Measure twice, cut once
Layout and Measurement – The Essential Tools

Neville Comins

What is it all about?

- The success of any project is basically linked to ‘cutting to a line’
  - The accuracy is thus a function of the **quality of the layout** and **the method and set-up of cutting**, i.e. hand-work or machine
  - Flawed measurements will plague a project through every stage
  - There are different levels of layout depending on the stage of the project

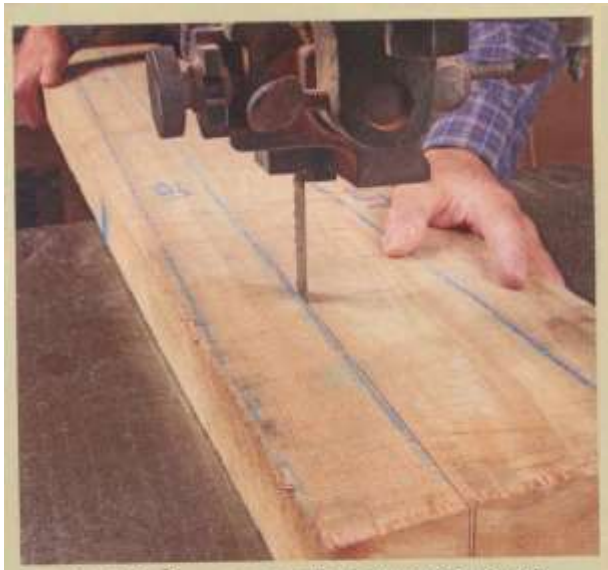
Levels of Layout
Rough layout

- Starts with the preparation of the cutting list
  - In particular the ‘rough cutting list’ (Pre-finished)
- Preliminary layout begins at the selection of the rough planks
  - Layout of the pieces, their cutting and labelling
  - Cuts generally need not be precise as allowances are left for milling
- Primary tools
  - Metal measuring tape
  - Long ruler
  - Fat pencil, chalk and crayon

Rough layout

When rough-cutting or milling lumber, visibility is more important than precision.

Bold lines of attack. *Mark out parts on the rough boards with a lumber crayon or fat pencil, factoring in extra length and width. Use a long ruler to align parts with the grain.*



Cutting it close enough. *Follow the rough lines on the bandsaw. These cuts don't have to be perfect. Make crosscuts with a miter saw or circular saw.*

Milling marks. *When you mill parts, use a fat pencil or a crayon to mark reference faces.*

Milling

- Accuracy determined by machines set-up
  - Mark reference faces
  - Many machines (e.g. jointers, thicknessers, and table-saws) do not have accurate calibrations
  - Do not cut all pieces to length from the cutting list
- Key tools
  - Accurate rulers
  - Accurate try square, engineer’s square or combination square
  - Venier or dial calipers

Levels of Layout
Mid-level layout

- This level refers to the marking of curves or shapes, mostly cut with a bandsaw
  - Often based on tracing patterns
  - Finishing done with:
    - Router and template
    - Rasps, files scrapers, etc.
- Mark-up tools used
  - Pens or sharp pencil
  - With dark woods, a range of coloured pencils are useful
- When a project is partly assembled, size parts by fitting not measurement (cut and test)

Mid-level layout

These lines must be accurate and easily visible, designed to get the machine setup as close as possible. Make test cuts to creep up on a perfect fit.

BANDSAWN CURVES

These don't often mate with any other surface, so the exact curve isn't critical. Use a template to ensure consistency, and mark a very visible line for bandsawing.

Trace and cut. *A pen shows up well on walnut, marking a line that's offset from the template (right). Now you can bandsaw right along the edge of the line (below), leaving a thin, consistent amount of waste to remove.*

MARKING PARTS IN PLACE

Once a project is partly assembled, it's often easier to size some parts by fitting rather than measuring.

Mark in place. *Miller fits one end of a backboard into its rabbet and uses the opposite rabbet to mark the far end of the board.*

Cut and test. *Use a tablesaw or miter saw to crosscut the board close to the mark, and then try the fit. When it's perfect, crosscut other backboards with the same machine setting.*

wood as opposed to being simply marked on it, using a knife or point-shaped tool.

Coarse vs. fine marked lines

For rough layout—when breaking down rough lumber and labeling parts, for example—a lumber crayon, chalk, carpenter's pencil, and a fat 6mm artist's pencil are ideal. Go with the crayon or fat pencil if you need the marks to remain visible for a while. Save the chalk for marks that you want to easily brush or rub off.

For mid-level layout such as marking curves to be cut on the bandsaw, pens and sharp pencils are best. Keep in mind that tracing a pattern means your layout will be slightly bigger

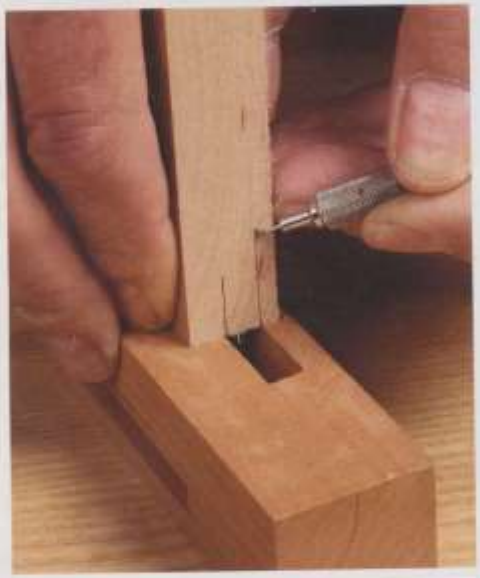
Machine Joinery

- Need accurate layout lines (e.g. Mortise and Tenon, Half-lap, Dados, etc.)
- Final set-up often based on test cuts and fine adjustments
- Layout tools
  - 100 mm Double-square,
  - 300 mm Combination square
  - 15 cm steel rule or perforated rule
  - Mechanical 0,5 mm pencil
  - Protractor

TABLESAWN TENONS

Use a sharp pencil to transfer key dimensions from the mortised piece and lay out the tenon. The final fit is dialed in with test cuts on the tablesaw.

