

Ironbark Toolworks Philosophy: the Low Angle Hand Plane

Design ergonomics:

There are three main ergonomic grips that a craftsman uses to interface with a tool. The most common of these grips is the power grip where the user makes a fist that allows a lot of force to be transferred to a tool. Think about a shovel or rake where your hand wraps around the handle entirely. This type of grip seems useful because it allows for a lot of energy transfer, but it has problems in hand planes since it is frequently not controlled easily. Many hand planes take advantage of the power grip, but modify it slightly to make it more controllable.

On traditional bench planes made by Mattheson, Norris, Spiers, etc. the 'totes' (rear handle) seem to be uncomfortably small for most people, but this is because you aren't meant to wrap your entire hand around it with a power grip like it's an axe handle. Instead, these totes are meant to be held with only 4 or sometimes 3 fingers. The first finger to remove from the grip is the pointer finger. If you try clenching your fist as hard as you can around a dowel or length of broom handle about 300mm long, you'll see that the harder you clench, the more your hand shakes and the harder it is to control. If you clench all your fingers, except keep your pointer finger pointing off the handle instead of wrapped around, you'll notice the shaking stops no matter how firmly you hold the dowel. This leads to a grip that has many of the advantages of the power grip, but with much more control.

It might seem like losing the pointer finger on the grip should also lose all the power afforded by the grip, but this isn't true either. If you hold a broomstick in one hand with all your fingers wrapped around it and have a friend try to pull the broomstick out of your hand, you can see how well connected you are to the handle, therefore how much power you can deliver to the tool. Now take your pointer finger off the handle. You'll see that you lose some grip, but not much. Try again by taking your pinky finger off instead. This time you'll have hardly any grip on the handle. Surprisingly, most of your grip comes from your pinky and palm in that configuration which is why most plane totes keep your palm tight against the tote and your pinky finger tightly held at the base of the tote or along the bed of the plane just behind the frog (part that the blade is bedded on).

Besides the power grip, there is also the external precision grip (how you hold a pencil) and the internal precision grip (how you hold a computer mouse). Both of these grips are much more important to block planes than a power grip, but they are more difficult to analyze. Since we now know where power and control come from by looking at the power grip, we can take advantage of these qualities to benefit the two precision grips. Most block planes just nestle into your palm and leave you to figure out the rest. This is good because your palm is half of the equation to transfer power, but what do you do with your pinky, and will your hand shake when you clench your grip?

The standard one handed grip for a block plane is an internal precision grip with a right handed person nestling the rear of the plane (wedge or lever cap) in their right palm. In most block planes it's easy to wrap your pointer finger around the plane and lose control. It's also easy to have your pinky finger floating off in the air giving you no benefit.

To address the pointer finger problem, the plane should be designed so that the palm of your hand presses forward more than down. This positions the pointer finger to exert force down on the toe of the plane (benefiting planing dynamics) rather than pressing sideways on the plane removing control.

To address the pinky finger problem, we would like to give the pinky finger something to reference against. For me, because of my background with musical instrument building,

this problem reminded me of the baroque fingerstyle guitarist/lutist right hand position. Today, if you see how a guitarist holds their 'strumming/picking' hand, you'll see that their forearm touches the instrument and the rest of their arm is floating above the instrument. Going back in time to look at the predecessors to the modern classical guitar, you'll see that lutes are sometimes played with the pinky finger anchored against the soundboard of the instrument. This allows the musician to play more quickly and accurately. Most guitarists today learn that this is bad practice for two reasons: it's bad for the finish on the top of the guitar and it can lead to ulnar deviation (a wrist defect similar to carpal tunnel). If you look at some of the cousins to the guitar (like the ukulele or vihuela), this pinky position is still common because it offers far better control and accuracy. In a block plane, ulnar deviation isn't much of a threat since the plane can be held at any angle to keep the user's wrist from contorting, so we can use the same logic to allow the operator's pinky finger to reference against the piece of wood being planed. If the outside back edge of the wrist leans slightly down, then the pinky finger will be well positioned to either brush against a surface coplanar with the sole of the plane or with a face below and perpendicular to the sole. This is solved by positioning the palm forward (instead of down), by positioning the plane forward of the hand slightly, and by lowering the profile of the plane with a low blade bedding angle.

