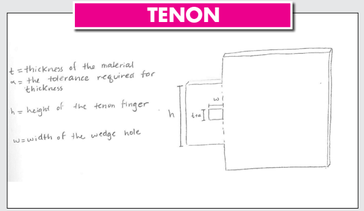
Design

Part files for keyed mortise & tenon joint: LCLAB_Mortise_Artifact.sldprt, LCLAB_Tenon_Artifact.sldprt & LCLAB_Wedge_Artifact.sldprt

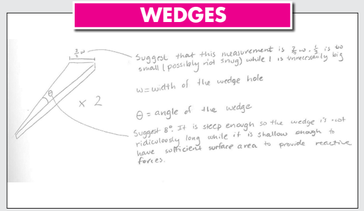
MORTISE



TENON

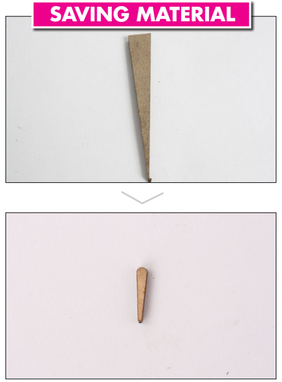


WEDGES



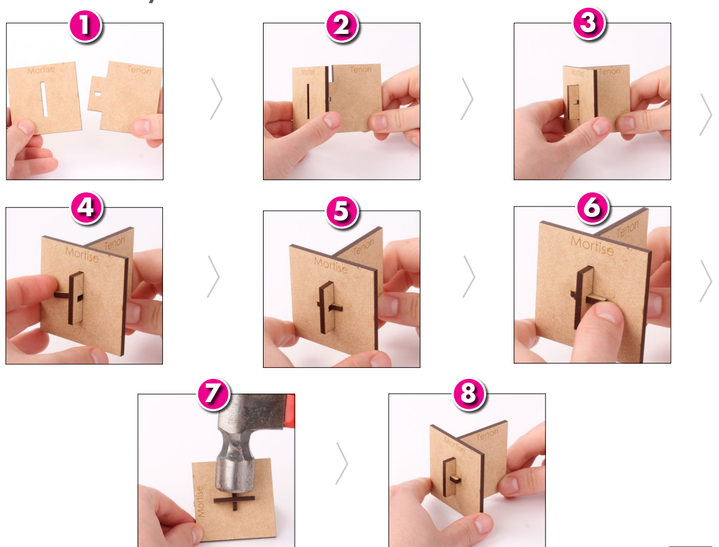
Cutting

SAVING MATERIAL



With wedges, you want to start big and then adjust for your aesthetic needs. You can home in on the range that produces a snug fit and then change your wedge cut accordingly.

Assembly



DESIGN

# of Parts: 3-4

It depends on what kind of wedge you use. You can use loose-wedges which require two parts or one wedge. Two wedges are strongest because they cover the greatest surface area. One wedge is more convenient but since it covers less surface area of the wedge hole, it gives a little bit of wiggle to the joint.

Tolerance Sensitivity: Tolerance sensitivity is medium for the mortise and tenon parts. In the wedge sections, the tolerance sensitivity is low because wedges are actually designed to allow for some uncertainty. That si why they are awesome!

Time to CAD: Medium. The design of the wedge is pretty fluid so you can either spend a long time on them or make them simple triangles.

CAD Comments: This CAD is the simplest I could make it. The wedge hole is directly against the mortise wall for the most secure fit. The wedges are set to 8 degrees as suggested by most woodworking books. After some consideration, I concluded that this was valid advice. Eight degrees is steep enough that you get a good range and your intial wedge is not inconveniently long. It is also shallow enough that you get a good amount of material into the wedge hole so it is secure.

Tips: Home in on the wedge size. Start big and then get smaller to suit your aesthetic.

ENGINEERING

FBD: See the next page for the FBDs. Various situations are applied to the joint including a tension and two types of moments.

Failure Modes: See the next page and the 'What can go wrong' section above.