Mechanical layout. *For machine-cut joinery, Miller does layout with a mechanical pencil for its uniform line. He transfers the mortise dimensions, then uses them to lay out the entire tenon (below).*



Fine-tune the machine setup. *At the tablesaw use the pencil lines as a guide (left), but dial in the fit by testing the tenon in the mortise (below). Now you can cut other tenons with the same settings.*

Fine Layout

- Mostly for hand-made joinery
- Best practice is using scribed lines
  - Provides a place for a chisel to pare or chop
  - A small notch can be pared for accurate hand-saw placement
- Various tools for incised lines
  - Marking knife
  - Awl
  - Marking Gauge (Point) or Marking Gauge (Knife-edged)
  - Combination square
  - Bevel gauge
  - Steel ruler

DOVETAILS

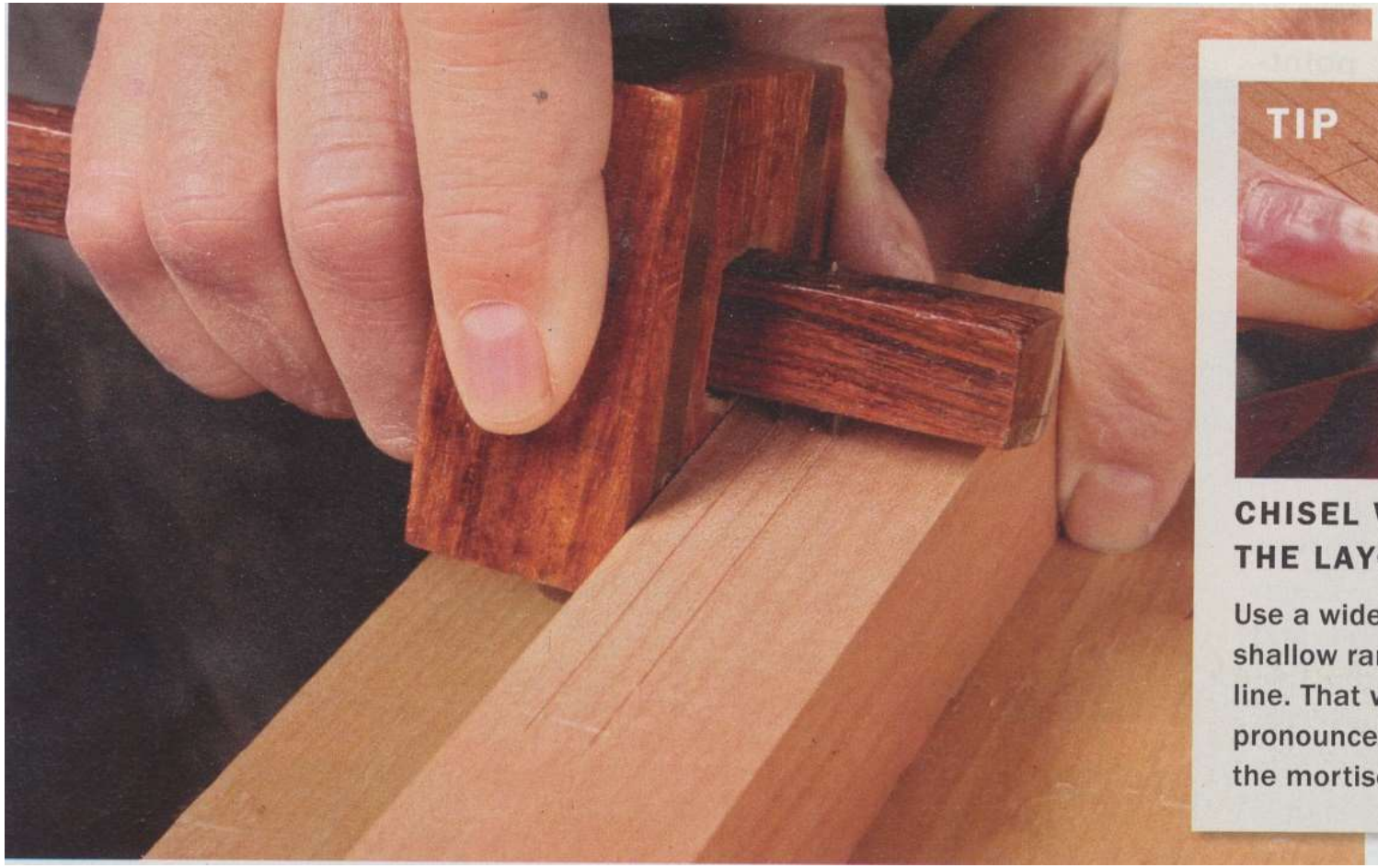
Miller employs three marking tools to cut the various lines he needs.

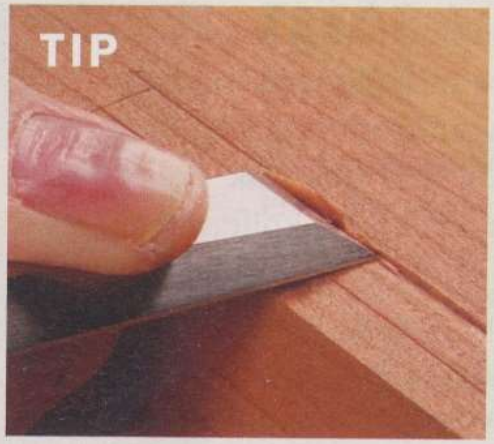
Disk cuts the baselines. *Use a disk- or knife-style marking gauge here, with its bevel facing the waste area and its square edge starting the square shoulder cut.*

Transfer with an awl. *Miller favors the awl for transferring the pin layout to the tail board (left), as it won't cut into the pins the way a knife can. Then he uses a knife to carry the lines around the corners of the tail board.*

TUNE UP YOUR AWL

Watch out for awls with a steeper secondary taper near the point, which makes them useless for precise marking. Regrind the tip to a single gentle taper by spinning the tool as you hold it up to a grinding wheel.





