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Foreword

I made my first metal plane in the early 1980s (a brass shoulder plane) and was immensely pleased with it at the time. It worked well, though in later years I decided it looked rather amateurish . I made a few “hybrid” planes of metal & wood over the next 20 years or so, but became a bit more serious about plane making around 2,000. At that time there was not a lot of available information on types & sources of material in Australia. I struggled a lot with my first plane, making blunders and putting it aside for long intervals while I worked out my next move. It took several years to complete, and was almost abandoned a couple of times, but eventually I finished it. Remarkably, the plane worked tolerably well, but I went through a very steep learning curve, which would have been made a lot easier had I known a few things in advance.

Since then I have made quite a few more planes of multiple types and made a few more mistakes as I learnt about the materials and the processes involved in making planes in a backyard shed with basic hand tools. After being asked numerous times “Where do you get this?” or “How did you do that?” I started writing what was intended to be some basic instructions and a short list of sources that would be helpful to others starting out from scratch.

Like my plane-making, that project got a little out of hand, and I ended up with what amounts to a ‘manual’ on making metal planes. The first edition was a bit disorganised and definitely long-winded in places as I strove to cover every aspect in (too much) detail. So I have completely revised it to bring a little more order to the chaos, reduce repetition, and (I hope), make a few explanations clearer. Of course there are bound to be omissions and errors, but I hope what follows is helpful for beginners and sufficient to encourage anyone considering making a plane to go ahead & give it their best shot. The shoulder planes described in chapter 2 are relatively simple but can be very elegant & useful tools, so you don’t have to begin with any of the more complex types.   Even if you have never done much toolmaking before, I think that making a good plane is within the abilities of anyone prepared to make the effort.

My main aim is to show that making a metal plane does not require machinery or great expertise, all you really need is some appropriate hand tools & persistence. Most home workshops probably already have the majority of the tools required.

There is far more information available on plane-making now than when I began; almost too much! ***Handplane Central*** has a section devoted to plane making (http://www.handplane.com/category/planemaking/) which is worth perusing because reading different descriptions of a process often helps to make it clearer. In particular, Cameron Miller, who made infills commercially in Melbourne for a while, has written several articles, including one with his recommendations for tools. These are similar to my suggestions but there are a few differences, so follow whichever you find most logical. Personal preferences & what you have on hand usually dictate exactly which tools we choose to work with and this is particularly so with files, which are made in a wider range of types & sizes than any other hand tool .

If you prefer action to words you can spend some useful time watching Bill carter at work making a metal mitre plane. https://www.youtube.com/playlist?list=PLtrJ_TcbkJKK_qNTTpeF5DKmDuik6hSEf Bill’s laid-back style can be highly entertaining as well as informative.

With care, anyone of average ability can make a plane that not only works very well, but is highly pleasing aesthetically. And as I always say, making tools is the best way to develop a deeper understanding of what makes them tick & helps you get the most out of them.

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Chapter 1.

Tools, Techniques and Materials

Introduction

For those who have never worked with metal before, it is a little more difficult than working with wood, but not that much, it just takes a bit more time to cut out & prepare the individual parts. Sheet material of brass or steel is quite easy to cut with a common hacksaw. You can make both straight cuts and rough out curves by cutting a series of narrow fillets to a line & breaking them off. Another method for cutting curves or enclosed holes (e.g. cutting out a mouth opening in the sole), is to drill a series of small holes as close together as possible just outside the line & "join the dots" by breaking or cutting the narrow webs of metal between the holes. Both this & the "filleting" method leave a jagged edge that requires much filing to tidy up. If you happen to have a metal-cutting bandsaw or a scroll-saw that can handle metal, of course both straight & curved cuts are a simple matter of fitting an appropriate blade.

