Box Bits # 10

Routed Boxes

Introduction
When routed boxes are mentioned, a lot of people think of the type of box where the "inner space" of the box is removed using a router as shown in **Figure 1.**

Figure 1

Whilst this is a legitimate style of box making (albeit a bit wasteful) this is not the method of construction detailed in this article.
What we are talking about here is the use of a router to mill all of the mitres and dadoes, even down to separating the lid and carcass....hence a routed box.

Assumptions
The following assumptions are made:
• You have read Box Bits #1 and Box Bits # 6.
• You have a Table Mounted Router System
• You have a means of cutting stock accurately to the required dimensions. (ie a table saw etc)

So away we go:

You will need the following router bits:
• a 45º Chamfer bit fitted with a bearing
• a 3mm (or larger) Spiral Upcut Straight bit (no bearing)
• a round-over or chamfer bit as required.
NOTE: For Hexagonal or Octagonal boxes you will need a 30º or a 22.5º bearing chamfer bit.

The most important features of the chamfer bit for this method, is the accuracy of the 45° angle, and the cutting height. The cutting height must be greater than the thickness of the stock used for the box for accurate mitres to form. The angle...well.... buy quality.

Figure 2

Cutting Height

Now, the retailers of router bits give you all the dimensions of the bit, which sadly doesn't include the maximum thickness of the stock that could be mitred with the bit or the dimension we need to know.....the **Cutting Height.**

To explain, they detail the dimensions shown in **Figure 3**

- The maximum bit diameter
- The cutting length
- The shaft size.....which apart from fitting your router is not relevant to finding the cutting height.

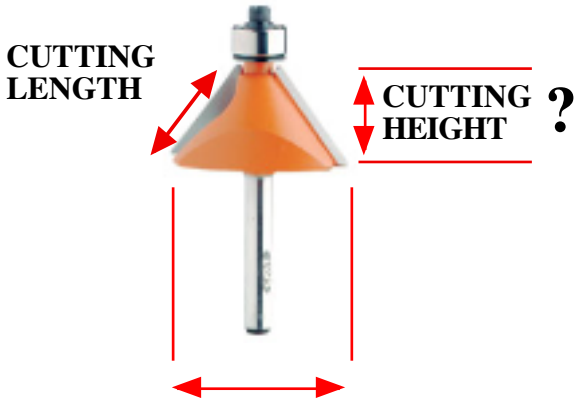
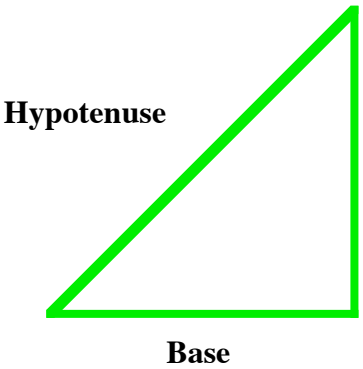


Figure 3

So, we need to call on our old friend **Pythagorus** (Gasp & Horror!)
His right angled triangle rule states that:
The square on the Hypotenuse is equal to the sum of the squares on the other two sides.



Therefore:

$$\text{Hypotenuse}^2 = \text{Base}^2 + \text{Height}^2$$

Figure 4

Now where is the right angled triangle on a chamfer bit???

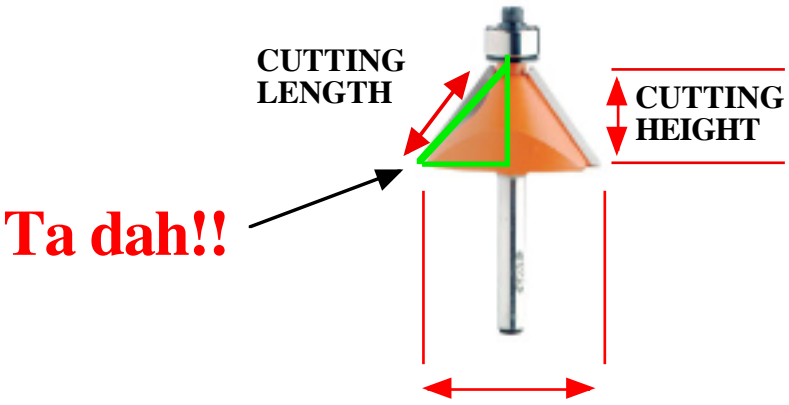


Figure 4 (again)

The **Hypotenuse** is the **Cutting Length.**
The **Base** is half of the **Bit Diameter.**
The **Height** is the **Cutting Height.**

If we take the dimensions of a typical chamfer bit as supplied from a catalogue:

- Cutting Length = 26 mm.
- Bit Diameter = 65mm.