CHISEL WIDENS THE LAYOUT LINES

Use a wide chisel to pare a shallow ramp inside each line. That will leave a more pronounced shoulder to guide the mortise chisel.

Summary of the Essential Layout Tools

- 4-5 m steel rule
- Variety of pencils, chalk, crayons
- 15 cm steel rule
- 300 mm Combination square
- 100mm engineer's square or try square

  or
- 100 mm double gauge
- Accurate long steel rule
- Framing square
- Venier or dial caliper
- Marking knife(s)
- Marking gauge
- Scratch awl
- Bevel gauge
- Compass/ trammels

Characteristics of quality layout tools

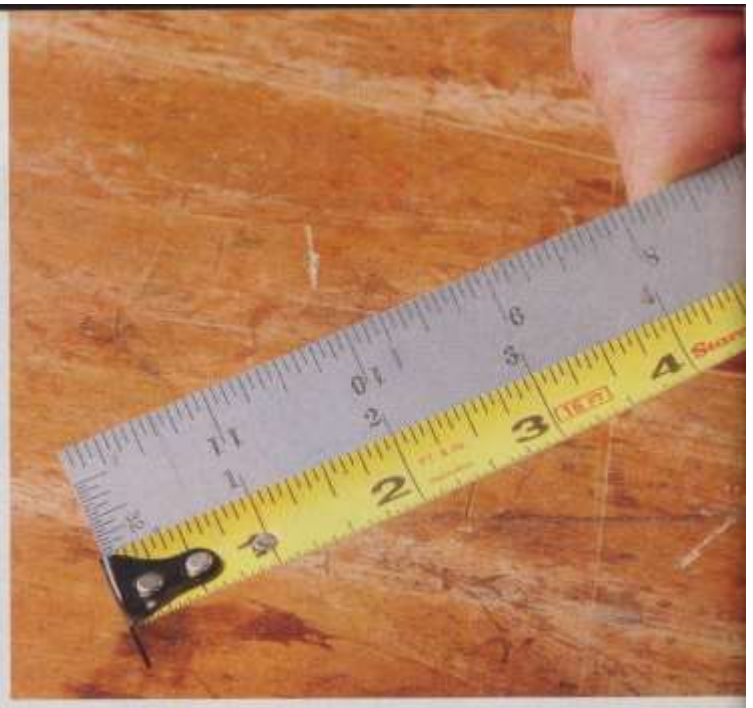
- Accuracy starts with quality layout tools
  - Good quality tools last a lifetime
  - Often limited by selection available
  - The cheap ones may look the same as the pricey ones
    - Don’t be afraid to buy machinist’s layout tools
  - Do you check the accuracy of the ones you have? Not all measurement tools are born equal
    - Inertia to upgrade if not ideal
  - Layout tools need to be handled with care and avoid dropping, impacts, etc.
  - Think of the value of your projects to make a judgement

Some specifics

- **Tape Measure**
  - Many reputable brands are accurate for general purposes
    - Need to check this at purchase
    - Wider tapes are more self supporting but may be more difficult in some applications
  - A critical element is the loose hook
    - Easily damaged with wear and tear
  - Markings are printed and can fade or become indistinct

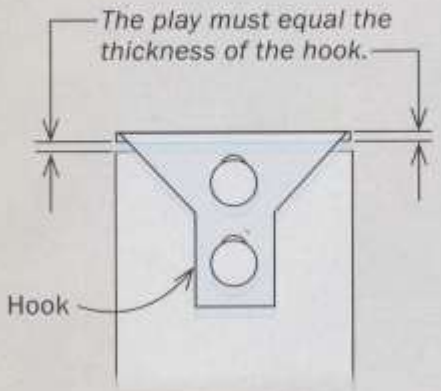
Does your tape measure up?

A tape measure should give accurate readings for both inside and outside measurements. Since quality can vary from one tape to the next, use a steel rule to check it for accuracy before you buy it.