Cutting steel with a 1mm cutoff wheel against a guide

Hacksaw cut (left) compared with disc cut

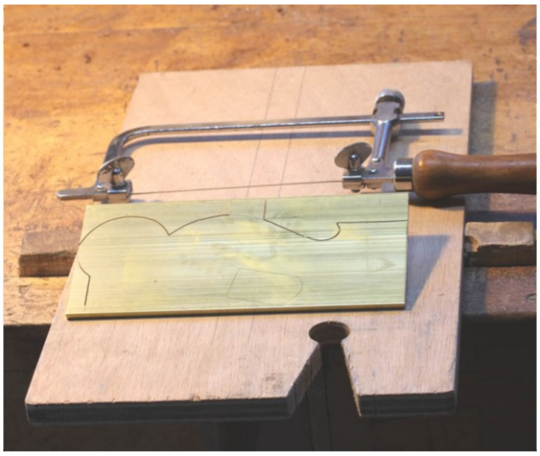
A quick and accurate way to make *straight* cuts is to use a 1mm cutoff wheel in an angle-grinder. Cuts can be made 'freehand' but by clamping a straight piece of steel beside the layout line to act as a guide, very neat & accurate edges can be achieved.

For much of the cutting required for typical side & sole material (3-5mm thick), I use a jewellers' saw fitted with coarse blades (#6-#8). With good quality blades, sawing 3-4mm thick brass is very easy. Sawing steel is a little slower, but still tolerable. The advantage of using a jewellers' saw is that you can make clean cuts very close to your layout lines & only minimal filing is required to bring them to the scribe lines. Of course the thicker the material, the slower the progress, but coarser blades (#7 or #8) will manage even 19mm thick brass (the thickness of lever-caps for larger planes), at an acceptable pace.

Reasonable quality jeweller's saw frames can be had for around $25-30, so you needn't blow the budget on a fancy light-weight titanium model to make a plane or two. However, rigid frames & highly-tensioned blades are highly desirable when sawing metal so if you aren't strapped for cash & envisage an ongoing need for such a saw, you probably won't regret buying one.

If you haven't used a fret or coping saw before, the first lesson to learn is to install the blade with adequate tension. Ensure the clamps are tight, if the blade comes loose while sawing, it will almost certainly break. You'll soon figure out the optimum tension & how much tightening the blade clamps need.

Make a “bird’s mouth” support for sawing out he pieces from a scrap of 12 or 16mm plywood. This takes its name from the shape of the cut-out (as shown at left), which provides access for the saw while giving maximum support to the workpiece.



Birds-mouth cutting board. The various cuts needed to remove the waste with the shallow saw are highlighted

Most simple saw frames can clamp the blade in one position only – it cannot be set at a different angle to allow sawing along edges deeper than the throat. If your saw has a 75mm deep frame like the one illustrated, you may need to be a bit creative to reach all parts of sides longer than twice the saw’s throat depth, but by approaching from various points (as shown by the partially-completed cuts at left), you can usually manage the job. A deeper-throated saw is handy, but also heavier, harder to keep straight, & more tiring to use (the expensive ladder-back saws have a distinct advantage here in being both lighter & more rigid).

The coarser the teeth, the thicker & more robust the blade is. Coarse blades are also a little wider, which makes it easier to cut in a straight line than with very fine blades. You will probably break blades fairly often at first, but once you develop your technique you should more often wear them out before they break. Sawing with full, steady strokes and watching the line a little ahead of the saw blade will help you to cut smoothly. I like to clamp the work to the support board with spring clamps so I can hold the saw with both hands, which helps me to keep the saw vertical, especially when negotiating tight curves. The aim is to saw with minimal wander, staying close to the layout lines.

