In the beginning!

* I will only discuss mitres done on a table saw. Not a compound mitre saw. But much of what I say will apply
* Legs – term I use which applies to the four pieces that make up a picture frame. There are two short legs and two long legs.
* Flat vs Tall mitres
* Mitres here are end grain cuts at 45⁰. There are other types and uses of mitres
* References – Understanding Wood by Bruce Hoadley
* Website – [www.wood-database.com](http://www.wood-database.com)

Used to own a frame shop – Newport News VA, picture framing not construction framing

Talk about Mitre joints: IMHO – Mitre joints are a decorative joint first and structural second. In fact, structural often isn’t even considered most of the time because of the way and where mitre joints are used. I don’t think anyone decides to do a mitre joint because it is the strongest joint for the application. They use the mitre because it looks good in the application. Mitre joints are clean, no end grain showing. Allows grain to wrap around a corner. Allows continuous unbroken line, even grain. The surface can be worked such that the worked edge provides a continuous edge – as in a picture frame.

Two takeaways from tonight

1. The mitre you cut is a compound cut - 45⁰ and 90⁰ - both must be accurate/ dead on.
2. Mitres are finicky. 1/4⁰ off is doubled to l/2⁰ when the joint is assembled- errors are doubled and they compound.

There are 3 parts to building the frame:

1. Saw set up
2. Cutting the joint and the legs
3. Joining

Of the three, joining creates the most difficulty. I will get to this.

I’m not the expert. If you do something differently and if it works for you, then keep doing it. What I will talk about are errors which I have made and corrected. Yes, I am obsessive when it comes to mitres. My goal in my shop was 100% correct, 100% of the time. No picture went out of the store with an open corner.

Some of this will sound trivial, like I’m repeating something you have already heard, **but errors are additive/ cumulative**. Any error, anywhere along the process will increase the error in the product. So, my goal is - don’t make any errors.

Since everything starts at the saw blade, I’ll start there.

Saw blade/ Saw set up

The goal is to get a blade set at 90⁰ exactly and have it cut smoothly. Some joints can be “off” and still have a workable joint. This is not the case with mitre joints. They have to be exact.

***The key feature on setup is to make sure that everything on the saw is squared up. Exactly squared up.***  These are the steps I go though. What we are doing here is “stepping up our game” by focusing on each and every step of the process. And checking each of those steps.

1. Is the throat insert flush with the tabletop? Too high or too low may result in a poor measurement when checking for vertical.
2. Have you checked your square to see if it is square? One of mine wasn’t.
3. How do you measure to check for vertical on the blade? --- 2 squares working together.
4. Use of digital gauge – off by .1⁰ (Johnson Professional digital angle locator - $99.99, Woodcraft). A 1/4⁰ is .25 degrees. The built in error is about ½ that.
5. Measure for square in the gullet between the teeth not on the teeth.
6. Double check Mitre gauge when set at 90⁰ is square to the blade and that the fence is parallel to the blade. My Incra needed some adjustment right out of the box.

Cutting the joint and the legs

***The key feature on cutting is the legs must be exactly the same length, the mitre cut is 45⁰ exactly.***

1. Remember, this is a compound joint - 90⁰ and 45⁰
2. Is the blade sharp? Sideways pressure on the blade. Dull blades deflect more. That means an uneven cut. My saw guy told me this.
3. Is your wood milled straight and true? No cupping, twist or bowing. If not, don’t use it.
4. Check your set up for 45⁰ , make cut and test before cutting legs.
5. Absolutely imperative that the paired legs are identical in length. As little as 1/32nd off will prevent a good joint on two or even all 4 joints.
6. For flat cuts, I add a long fence to the mitre head.
7. For flat stock --- Stack the long legs and short legs and cut each stack. Ensures same length. Use this approach especially if the long legs are too long to easily cut on your set up.
8. For tall cuts I use a cut off table with a stop.
9. Use a shaped stop and lift slightly above the table to allow sawdust to exit.
10. For long pieces which might be hard to handle, cut wide and rip both out of single piece after the mitres are cut. For example, an apron under a table top used to hide a sliding mechanism. Picture of the long picture Dale gave me.
11. Beware of holding pieces to cut off table or mitre head extension with clamps
12. Alternate solution to cutting long pieces – go to a local frame shop and pay them.