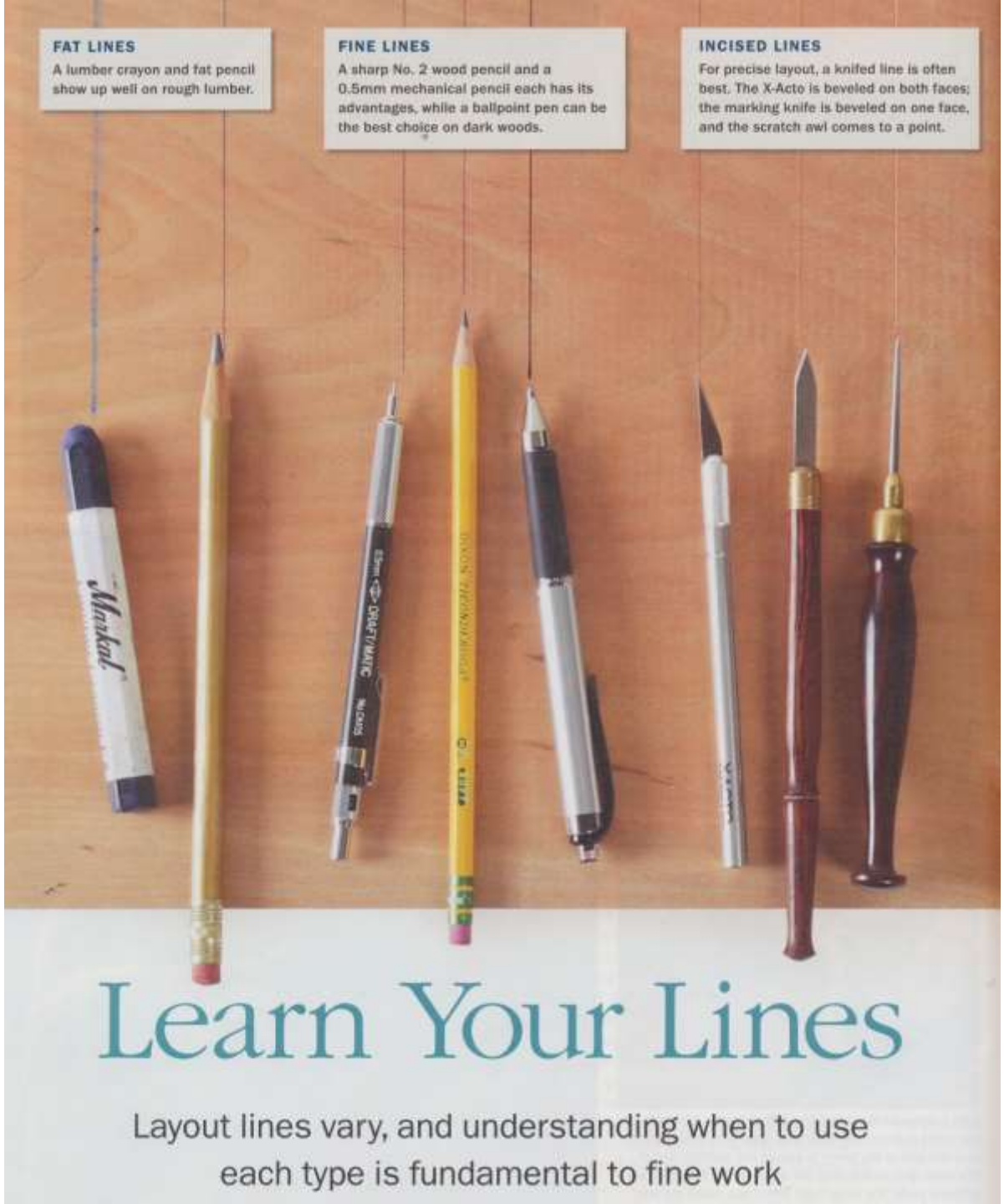
PRECISION SLOP

The hook on the end of a tape measure wiggles for a reason, allowing precise measurements whether the hook is pushed or pulled.



Different types of marking tools

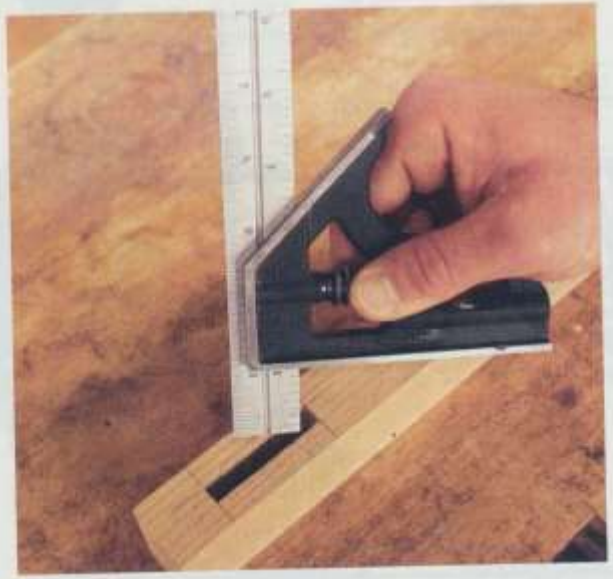
- Need a selection for all the tasks
- One type does not fit all
- Add to this marking gauges



Combination Square and Double Square

- Listed by many authors as the most essential Layout tool
- Key uses
  - A square/try square
  - A depth gauge
  - Checking Joinery
  - As a marking gauge
  - Calibrating a table saw
  - Adjusting a router
  - Height gauge
  - Mitre gauge
  - Marking centres

Check the thickness of a board. *Loosen the thumbscrew of the square and measure from the top of the workbench to the top of the board.*