This means:
- the Hypotenuse = 26
- the Base is 65/2 = 32.5
- the height which is the Cutting Height is the unknown.

But by manipulating the right angle triangle rule (thank you Pythagorus) we find that:

The cutting height = $\sqrt{(32.5 \times 32.5) - (26 \times 26)}$

= $\sqrt{1056 - 676}$

= $\sqrt{380}$

= 19.5mm

So that's how you calculate the cutting height of a chamfer bit from the data given in a catalogue, and for mitering box stock this particular bit would be ideal as it can mitre from 19mm down.

When mounted in the router table, the bit should be set to maximum height, and the fence aligned flush with the edge of the bearing, as shown in **Figure 5.**

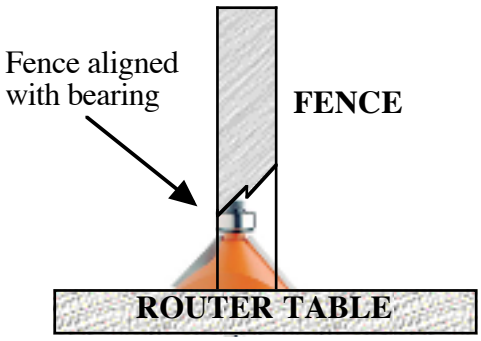


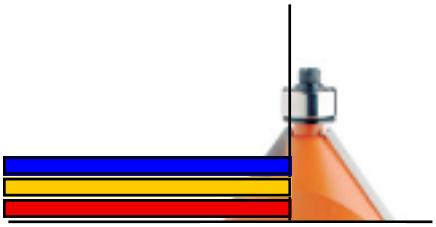
Figure 5

If we use our example bit from **Page 2**, the router when set correctly will take a triangular bite of the stock approximately 32 mm wide and 19mm high. That is a fair chunk of stock to rout in one pass, especially for some of the smaller routers, and this is not good practice because of:

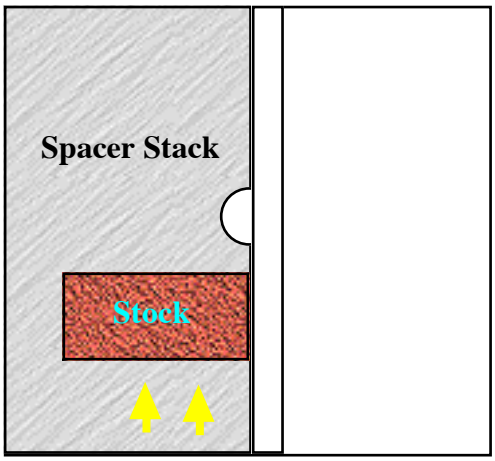
- Motor strain
- Edge burning
- Router bit deterioration.....Not Happy Jan!!

So once the fence is set flush with the bearing edge, we need to insert spacers of varying thickness between either the fence and the stock or the table top and the stock, to enable us to make several light cuts to achieve the mitre. After each pass across the bit, a spacer is removed until the stock is passed across the bit directly against the femce or table top.
Both methods of spacer orientation will achieve the same result and varying sizes of spacer may be used. A good tip is to use the thinnest spacer to remove last, thereby giving a finer finishing cut. The spacer stack may be clamped or double-sided taped in place for quick removal between passes. **Figure 6** shows a typical stack used between the stock and the Router table.

Stepped Cuts
The reason for using the stack method rather than altering the bit height after each pass is that some "non-expensive" routers will actually shift the router bit a small amount offline at each depth setting resulting in a Stepped Cut. NOT GOOD!!
The stack method prevents this problem.



Spacer Stack



Plan view of spacer location

Figure 6

BIG HINT: Before you start mitering, do yourself a favour and mark each length of stock as inside & outside.
Another hint : OUTSIDE goes UP.

Figure 7 shows the method and results of 4 passes with the spacers between the stock and the table top.