Joining

What are the elements of a good joint?

1. Surfaces are well mated – flat, even across entire surface – both surfaces
2. Glue thickness is correct and even across joined surfaces - >.004”
3. Apply enough pressure to flatten any imperfections and squeeze out excess glue to reach an even glue line .004” thick (thickness of a piece of copy paper).

If all three of these conditions are met, then a mitre joint is a strong joint which in some cases will not need mechanical support. Except picture frames. Will talk about this.

***How do we apply glue to a mitre joint?*** Two steps – apply glue to both surfaces and allow to soak into wood (clarify). This takes 5 – 10 minutes. This fills up the vascular tubes and closes them. Then wipe off the excess glue, apply a second layer of glue and clamp immediately.

***How does glue work?*** Two types of bonds – mechanical and chemical. The chemical bond acts as if there is no distinction between the two layers of wood, it will cross the gap. That bond can only span a limited distance – about 3 – 4 thousands of an inch. The average thickness of a piece of copy paper. Wider than that the chemical bond fails and there is only the mechanical bond holding the pieces. That is by far the weaker of the two bonds.

***How much clamping pressure is needed?*** Between 150 and 250 lbs/sq in. depending on the density of the wood. This is needed to squeeze the glue to an even 3-4 thousands thickness and to level any imperfections. Eastern Hard Maple requires about 200 lbs/ sq in. And that pressure needs to be applied across the joint perpendicular to the glued surfaces. This pressure can easily be accomplished with most F-clamps or a C-clamps but not necessarily enough for the glued surfaces as they become larger. E.g., two 12” square maple boards being glued needs 28,800 lbs of pressure to meet this threshold. (12x12x200=28,800=14.4 tons). Note: it is really hard to over-clamp a joint.

C-clamps, and F-clamps, bar Clamps, vs quick grip clamps

Types of clamps/ procedures for clamping mitres.

***Strap Clamps***

These come as a strap or metal corners pulled together with rods – with lots of variations. These do not work well. First, many people forget to put the metal corners on them, so the straps don’t slide to even out the pressure. Second, the clamps do not apply enough pressure for all four joints simultaneously. Third, the direction of the clamping force is at the end of the joint and parallel to the joint and not across it. This clamp does not pull the joint together. Fourth, with enough force the clamp will try to turn a square into a circle thereby opening the joints on the inside.

***Tape and clamps***

Lay out mitered pieces on masking tape (other tapes work too). Then “roll” up, stretching the tape in the corners. Tape final corner. After rolled and taped, check for square and finish pulling together with clamps/ cauls. Good for smaller items. Better than straps because it has even pull in each corner. Can also try other clamping techniques.

***Framing vises***

Better than strap clamps. These work on one corner at a time and allow more pressure into the joint. With finagling they can be pulled together even if off slightly.

***Glue blocks***

Glue shaped blocks to ends of piece and clamp across the joint. This is the best. Puts the pressure where needed and can deliver enough force to adequately close the joint. When done take off with chisel or saw and a handplane. Use hide glue (or Old Brown Glue or Titebond Hide Glue) because hide glue will not stain the wood. May also use double sided tape.

***Mechanical fasteners in conjunction with glue and clamps***

Not all mitres need mechanical fasteners. It depends on the application.

Mitres are not as strong as mortise and tenon, bridle joints, dowels and other types of joinery. Done right, they are not as fragile as many think they are. (They are fragile because there is little chemical bonding – less wood surface in an end grain to end grain joint. Most of the bonding is mechanical bonding. If the mitre is side grain to side grain then they are very strong. As strong as any other glue up.)

They are decorative joints. They don’t show any end grain. They can show continuous grain – like a waterfall. As a decorative joint, we shouldn’t ask that they be structural.

Lots of types of mechanical fasteners

Splines – Often the fastener of choice

Nails – traditional choice – yep, I include them. I used them in the frame shop on occasion and still do.

V-nails – attached from underneath so hidden from view. This is the most common fastener in framing industry. These are engineered to pull the wood together and not pull out easily. But, these are not for the home shop. They cannot be hammered in. They need a machine to set them.

***Not all applications need mechanical fasteners, but virtually all picture frames need them.***

The pull of the wire will twist the frame. The pull will eventually pull apart poorly made or unsupported joints. Only in special circumstances should a picture frame be assembled without corner support.