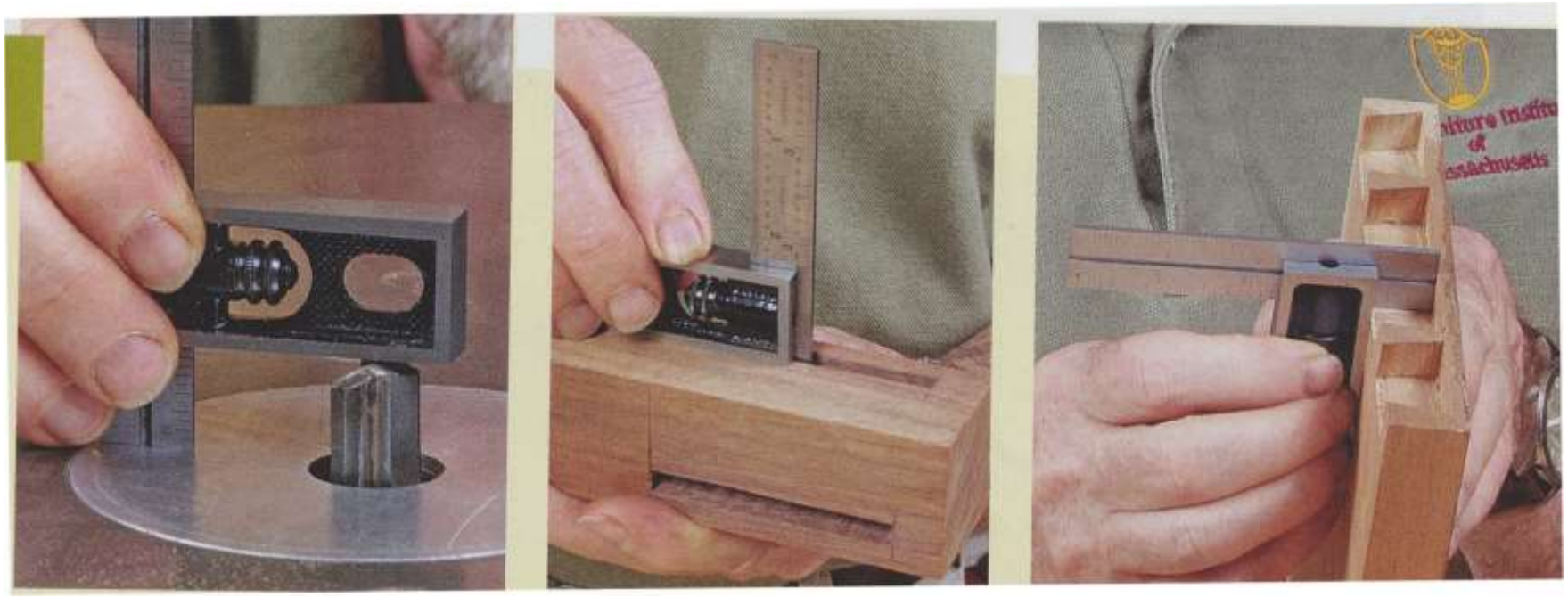


Use a combination square as a depth gauge. *To check the depth of a mortise, rest the head of the square on the face of your wood and lower the blade into the mortise.*

The square works as a marking gauge. *Set the blade to the desired width, hold the head against the edge of a board and, while holding a pencil at the end of the blade, slide the square along the edge of the board.*

Top photo: Michael Pekovi

Smaller **Double Square** can be easier to use for these functions

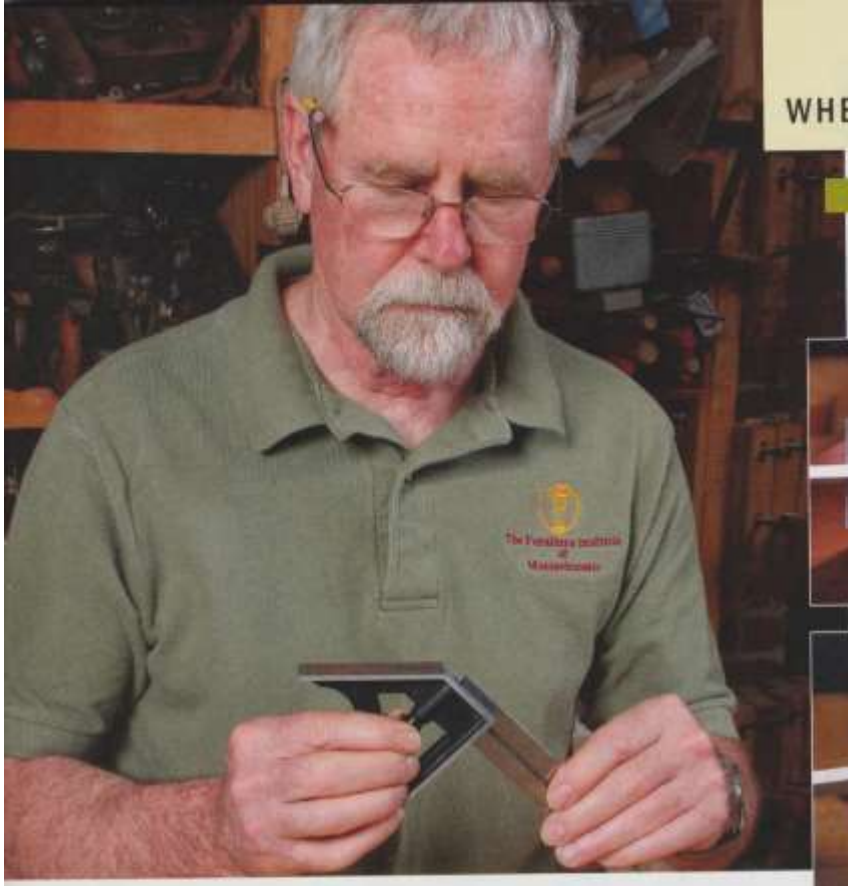


Framing Square

- Useful for layout of large pieces
- Check the accuracy as this is really a carpenter's tool although many are accurately made.

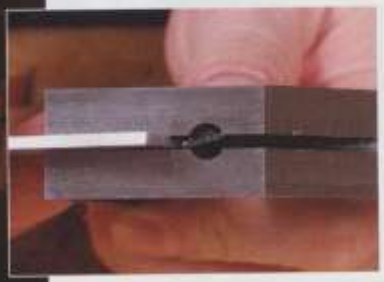
What to look for in a quality Combination Square?

- The sliding blade should be heavy and stiff
  - Can be used as a straight edge
  - Graduations should be machined into the blade
    - Graduations visible under shop lighting (Satin chrome if possible)
    - Not stamped
  - Different blade lengths available
- The Square head should have:
  - Accurately machined edges
  - Easy-to use locking thumbscrew which clamps the blade and assists in blade changes
- In tests, the big differentiator is the lock-bolt
  - You get what you pay for!



LOCKBOLTS

Some are finicky. *Combo-square blades are removed and flipped frequently, and some lockbolt designs are more troublesome than others.*



The trouble with alignment. *It's difficult to keep lockbolts aligned when attaching the rules on most squares (top). But the tabbed lockbolt on the Starrett (bottom) stays aligned for smooth changeovers.*

its own sometimes. Having to toy with the finicky lockbolts found on other squares is an annoyance. The fit, finish, and machining on this Starrett model were just as excellent. I also tested a Starrett with a shinier, hardened-steel rule ($77), but my students and I found that the glare on the blade made the markings harder to read. Its superior lockbolt would still make that model a solid choice, but not the best.

