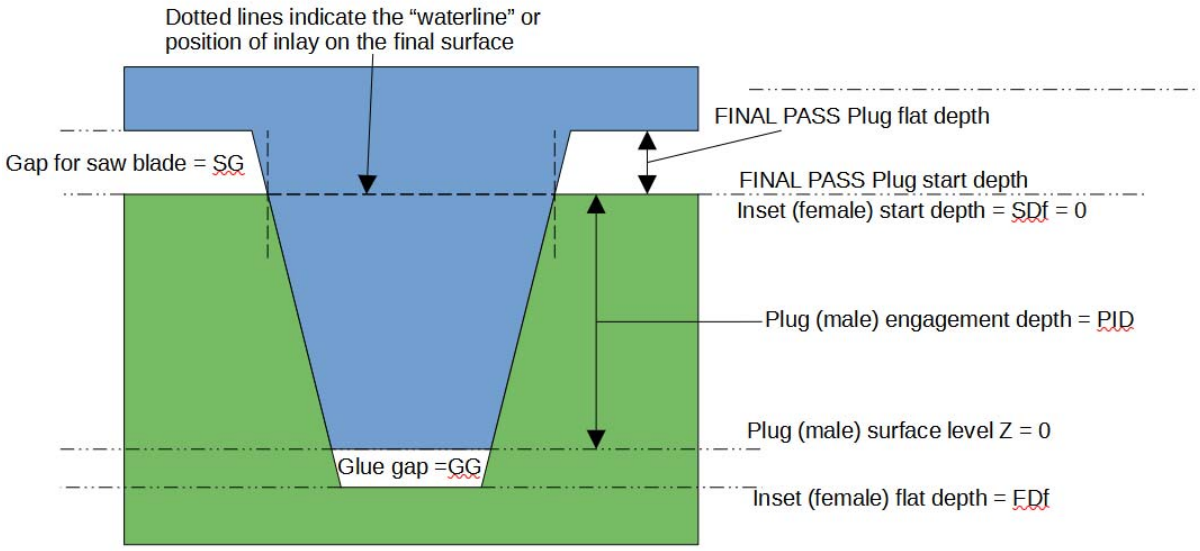
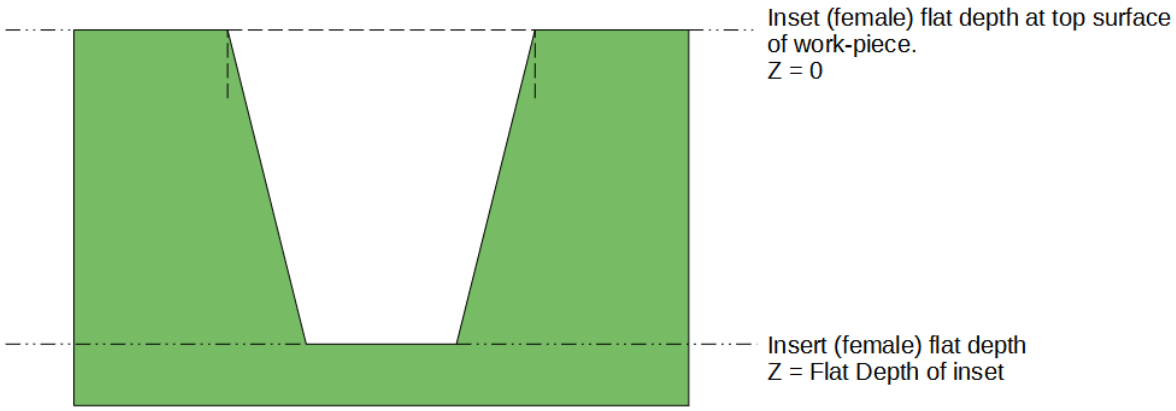
Vcarve (Zank) Inlays

I could never understand why this inaly technique seems so depend on blind faith in some or other rule for calculating the depths (3:2:1, 2;1;1, 0.18:0.02 etc). So, I decided to try to work out the logic so that it is possible to choose a specific value for the glue gap, the gap between male and female for the saw, and the plug insertion depth and from that derive the required values. It includes dealing with pre-cuts on the male part to avoid the deep plunges implicit in deep insertions.

I hope it makes sense to you. It took me a while to get my head around it! Feel free to pass it on. The principles apply for Fusion 360, Freecad, and whatever other CAD/CAM you may be using, but may not be so easy to apply.



Plug and Inset (female) combined profile measurements



Inset (female) profile measurements

NOTE: the dashed lines show the position of the inlay surface when it is completed.

The surface of the finished inlay is on the surface of the stock on which the vector outline of the female part is drawn. The (mirrored) male plug will have its 2D vector outline in the same plane so that the two parts mate together properly. This is also the level that defines the Start Depth for

both the inset and the plug portions. We use this as the reference datum line or waterline forming the basis for all the measurements. It is important to remember that the process depends on the NON-removal of stock on the plug portion ABOVE the desired location of the actual final surface of the finished inlay. Once the plug piece is inverted, that non-removed material fits into the female piece precisely. Or, at least, that's the plan!

One point that I found confusing is that the "Start" and "Cut" depths in Vectric Vcarve etc are not the absolute Z values, but are the distances between levels. So the flat depth is actually the distance from the start of the cut to the flat depth of the cut.