[*Note: Jewellers’ saw blades come in 16 sizes from #8/0 (finest) through #0 to #8 (coarsest). Don’t make the mistake of ordering blades with an “0” in the size designation, they are too fine and will cut painfully slowly and break very easily in the thickness of metal typically used for plane making. I suggest using nothing finer than #5 for this type of work. While harder to find for some reason, #7 or #8 blades are my choice, they cut 3-5 mm material very easily and being more robust, you won’t break nearly as many. If you can’t get heavy jeweller’s saw blades, you can use metal-cutting scrollsaw blades at a pinch, but the ones I’ve tried don’t cut anywhere near as well as the better quality jewellers’ blades. Glardon, Super Pike, and Eberle are brands I can recommend from personal experience. Do not waste your money on “budget” blades, they may be half the price, but they can be utterly useless for sawing metal – one lot I tried out of curiosity would barely cut wood!*]

It takes a bit of practice to make smooth wobble-free cuts. As for woodworking, saw from the ‘show’ side of any piece & stay far enough from your line that you don’t stray over it. It’s better to leave a wider margin at first, a bit of extra file-work is better than ruining a piece of expensive metal.

It helps to get in a comfortable position for a sawing session. I sit on a low stool so that the workpiece is a bit below shoulder-height. This gets my sawing arm in a comfortable position & gives me a good view of the layout lines. Saw with full, even strokes, applying just enough pressure on the blade to make it cut, but don’t force it or the blade will jam and most likely break as you try to unstick it. When sawing steel, the set slowly wears off the teeth & the blades start to bind – once this happens it’s time to fit a new blade, there is no point in flogging a dead horse. To give you a rough idea of what to expect, a good-quality blade can saw about 70mm or longer in 5mm thick steel (a typical sole thickness), while a “budget” blade will be flat out going 1mm. You can cut out an entire plane side and more in 3.2mm brass, as long as you don’t break the blade

With hacksaws, the better quality (& dearer) frames are billed as being “high tension”, & these are preferable to the cheap versions. As with jewellers’ saws, if the blade isn’t well tensioned you’ll have trouble sawing smoothly & liable to break blades, particularly if you have not used hacksaws much before. A high-tension frame costs around $50-60, but should last a lifetime, and every workshop needs a hacksaw, so it’s money well-spent in the long run.

For the thicknesses of metal typically used in plane making, the finest hacksaw blades (32tpi) are the most suitable. I’m afraid that as with so many other hand-tools, the quality of hacksaw blades has declined over the last 40 years.   For reasons unknown to me, most blades are also covered with a thick acrylic paint which causes binding and erratic cutting until it wears off. Of the blades you’ll find in a typical hardware store, Sutton & Bahco are about the best of a bad lot, but be prepared for a high proportion of blades that want to cut to left or right and need constant correction. “Starret” brand blades are said to be superior, but are not so easy to get your hands on. Also note that once you have used any blade on steel, you’ll find it less willing to cut brass, so it’s advisable to do any required brass-cutting first, before starting on steel.

Hacksaw blades cut quickly, but leave a very rough surface even with the finest blades & it takes much filing to straighten & square a cut on 5-6mm thick steel. As mentioned above, using a cutoff disc in an angle-grinder can improve both speed (particularly for thicker gauges) and accuracy.

Good quality files are mandatory and again, don’t waste your money on ‘bargain’ files. If you buy them from specialist tool suppliers they generally cost the same or only a little more (without handles) than unbranded hardware store files, and are far less frustrating to use. Good files are not cheap, but last a long time if used sensibly and kept clean. A good selection of decent files is handy to have in any workshop.

Oher tools you’ll need include a metal scribe, a steel rule, a fresh felt-tipped marker pen (as a substitute for layout dye), and a ball-peen hammer (or two). Peening is the art of moving metal *controllably* to where you want it to be, & best achieved by using multiple small strikes rather than a couple of big heavy wallops, so you want a hammer that is heavy enough to have a good effect, but light enough that you can use it comfortably for many minutes.   A small hammer is easier to control & obstructs your view less while a properly-shaped ball makes it far easier to strike accurately & consistently. I find an 8 oz (226g) suits me best for peening plane bodies & larger rivets, but I turn to a 6oz (170g) or even a 4oz (113g) hammer for smaller work. Ball-peen hammers come in 2oz (60 g) increments up to several pounds (>Kg) so find the size(s) you feel most comfortable with.