You can find decent 12-in. squares from other makers, too. Among those I tested, the combination square from Products Engineering Corp. (PEC Tools) stood out. It performed well, had a lockbolt that was relatively easy to use, and came with a

KNOBS

Get a grip. *The two rows of knurling on the Starrett knob (left) were easy to grip, but the shallow knurling on the Mitutoyo (right) was tougher to get a handle on.*

Marking knives

- Essential tool for inscribed lines
  - Common for fine layout (Cannot smudge or wear)
  - Different types with single or double bevel
    - Double bevel requires tilting the knife along an edge
  - In use, one must ensure that the knife does not follow the grain instead of ten rule edge
  - Essential for setting of hinges and hardware
- Can also be used to:
  - Score cut-lines to avoid blow-out with table saw or bandsaw cuts
  - Marquetry and inlay work

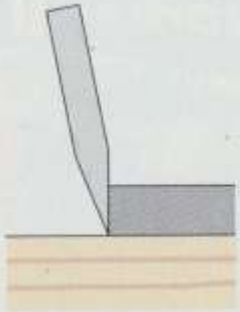
KNIFE TYPES

DOUBLE BEVEL

Most general-purpose knives have a bevel ground on both faces of the blade.

CHIP-CARVING KNIFE

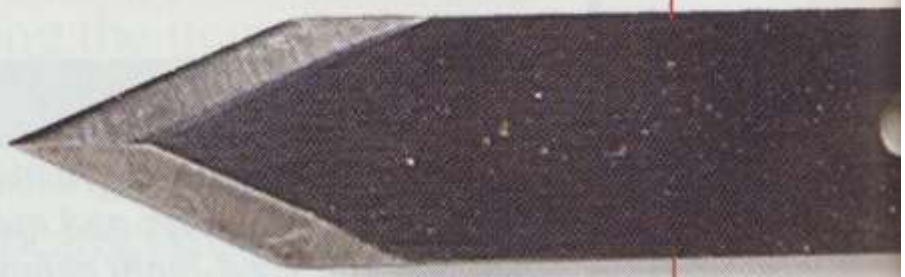
DISPOSABLE BLADE



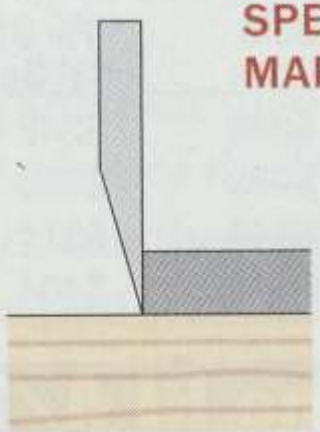
Tilt the blade to keep the bevel flush with the straightedge.

SINGLE BEVEL

A blade designed for marking is typically beveled on one face only.



SPEAR-POINT MARKING KNIFE



Keep the flat side flush with the straightedge.

Improve your layout

Knifed layout lines can be hard to see and don't tell you where to cut. But Pekovich's tape trick leaves n doubt about where to cut, and where the waste is.

Tape the ends. *After cutting the tails, and scribing should lines on the pin board with a marking gauge, apply an ove size piece of blue painter's tape to each end of the board (left). Use an X-Acto knife to trim the tape flush (above).*

Transfer the tails. *Apply enough pressure to cut a scribe line through the tape and into the end grain (above). The scribe line acts as a visual reference in case the tape comes off and provides a precise line to pare to during fitting. Then remove the "waste" tape (right).*

oak and wenge. The tape ledge puts an end to that, keeping the saw on track to cut a more accurate kerf. It also provides a visual guide when paring away the waste to the scribe line.

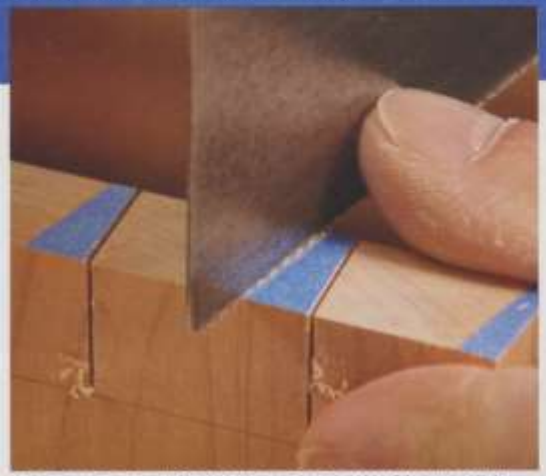
The tape trick worked well for me, but to confirm my findings, I wanted to see if it would help other woodworkers. So, I took it on the road.

Tested and confirmed in the classroom

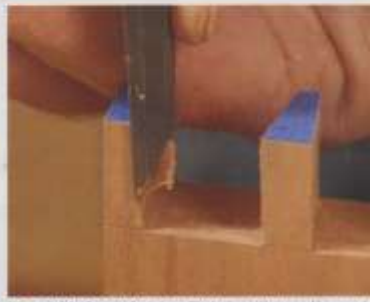
When I first started teaching students to dovetail, I'd always preach sawing right to the scribe line. By

Cut and fit with confidence

The edge of the tape is a visual and physical reference for your saw and chisel.



Use the tape as a saw guide. *Align the saw along the edge of the tape and take light cuts until the kerf is established. As long as you don't cut into the tape, you shouldn't have gaps in your dovetails.*



It's a guide for paring, too. *Find where the wood is proud of the tape, and then pare those areas back to the tape (top). Then check for plumb. Pin walls that aren't vertical won't let a joint fully seat and can cause the outside pin to crack if you try to drive the joint home. Let the tape guide those cuts, too (above).*

cutting closer to your mark, you'll do more accurate work with less fitting. While it's great in theory, it was not so great in practice. Students tended to shy away from the scribe line when cutting pins, resulting in more paring and fitting. It was also common for students to cut on the wrong side of the line, which guarantees gappy joints.