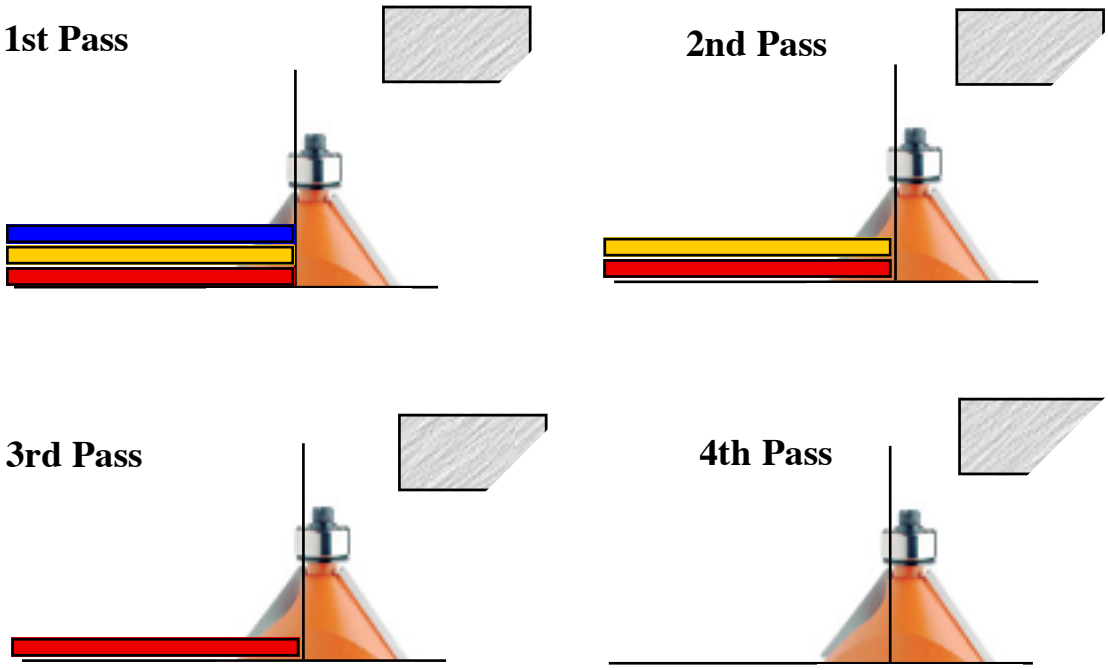


Figure 7

Cutting the Mitres

Now this is an end grain cut across stock that is usually longer than its width, and it will try and wobble when it hits the bit.

So the easiest way to achieve this is to use a substantially wide Push block that ensures that the stock stays against the fence in a stable manner without moving off line. An example is shown below in **Figure 8**