Basic set of tools for making metal-bodied planes

The set of files illustrated is what I consider basic & includes (from left to right): a pair of 250mm flat files (one coarse (bastard cut), & one fine), a pair of 150mm warding files (coarse & fine), a pair of triangular files (150mm slim, and 125mm extra slim), & a round file. Round & half-round files are optional, but very handy. Warding files are very thin (~2.0mm for a 6 inch warding file vs. ~3.2mm for a 6 inch flat file), which allows you to get into narrow places such as when you are forming the mouth opening in the sole of a bevel-down plane. I've put one flat file & one warding file on edge beside each other in the illustration to show the difference in thickness.

When making metal dovetails, you will need a file that can cut into the corners of the angled tails. Even very fine triangular files have slightly rounded edges and cannot cut a truly sharp corner. A type of file called a "barette" is the ideal tool for this job. These are like flattened triangular files, with teeth on one face only, so they can work right into an acute angle without cutting the adjacent side. However, they are absurdly expensive and would have limited other uses for most people, so I suggest as an alternative to grind the teeth off two sides of a regular small triangular file so that it gets into corners without cutting the adjacent face. The ground edges need to be clean & straight, so you may need a jig if you are not used to hand-grinding. Take care not to overheat your file & ruin it. I have lots of old saw files that are worn out on the corners but still have plenty of life left in the teeth on the faces, so I don't have to sacrifice new files, but even if you have to grind a new file, it will still be far cheaper than a machinist's barette.

A 6" EST file converted to a pseudo-barette by grinding two safe faces. This is a handy size for most small to medium planes.

For right-angled corners, safe-edged (or "equalling") files are a good choice, but again, you can simply grind a square edge on an ordinary flat file to enable it to cut to an edge.

If you already have metalwork experience & have developed your own preferences in files stick with what you know works best for you. The files I've suggested are common sizes that are easily obtained & suitable for making a range of planes, but other sizes & cuts can be substituted, and may be necessary for larger or smaller jobs.

[*A very brief note on files, for those not familiar with their nomenclature:*

1. "Regular" files come in two basic types, "Mill" files & "Flat" files which both of which may be flat, or half-round, just to confuse you. However, size for size a mill file has much finer teeth (i.e. a finer 'cut'), than the same size of flat file. Most files come in 3 grades, "smooth", "second cut" and "bastard cut". Bastard cut is the coarsest, but a bastard cut in a 10 inch mill file is about as coarse as the 'smooth' cut in the same-length flat file. Coarser cuts in the larger flat file sizes also tend to be "double cut", meaning the teeth are formed by two intersecting cuts across the face of the file. A double-cut file cuts more aggressively than a single-cut file of the same tooth pitch, but generally leaves a rougher surface.

Warding files are another type of file. These are much thinner than a flat or mill file of equivalent length. They have a more restricted size range, but also have 3 grades of 'cut'. They are useful where regular files won't fit, such as when initially forming the mouth in a plane sole.

2. For <u>*every*</u> *type of file (flat, half-round, round or triangular), as the length increases, the teeth become coarser.*

3. 'Needle' files are short, very narrow files with very fine teeth. They are also commonly double-cut, but the teeth are so fine they leave a smooth surface. They are made in a wider range of cuts than the previously-described files, typically 6 grades. For our purposes a #4-cut is a good place to start and you can progress to finer or coarser cuts as you choose.

4. Triangular files come in different lengths, and again, the teeth become coarser as the length increases. However, there's an additional twist. These files are graded by "slimness" (which refers to the width of the face), and each size (length) comes in 'regular', 'slim', 'extra slim' and 'double extra-slim'. With each increasing degree of 'slimness' (in the same length), the cut gets finer and the corners become sharper. The teeth sizes overlap, a double-extra slim file in one size may have the same cross-section and tpi as a slim file in a shorter size (you can find tables of widths & tpi).