When I taught a class at the Marc Adams School of Woodworking that involved a dovetailed case, I decided to break out the blue tape to see if it would help any of the students. I was amazed at how quickly they blazed through the dovetailing process and I was equally stunned by the exceptional results they achieved. Not only did the tape guarantee that the students were cutting on the right side of the scribe line, but it also gave them the confidence to saw right up to it. I think that it must be easier to envision cutting next to a piece of tape than cutting exactly adjacent to a skinny little knife line. No matter the reason, I am convinced that the tape trick wasn't just an illusion. □

Michael Pekovich is Fine Woodworking's executive art director.

Check the fit. *Chances are you'll get a pleasant surprise—no gaps and no banging the joint together—even if it's your first time cutting dovetails.*

Venier/Dial Caliper

- Extremely useful for accurate measurements
  - Inside and outside measurements
  - Diameters of holes
  - Sizing tenons and mortices
  - Widths and depths of dados and rabbets
  - Root diameters of screws for pilot holes
  - Confirming drill sizes
- Digital readout models quick and easy to use

Marking Gauges

- Pin-type (also as a mortise gauge with 2 pins)
  - Good for with-grain and end-grain
  - Problems with cross grain, unless the pin is ground to suit
- Cutting blade type
  - Preferred as this provides clean cut lines
    - Cutting edge should be ground with a bevel and rounded end
  - Common for woodworkers to make their own
    - See References

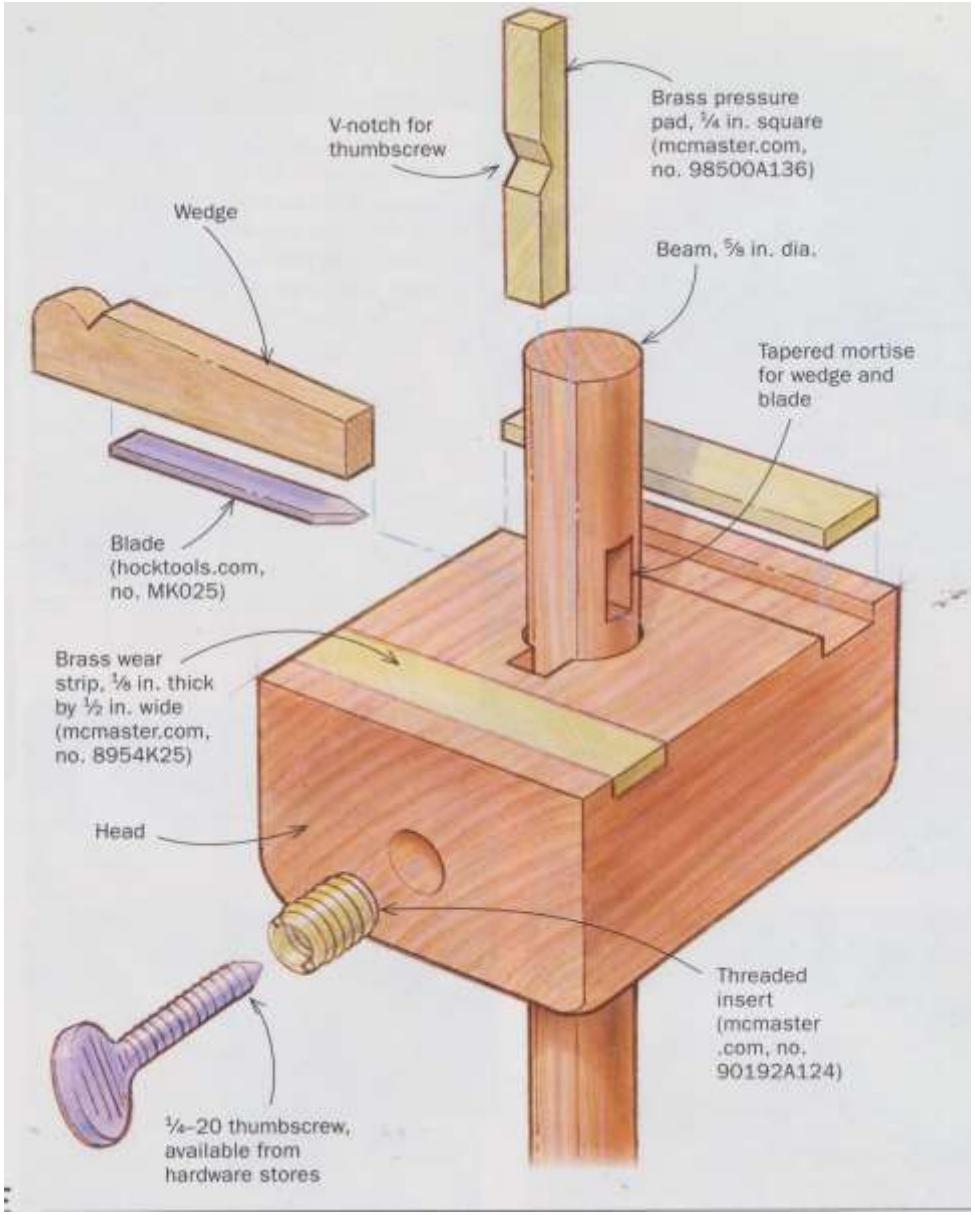

Brass pressure pad, ¾ in. square (mcmaster.com, no. 98500A136)
V-notch for thumbscrew
Wedge
Beam, 5/8 in. dia.
Tapered mortise for wedge and blade
Blade (hocktools.com, no. MK025)
Brass wear strip, ⅛ in. thick by ½ in. wide (mcmaster.com, no. 8954K25)
Head
Threaded insert (mcmaster .com, no. 90192A124)
¼–20 thumbscrew, available from hardware stores