To make this grip become a two handed grip, the left thumb goes on top of the toe of the plane while the other fingers in the left hand curl up underneath the sole forming an external precision grip. In this case, the left hand provides a lot of control (and some power through the thumb) while the right hand can provide more power (while keeping control from the pinky). The problem with this grip is that the only left handed interface to the plane is the grip between the thumb and pointer finger. On top of that, the pointer finger is wrapped up which makes it very easy to clench it and negate any additional control that may have been afforded otherwise. It's difficult to find space or any alternate configuration to create an external precision grip with this hand, but we can at least try to keep the forces more in the hand and central to the palm rather than centering it all around the pointer finger and above the hand. We can do this by moving the pointer finger above the plane (just ahead of the infill) and pinching between our thumb and palm/middle finger. A 'perfect' grip is likely impossible with two hands on such a small plane, which is why most larger modern bench planes have a knob for the left hand to hold in a traditional internal precision grip. Many cast planes have a similar knob that pulls double duty as a thumb rest and a mouth adjuster, but it comes across less comfortable than a smooth pad for your thumb, and doesn't have any of the benefit of the knob from a larger plane, so I believe it is best to avoid it in a smaller plane.

Low angle purpose:

Planing dynamics are very dependent on the angle that the cutting edge of the blade is presented to the work. In the case of a bevel down plane, the angle that the blade is bedded at is also the angle that the edge enters the wood. This kind of setup is very powerful if you can design a plane for a specific job. For example, if you want to cut end grain with a shooting plane, then you might bed the blade at 35 degrees like a strike block plane. If you want to smooth interlocked and figured grain, you might bed the blade at 55 degrees and take advantage of a chipbreaker to limit tearout. Either of these planes will excel at their specific jobs, but they will be terrible if they need to switch places.

In a bevel up plane, the planing angle is the sum of the blade bedding angle and the sharpening angle. For example, a bedding angle of 20 degrees with a sharpening angle of 25 leaves a 45 degree planing angle. The advantage of this is that you can change your

planing angle by using blades sharpened with different bevels. For example, you can keep a 50 degree blade to make a 70 degree 'scraping' plane that is practically immune to tear out but won't be able to remove much material. You can swap this blade out for a hollow-ground blade that is only 17 degrees at the edge for a 37 degree planing angle that can remove the end grain pins sticking out of a dovetailed drawer. Even better, if the plane body has a low bedding angle (12 degrees), you can decrease the planing angle all the way to 29 degrees which would shear through end grain like a paring chisel.

Unfortunately, there is no such thing as a free lunch in the case of a bevel up plane; especially a low angle one. By going bevel up, you lose the option to have a chipbreaker. This may seem like a meaningless loss to people who have struggled to get good results out of chip breakers on cheap and damaged bailey pattern planes, but a well mated chipbreaker/iron combination that is setup properly for the job being done can leave a glassy-smooth tearout free surface on even the most challenging wood while also being capable of a substantial shaving if needed. Modern woodworkers like to replace chipbreakers with tight mouths and high angle blades, but those solutions were replaced by the chipbreaker in the mid 1700's because the chipbreaker is more convenient, more effective, less expensive, and more versatile. The only reason why chipbreakers are going out of fashion today is because they need to be well manufactured and properly set up.

On a block plane, this isn't that big of a loss. A block plane's ability to cut end-grain is far more important than a 1% improvement when surfacing a panel because endgrain is something that a block plane will be used for and surfacing is probably not. Additionally, the ability to have one plane with minor adjustments that can go from cleaning the edge of a tearout-ridden board to cleanly shearing endgrain is far preferable to hauling two planes with you to any cabinet install or messing with a chip breaker with shavings falling into your eyes while you try to clean up glue squeeze out under a table. In this case, the tradeoff is worth it, but should we use a standard angle 20 degree plane or a 12 degree low angle plane?

There is an ergonomic benefit to a 12 degree bedding angle: it lowers the profile of the plane and makes it more comfortable. On top of that, the low shearing angle cut you can get out of that plane is far better on end grain or knotted wood. Traditionally the reason to avoid these ultra-low bedding angles was because the wooden plane body wouldn't hold up to the stresses of planing when the only support under the blade edge is a millimeter of beech. Today, that isn't as much of a problem because steel can easily handle that kind of environment. Despite all the upsides, there is a downside to decreasing the bedding angle of the blade.