MANUFACTURING

Final Cutfile Name (# of Prototypes ex. 'joint.dwg (3)'):
LCLAB_Mortise_Artifact_CutFile
Time for Final Cut: ~2 minutes
Final Cut Settings: R=20/75; V=20/50/500
Cutting Comments: It was pretty fast and made limited smoke.
Tips: There was a strange thing happening with small curves on the wedges. They had small notches in them. While they do not hinder the function so I continued on, however they are not really aesthetically pleasing. I think that it has something to do with small curved on a laser cutter in SolidWorks.

Another tip is to perform an Asparagus test to find the correct tolerances. This test needs to be completed only for the mortise and tenon and wedge thickness bits. Wedges are designed to have a certain amount of give in terms of their measurements.

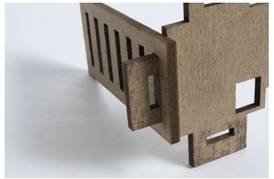
ASSEMBLY

Assembly Notes: The assembly of this joint is pretty easy. When the tolerances were correct, assembly was very easy.
Tips: To get a truly snug fit, use a hammer to push in one of the wedges. Hold pliers around the other wedge to keep it secure.

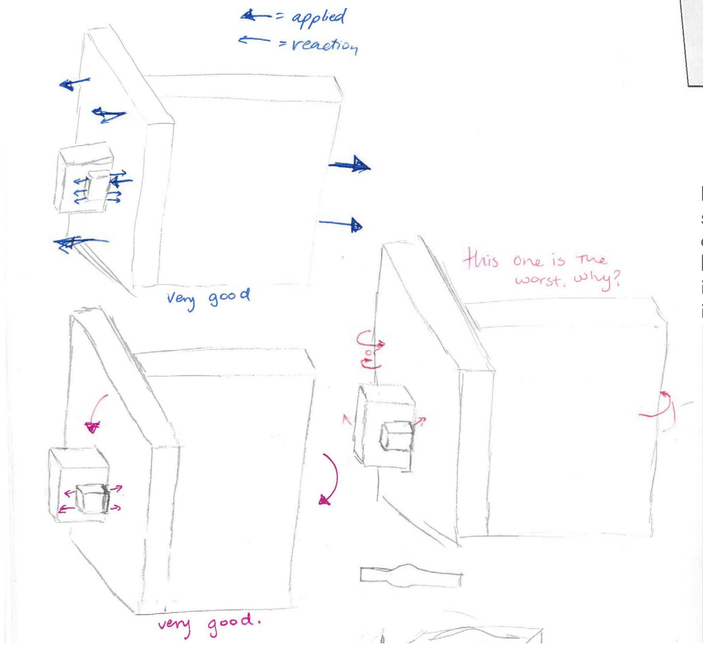
Use the hammer until you hear a high ping. This sound means that the wedge is in as tight as it should be. Hammering further could cause damage to the wedge or tenon.

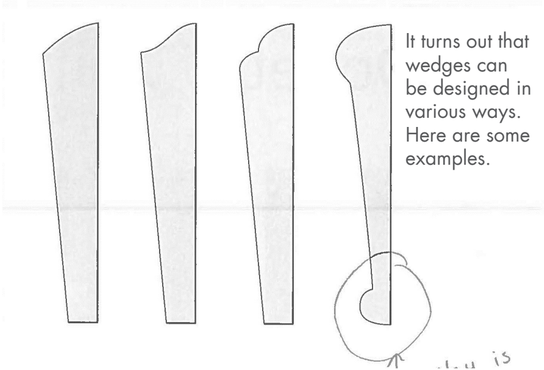
VARIATIONS OF THIS THEME

This time around, I performed an 'Asparagus Test' pictured to the left. I think that a section of the book (perhaps at the beginning of the book) should explain how to do an Asparagus test to find tolerances.



FBDs





It turns out that wedges can be designed in various ways. Here are some examples.

I got the tolerances off at one point which meant that I split the mortise in a very paricular way. I was thinking of including this in the 'What can go wrong' section but decided that this issue is not specific to this design; it can happen with designs whose tolerances are incorrect.