Start off by:

- Decide maximum stepdown for the cutters you propose to use, where maximum stepdown = Smax (eg Smax = 3 mm)
- Choose the depth of insertion of the plug into the inset, PID, to get adequate glue coverage on sides (eg PID = 3 mm)

  IF the chosen PID exceeds the value of the maximum stepdown your machine can handle, you must use sufficient pre-cuts to step down to the required original plug Start Depth.

  This is because the tool will plunge direct to the specified start depth. The plug first pass (ie Plug Start Depth) is the same as the Plug Inset depth, and the tool path does not account for there being uncut material above the "start" level.

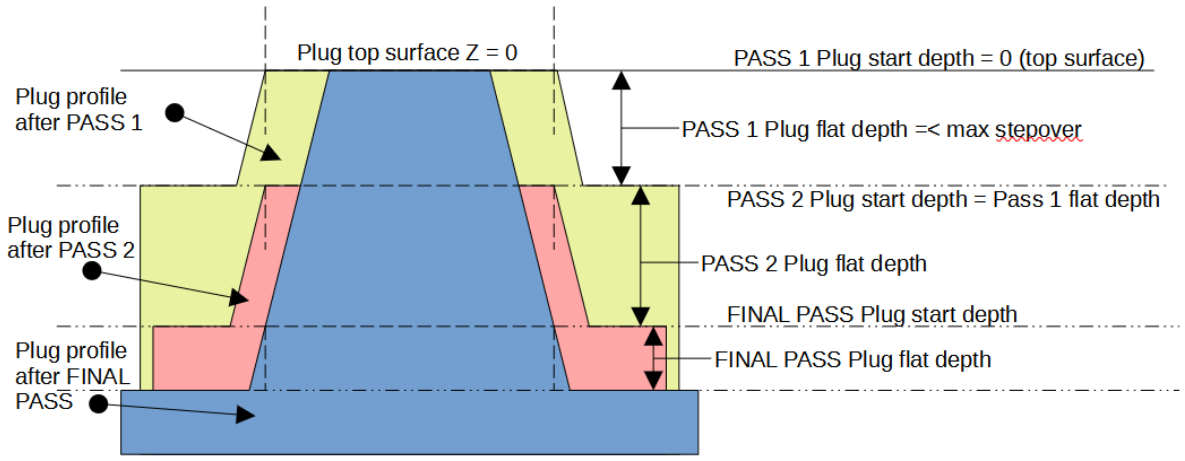
- Choose required Glue Gap (eg GG = 0.5 mm)
- Choose required Saw Gap (eg SG = 2 mm)

CUTTING PLUG IN SINGLE PASS
If the maximum stepdown (Smax) >= PID, and you are certain the tool and machine will survive the plunge to the "Start" level, no initial cuts are required, then the settings can be worked out:

Start Depth of PLUG: SDp = PID. This is the "waterline" or level of the vector on the workpiece, equal to the "plug insertion distance".

Given: GG = FDf -SDp therefore FDf = GG + SDp
Given: FDp = SG
=> Flat Depth of female (inset) part = GG + SDp
And Flat Depth of Plug = SG = 2 mm

CUTTING PLUG WITH MULTIPLE PASSES
IF multiple passes are needed to cut the plug:



Plug profile with multiple passes to Start Depth

[Notice how the "waterline" on the plug is gradually "pushed down" until it is in the correct place, with enough remnant material "above" the waterline to form the portion inserted into the inset portion.]

If the maximum stepdown (Smax) >= PID, extra cuts are required to cut the surface of the plug down. The "gadget" available for Vectric Aspire uses fixed stepdowns based on the maximum for the tooling, except for the second last cut which has a smaller stepdown to take the "waterline" to the level required for the final "proper" cut. I find it easier to divide the distance from the top of the plug (Z=0) to the start level of the final cut into equal depths less than the maximum allowable stepdown. Same number of cuts, slightly less pressure on the tooling. But you pays your money and takes your choice, as they say!

The first pass will be from a Start Depth of zero to a Flat Depth of at most the maximum acceptable stepdown of the cutters. The second pass and subsequent passes will be use the position of the Flat Depth of the first (or previous) pass as the Start Depth of the pass, and the Flat depth will be the stepdown (or to the final Flat Depth = SDF if it is within the stepdown). The final pass uses the start depth required for the correct "waterline" position, which is the same as the start depth you would use if just doing one cut. The flat depth for the final cut then sets the desired gap for sawing off the waste part of the plug, as for a "single pass" cut.

EXAMPLE: For two passes on the plug:

Pass 1:
SD1p = 0
FD1p = Stepdown

Pass 2:
SD2p = FD1p
FD2p = Final Flat Depth of Plug = SG

Nothing changes for the inset (female) part: Flat Depth of female (inset) part = GG + PID

I have devised a spreadsheet to make the calculations easier.

V-carve Inlay Calculator

		Glue gap	**0.5**
		Saw gap	**2**
		Plug engagement depth	**3**
		Bit diameter	3
		Maximum Stepdown	3
		Maximum Stepover	1.5
	Inset/ Female		
		Start Depth	**0.00**
		Flat Depth	**3.50**
	Plug / Male		
		FINAL single pass Start depth	3.00
		FINAL single pass Flat depth	2.00
		Number of passes	2
		Calculated stepdown	3.00
	Pass 1	Start depth	**0.00**
		Flat depth	**3.00**
	Pass 2	Start depth	**3.00**
		Flat depth	**2.00**
	Pass 3	Start depth	
		Flat depth	
	Pass 4	Start depth	
		Flat depth	
	Pass5	Start depth	
		Flat depth	

And there you are, QED! (Quite Easily Done).

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