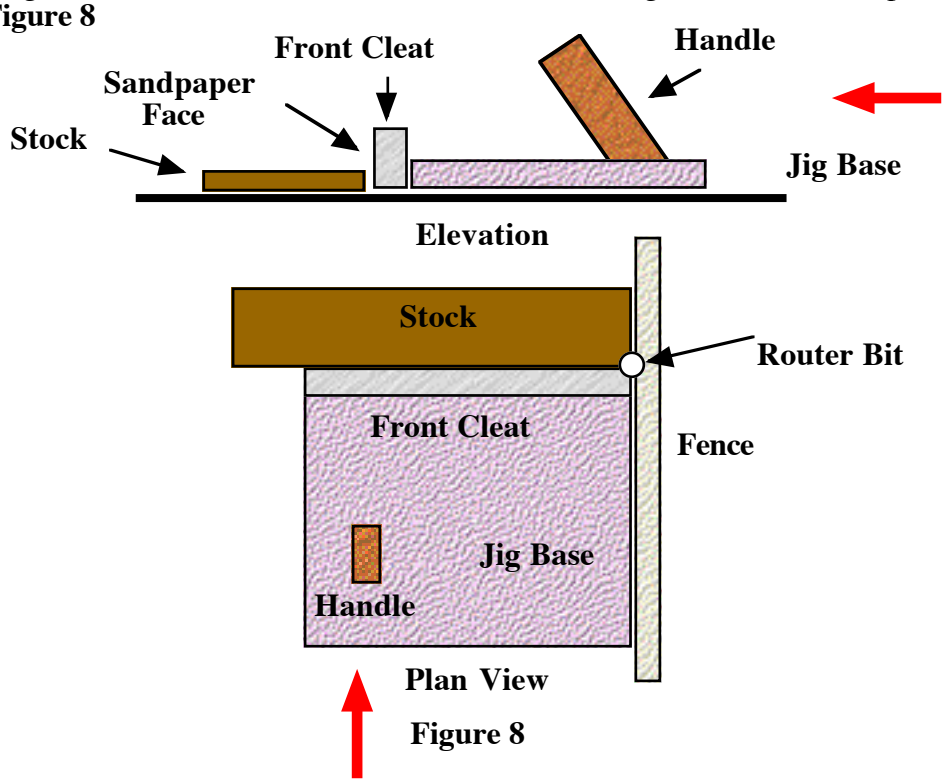


Figure 8

With the mitres cut..... the next actions we need the router to accomplish are:
- Mill the Dado for the mounting of the lid
- Mill the Dado for the mounting of the base
- Separate the Lid from the carcass
- Insert slots for the Mitre keys (if required)
- Apply rounding or chamfers as required for edges and/or hinges.

So lets look at the edge of the box stock lengthwise.

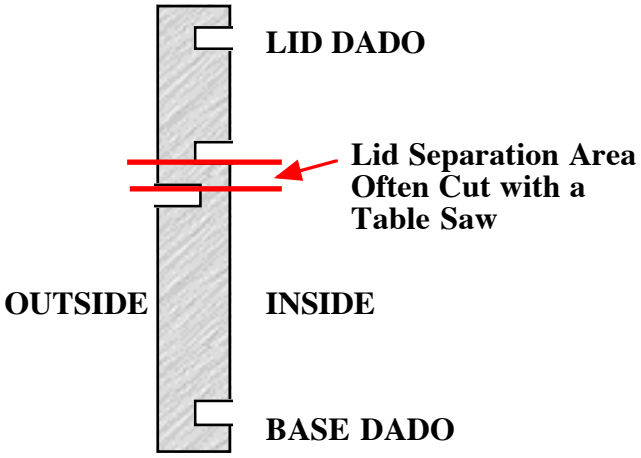


Figure 9

The diagram in **Figure 9** shows the initial routed dadoes milled on both sides of the box stock.

Remember the **BIG Hint** about marking the sides on the previous Page.

Now the question is....how deep are the dadoes into the stock, and at what position are they made with respect to the top and bottom of the box sides. This is the secret!!

And the Answer is....
Box makers are a cut above normal woodworkers.
Faced with this dilemma, a normal woodworker would have a bit of a "think" about it.....maybe accompanied by a beer or such. But**,** on the other hand, Boxmakers ....(being a cut above the normal woodworker)..... use a process called **COGITATION**....accompanied by something in the order of a Fine Red or the Aged Spirit of choice.

The Point is.....there is more to this than meets the eye. Lets just consider the **LID DADO** first

Things To Cogitate

- **What is going into the dado to form the lid?**
- **What thickness is it?**
- **How much will it expand or contract?**
- **How tight is the fit and how easy will the assembly and glue-up be?**
- **Will the lid be marked by glue squeeze out?**

.....more Fine Red!!

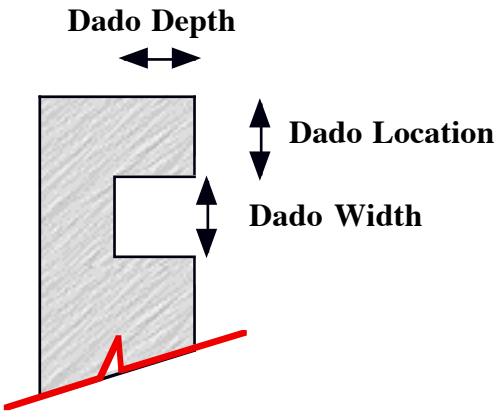


Figure 10

Three different lid configurations are shown below in **Figure 11** and although the details of each is beyond the scope of this article, the points detailed on the previous page must be considered in each case. We will discuss the straight lid style from **Figure 11 (A).**
These simple instructions also relate to mounting the box base.