If a blade dulls through normal use rather than chipping or rolling over, you can imagine a small radius being put on the edge where it used to be a point. This blade will still cut, but you will need to force it into the wood enough that the radius is completely buried. The amount of force needed to bury the blade depends on the volume of metal that you need to force into the wood. In the case of a sharp blade with no radius, the top bevel of the blade is submerged into the wood when there is nearly no volume of metal forced into the wood. In order to get the dull blade to cut, the entire radiused section and a portion of the back bevel of the blade (the polished flat of the blade in a bevel up blade and the polished bevel of a bevel down plane) must be pressed into the wood. The lower the bedding angle of the blade, the more of this back bevel must be pressed into the wood. Imagine paring a thin shaving with a chisel. If you hold the chisel at an angle to the wood, it will want to dig into the wood and gouge the wood easily. If you lay the chisel down so it rests nearly flat on top of the wood, you will take a much finer shaving, but increasing the thickness of the shaving would involve a lot of downwards force, or lifting the handle of the chisel so it dives

down into the wood. Now imagine holding the handle below the surface of the wood (essentially a negative bedding angle). It would be impossible to make a cut unless you can somehow press the entire handle and body of the chisel into the wood, and this would blemish the surface even if you could achieve it.

Of course, we wouldn't bed the blade at a negative angle, but this outlines the trend: the lower the bedding angle, the more important it is to have a sharp blade. To have good results with a low angle plane, it is important to sharpen frequently, but luckily these blades are easy to sharpen as there are no skews or unusual geometries. Most people don't want to be sharpening all the time, so it's valid to ask if the cost of more frequent sharpening is worth better end grain performance. Since the first block planes and mitre planes in the 1600s, the general consensus was that it is worth the effort, but only if you needed a block plane. If you could get by with your other planes, you'd do as much as you could with them. In the mid 1900s the block plane became more and more of a general purpose plane and people would pull them out for jobs that previous carpenters may have used bench planes for. The popularity of sandpaper and machines to replace planes probably came from people not wanting to sharpen planes as much and being tired of the drastically poorer performance of a dull plane. Sandpaper wasn't a new invention, but it was getting cheaper and the style of plane that it could replace didn't perform well unless it was razor sharp.

Today hand tool woodworking is gaining popularity again, so is it worth reevaluating the bedding angle of block planes back to the higher angles that would've been used over a century ago? While hand tool woodworking is getting popular, the planes that people are gravitating towards are not all the same as the ones used by our predecessors. As much as woodworkers today rave about their old Norris and Bedrock planes, there are plenty of artisans equally excited by Lie Neilson, Veritas, and Bridge City. Today we can use new formulations of steel, different machining methods, different casting materials, and different maintenance procedures. Today it isn't uncommon to see a plane with a cast bronze body or powder metallurgy blade sharpened regularly by machine. The craftsmen who built the world we live in today wouldn't have dreamt of those luxuries in their tool chests. I believe that the advantage that new steels allow give modern blades the potential to fight the 'sharpness sensitivity' that low angle planes suffer from. Very hard and tough steels can survive low cutting geometries for longer while heat resistant steels can perform for a long time while scraping away at higher cutting angles. Before giving up on low angle planing, I think it's worth trying alloyed and powder steels since they give more time between sharpening to make your block plane comparable to the other tools you use regularly.

Bent brass:

The bent brass sides to the Ironbark block plane are a nod to historical mitre planes that frequently had creative side construction. Almost always they would be dovetailed to the sole, but most of those original metal bodied planes were more than just the steel channel stuffed with wood that make up most of the infill market today. Many had sides that were dovetailed to steel pieces in the front and back of the plane, bends around the front and/or back, or ornate castings silver soldered between the sides. The time and effort required for these details is cost prohibitive today, but back then the overwhelming cost of the plane was in the materials.

Structurally, the bent back makes the plane more robust against movement in the wooden infills as well as more resilient if the plane is dropped. The mortise and tenon joint at the apex of the curve going through the sole helps make the plane more robust against transverse flexing in the sole. Also, making the sides from one piece of brass that joins to the sole over an area rather than just two lines helps the plane to resist thermal damage that has been the downfall of many infill planes over the years. Substantial heat (and moisture) can cause the dovetails in the steel and brass to loosen as well as swelling in the wooden infills. This literally tears the plane apart at the seams and is practically impossible to recover. It's best to prevent these conditions no matter how well designed the plane is, but the curve around the back helps to give a bit more insurance against this kind of failure.