Fig. 2: Marking-gauge points

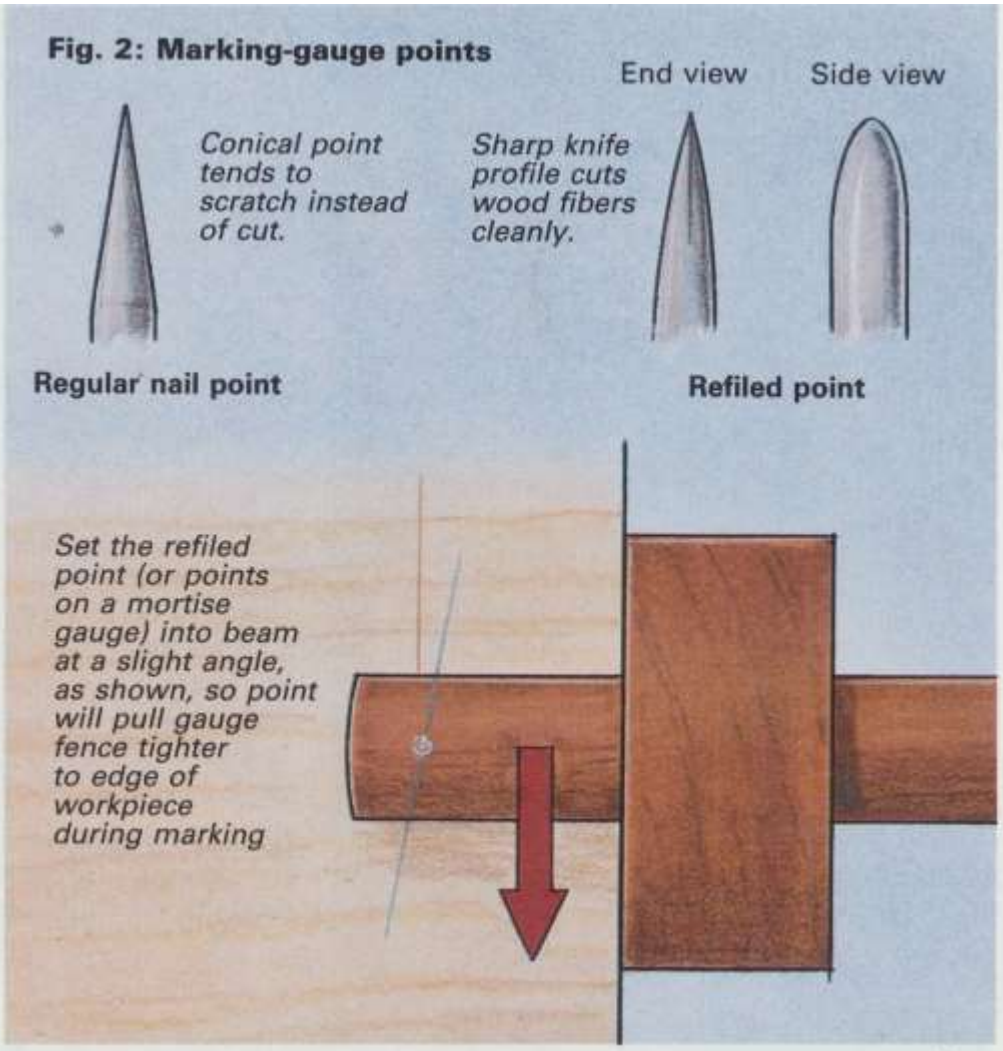
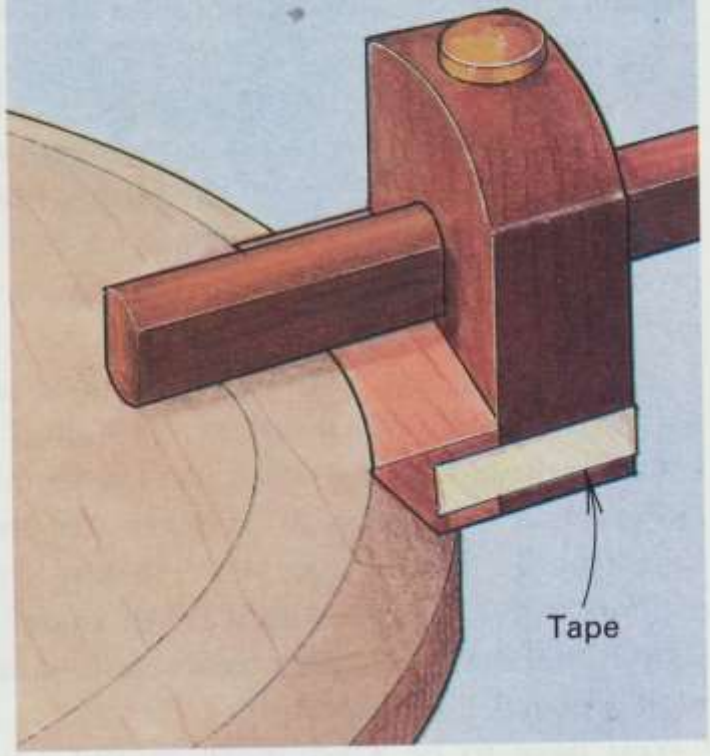


Fig. 3: Auxiliary marking-gauge fence

Shaped scraps taped to the marking gauge's fence act as auxiliary fences, allowing a gauge to mark along a curved or beveled edge.



Other layout tools and opinions

- INCRA perforated rulers Story sticks
- Digital height gauges
- Electronic angle devices
- Use of blue tape for dovetails

- The argument about marking knives and pencils – not all experts agree

Final advice

- Compare your layout tools with the suggested ‘list of requirements’
- Check the accuracy of all your layout tools
- Spend time to watch expert videos (e.g. FWW) and read some of the referenced articles
- Once you layout is inadequate, the drama will follow!!

8-IN. COMPASS

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Thank you