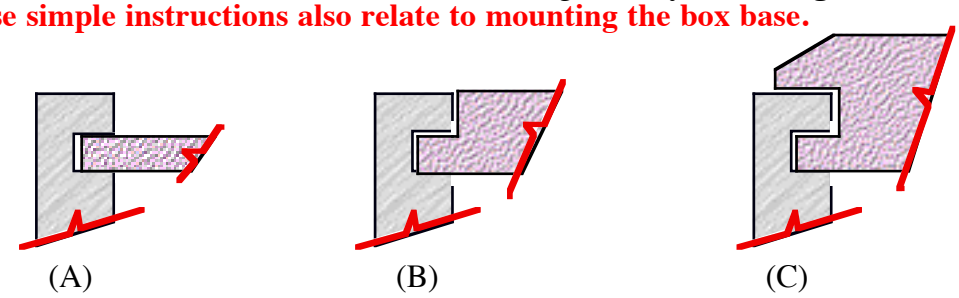
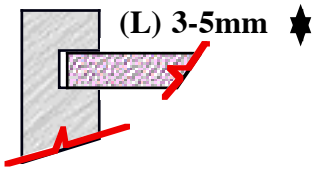


Figure 11

Dado Location (L)

The position of the Dado with respect to the top of the box stock should take into consideration the depth of the "lip" created, which asthetically should not be too deep as it will tend to become a dust gathering area, and also minimise the actual space available inside the completed box. Typically 3 - 5 mm is a good depth from the top of the box stock, which also gives ample room for any edge treatment such as a round-over or bevel that you may wish to "soften" the box edges with.



Dado Depth (D)

There are a few points to consider here.

- Ease of assembly for the "glue-up"
- Expansion or contraction of the lid material due to climatic conditions after the box is completed. Often the lid is left "floating" in the dadoes for this reason.
- The grain of the box stock is running in the same direction as the Dado, which can result in a split along the dado if the dado depth exceeds much more than **50%** of the width of the box stock, particularly when the dado location is less than 3mm from the top of the box stock.
- 1mm free space in each dado is considered enough play for lid expansion.

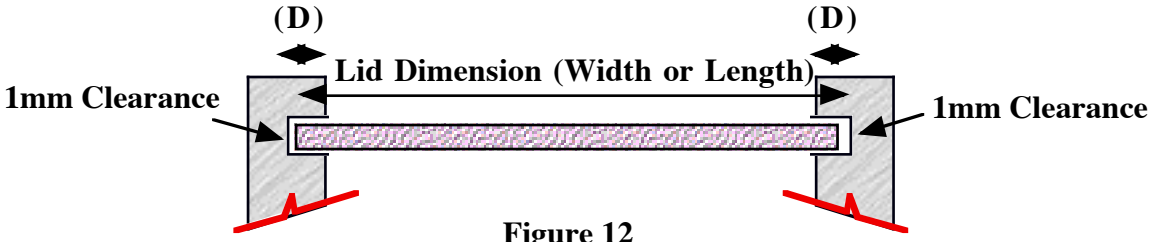


Figure 12

Dado Width (W)

As an experiment, rout a 3mm dado in a length of scrap, and then try and insert a length of 3mm MDF in that slot.....Does it slip in easily?? Probably not.
And remember that during assembly of the box, both the lid and base must fit into dadoes on all four box sides, the mitred corners must line up, the box must be squared up.....and all before the glue sets.....Ha Ha Ha!!
The trick is to find a fit somewhere between tight and sloppy, and no matter the thickness of your lid there will be a router bit very close to the required fit, and the stock may be shimmed out at the fence for another pass, thereby affecting a "good" fit.
A good tip is that **playing cards** are excellent shims as they are all a nominal 0.25mm thickness.
So a few tests on some scrap until the lid slips in easily will make assembling the box much easier, and a less than tight fit will alleviate any potential splitting along the dado.

BIG HINT. When you make these dado cuts, do the same cuts on a scrap length of the same dimensions as the box stock. REASON. When the box is assembled you can't see where the centre dado is to make the separation cut in the correct place.