So for example, "DEST" in a file's designation stands for "double extra-slim, tapered" and is the finest cut & thinnest file in that length. "Tapered" means the file tapers slightly over the last approximately 1/3rd of its cutting faces. Most triangular files you are likely to meet will be tapered though some European & Japanese saw files have straight sides with no taper. It doesn't usually matter if the file is straight or tapered for our purposes here, but in a few instances, a straight file is useful.

There is much, much, more to files, this is simply to make you aware of some basic terms if you are new to metal work.]

Drilling metal

For drilling steel and brass, good quality high speed steel (HSS) drill bits are recommended. Dull or poorly-sharpened bits are likely to go off-course and make oversize holes. Bits are not terribly expensive in the scheme of things, so if you are unable to sharpen your own, it may pay to buy some new ones for any critical drilling operations.

A very handy bit to have is a centre-bit. These are useful for starting holes accurately, especially if the entry angle is not square to the surface. I find the most useful size for plane making is the #2, which costs around $6 or so at machinery suppliers. Again, good quality bits are worth the little extra, you can buy cheap high-carbon bits on the internet, but the ones I've tried were of abysmal quality.

Raw Materials for plane-making

1. Steel

Steel can be used for making the entire plane body or for the sole only. Mild steel is highly ductile, & peens well, much better than some brass alloys. You can buy ground mild steel, but it is usually not available in small quantities. Hot-rolled steel is cheap and available in a wide range of thicknesses & widths. Unfortunately, it is coated with "mill scale" and deep pits that take a good deal of effort to remove manually. A linisher will speed the process greatly, or, if you have one, a drum sander should do a good job too, with the appropriate abrasive. Cold-rolled steel is about the same price, has less scale and is not as deeply pitted as the hot-rolled steel, but still needs some effort to clean it to a shiny surface. However, it isn't as readily available in the range of sizes that hot-rolled steel is. Mild steels have one little vice, they shed "crumbs" of metal when filed, which stick in the file and cause nasty scores in your work. This can be minimised, but not entirely prevented, by using sharp (fresh) files and "chalking" them (by rubbing a stick of blackboard chalk over the faces). Regular cleaning of the file teeth with a file-card is recommended.

You can buy clean, accurately dimensioned steel called 'gauge-plate' in a range of thicknesses and widths very suited to plane making. This is actually an oil-hardening high-carbon alloy (O1), but in its annealed form (as normally supplied), is as easy to cut & peen as mild steel, and marginally better to file. However, it's not cheap, a 500 x 75mm piece of 5mm gauge-plate (enough for two smoother-sized plane soles), costs around $85 at current prices.

Another alternative is stainless steel. Most alloys you are likely to encounter peen well but some alloys will work-harden rapidly when peened, which can be a problem. You can buy small pieces on ebay, or you may be able to buy small off-cuts or raid the scrap bin of a fabricator for usefulpieces. SS can be very tough on hacksaw blades & files and drill bits, so be prepared to go through more of each if you choose it as your medium. It does polish beautifully and feels a little more 'slippery' as plane soles than mild steel. I like to use it for making cap-irons.

2. Brass

Brass alloys are quite a bit more expensive than steel, but much easier to work with. Typical bar stock is quite accurately dimensioned and has clean surfaces that require little or no preparation. The most common brass stock available from merchants in Australia is UNS grade C38500 (often abbreviated as "385"). This is a high-zinc alloy with a small amount of lead to improve its machinability, and is a "hard" type, not as ductile as alloys containing a lower proportion of zinc. It will tolerate light peening & can be used for sides as long as you get a reasonably good fit of your parts so they require minimal peening to fill the small voids. It is a *good* choice for the body parts of laminated shoulder/rebate planes which require no peening; it will resist wear better and will not scratch as easily as softer brasses. As a further bonus, you get shallower dings if your hammer slips when clenching rivets.