Dovetailed infill construction:

Dovetailed infill planes have many advantages over cast planes and cast infill planes. It is very risky to make a dovetailed plane without infilling it, but there have been many infill planes that are not dovetailed. This affords the benefits of an infill plane like the heavier weight and more secure blade bedding desired in smoothers, all while achieving the cheaper price of a cast plane. Unfortunately, these planes are still cast, so they are brittle and unstable. Castings frequently have internal stresses that can take years or decades to show, and those stresses will flex the sole of the plane out of flat. Additionally, the material properties of cast iron are quite porous, soft, and brittle, so these planes rust easily and are easily damaged. Stanley's solution to these problems was the S series of planes which wrapped a mostly standard bailey pattern bench plane in a steel jacket that could be dropped and beaten without cracking (although it may dent or bend). Infill makers continued with the tradition of dovetailing plate material that was more robust and dimensionally stable. A steel sole also gives more confidence to the low 12 degree bedding angle than a cast sole that may fracture at the thin edge supporting the blade.

Ultimately, most people are drawn to dovetailed planes over their cast counterparts because of their design and beauty. Just like fine dovetails on the edge of a drawer front show a woodworker's skill and attention to detail, the dovetails on an infill plane are attractive and represent the quality of detail that the plane is designed to create. The dovetails can also be elaborated upon with ornate patterns like cupids bows that add little structural benefit, but provide an aesthetic quality to the design. The combination of intricate craftsmanship and eye-catching materials make a dovetailed infill plane seem much more special than a cast iron plane.

Additionally, dovetailed infill planes have a substantial historical quality to them. Dovetailed mitre planes would've been used to finish the marquetry on ships sent to establish colonies in Jamestown shortly before the English Civil War and the execution of Charles I. Holtzapffel organ builder's infill planes may have been used to make the organs

that Vivaldi used to compose baroque music. William Thomson, 1st Baron Kelvin may have used a Spiers infill plane in his work laying the transatlantic cable shortly after publishing his theories on thermodynamics while the American Civil war was about to erupt. Norris dovetailed smoothers would have been used to make ships and planes through both world wars marking a third century of infill planes being used for industrial change.

Single piece sole:

Most infill planes are made with a two piece sole. This means that the toe in front of the blade is a separate piece of steel from the heel behind the blade. The two pieces are held to the sides of the plane with dovetails and registered to each other with a short tongue and groove joint on either side of the blade. This method isn't inherently bad, but it was recognised as a weak point by many infill makers. Companies like Spiers and Mattheson experimented with lap joints and interlocking triangular joints before settling on the tongue and groove.

The problem with making the sole out of two pieces is that it is held together indirectly through the sides and has a lot of pressure from peening that encourages the sole to buckle at the point where the two pieces meet. Shock, vibrations, and heat can cause the joints to move slightly and the sole of the plane will no longer be flat. Since this instability revolves around the mouth of the plane, movement in the sole can also cause the mouth to misbehave or for the bedding surface for the blade to go out of flat. None of these results are desirable, but there was no better option until relatively recently.

Making the sole from two pieces means that you can form the escapement on the toe separately from the blade bedding on the heel. It also means that you can fine tune the width of the mouth before peening the plane together. The entire process of making these features can be broken down to simple geometries that can be cut with files and cold chisels. The machinery that could cut the mouth from a single piece of steel didn't exist until the mid 1800's, and wouldn't become commonplace for a few more decades. This means that the tongue and grooved two piece approach was the only manufacturing option available to planemakers for the majority of the history of infill planes. By the time that milling machines and shapers became an option for machining planes, the desire for low angle/tight mouthed planes had extinguished. By the early 1900's it was common to use bevel down bench planes with chip breakers rather than mitre planes and low angle planes.

In the past 30-40 years, hybrid woodworking has become more popular and high quality hand tools have had a resurgence for finish work. Low angle bevel up designs have become popular again for their ease of use and setup. Most of the downsides of low angle planes have been alleviated with better quality steels for blades and sharpening jigs for repeatable setups. Since the low angle plane is coming back, it's appropriate to use current machinery to make them without the issues seen in historic examples.

The Ironbark block plane has a sole machined out of a single piece of steel after peening. This creates a more stable sole that is less receptive to damage. The mouth is still tight and the bedding surface is still flat, but there is less chance for the plane to have fatal damage over time.