Lid Separation
The easiest way to describe the lid separation is to show it in a diagram with the lid and base in place as we have shown in **Figure 13.**

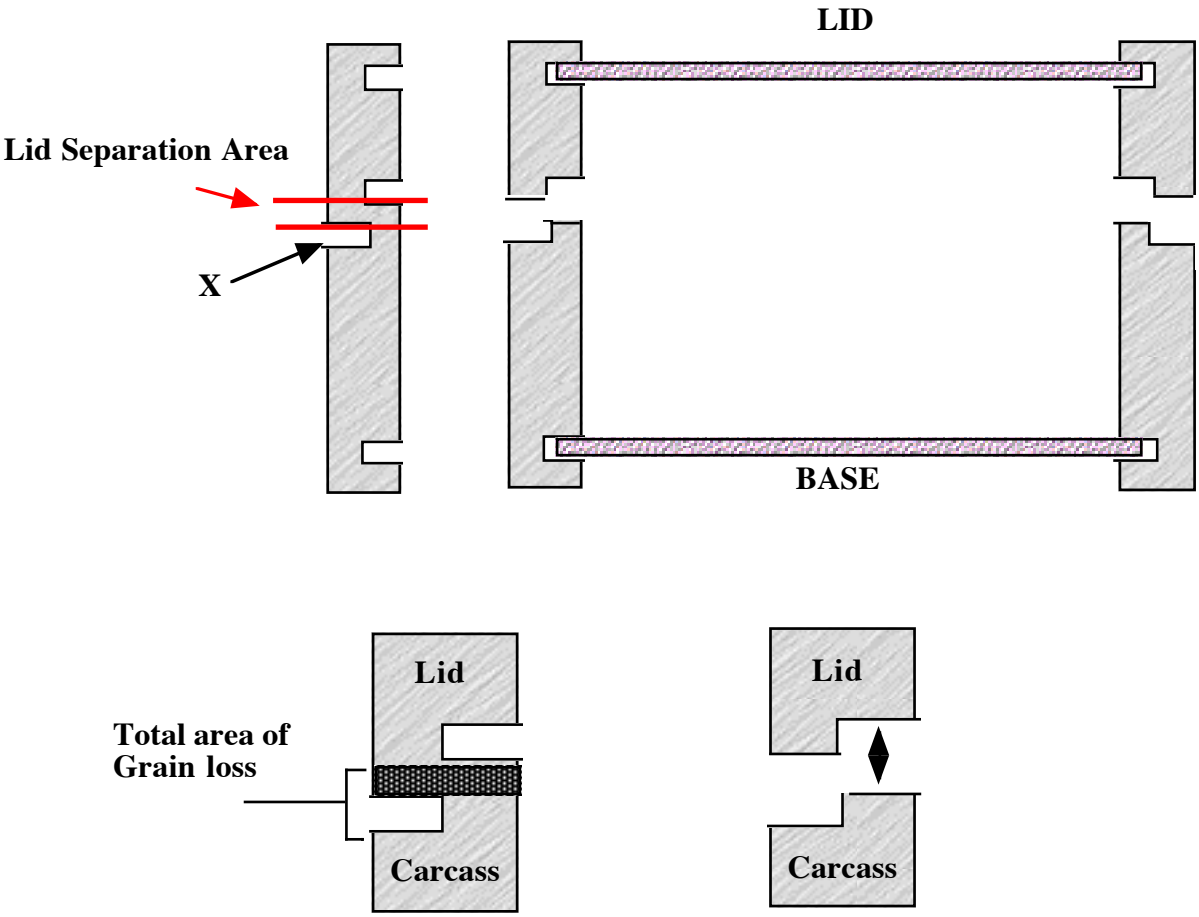


Figure 13

Points to Note

- On boxes with thick stock, several passes may be required to complete the separation. Again be careful of Stepped Cuts (Maybe consider using the Stack Method)

- Using this method of lid separation at least 6mm of grain is lost from the outside of the box.

- The cut made at **X** in **Figure 13** may be made a little deeper than the internal dadoes. (Maybe one playing card deeper). This helps the lid fit over the carcass rebate easily.

- Don't forget to check the scrap with the dadoes before separating the lid & carcass

- When completing the Separation Cuts use a back block behind the box to prevent "Tear-out"

- Try not to get any saw-dust in the Cogitation Beverage.

So that's a broad overview of the points to consider when routing a box. In later Box Bits we shall detail a complete plan for a Routed Box.....until then....Cogitate and Have Fun!