Softer brass is available; it comes in large sheets and some merchants will cut small pieces (for an extra charge, of course). You can also buy small sheets of brass on the internet, most of which is Chinese-made H62 alloy. This is softer than 385 and peens very well. It is advertised in metric sizes, so you may need to make allowances for that if using it for the sides of a rebate plane, for example.


C385 brass (left) compared with H62. The more ductile H62 has tolerated heavy hammering & spreading without flaking or splitting.

[*Note: Different countries use different designations for brass alloys. C38500 in Australia is roughly equivalent to, CZ121 (U.K.) or CuZn39Pb3 (Europe). These are known as "yellow brasses" because of the high zinc content, which makes them harder and more brittle than lower zinc alloys such as C26000 which equates (roughly) to H70 (China), CZ106 (U.K.) and CuZn30 (Europe). C26000 would be a good choice for your first dovetailed plane body because it is very easy to peen but it seems to be available as sheet* *stock in Australia. An alternative is to buy H62 brass (via e-bay), which has excellent cold-working properties (see illustration above left). However, there is never a free lunch, the cost of being so much easier to peen is that errant hammer strikes leave deeper dings.*

I will mostly refer to brass & steel by Imperial sizes, which I hope won't annoy too much. This is because although sold locally by nominal metric units, most round & flat brass bar is made to Imperial sizes, thanks to the power & dominance of the U.S. market. The brass sheet from China is made to genuine metric sizes. The different sizing standards may cause you some confusion, but local brass merchants are adept at translating from one system to the other, and my supplier isn't at all fazed if I ask for "150 millimetres of ½ x 2 inch flat bar".]

Despite their poorer cold-working properties, you can use the harder brass alloys for the sides of dovetailed plane bodies. If you arrange the joints as shown in chapter 3, the heavy peening will be on the steel. The brass will need less peening, particularly if your joints are reasonably well cut, because the gaps on the sole side are small and easier to close.

For rivets, I've found brass rod made by K&S to be excellent. It peens very well & will not split or flake from the amount of peening required for setting rivets. It is sold in small packs and sizes suited to plane-making by stores that cater to modellers.

Steel soles were often sweated on to bronze or brass bodies and if making a rebate plane from a softer brass alloy it may be worth considering doing this but I don't think it is worth the extra effort involved for a shoulder plane made from 385 brass. Still, it's a refinement, and offers a way to fix a mouth that went astray (see later).

If you're a woodworker with no prior metalwork experience, it *will* take a little time to adjust to working with steel or brass. You must work to tighter tolerances, but that is not as difficult as it may seem. Careful setting out, and cleaning-up cuts to the layout lines so you 'sneak up' on a good fit is the best strategy. Using some form of layout dye is highly recommended. A fresh felt-pen will do the job and make your scribe lines stand out, but engineers' layout dye is better if you have some. Unfortunately, it is generally sold in quantities far in excess of what most amateurs would ever use.

Working metal with hand tools is slow but slower progress gives you a better chance to see errors developing & correct them before doing irreversible damage. Of course, if you are really determined, you can make just as big a mess of a piece of brass as a piece of wood, that I can vouch for! You'll undoubtedly have moments of despair or panic along the way with your first plane or two (it can still happen after you've made dozens), however, all but the worst 'disasters' can usually be fixed. Some can't, of course, like cutting the dovetails the opposite way on each side of the sole as I did on my first plane. That could have been so easily avoided if I'd followed the advice I'm about to give you & marked my sole "top" & "bottom" clearly. In fact marking parts is a fundamental aspect of both metal and wood work. I always mark parts clearly now!

If you work carefully and methodically, there's no reason you can't end up with an excellent result on your very first attempt. The satisfaction you'll get from using a good tool you've made yourself is more than worth the effort.

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