Angle changes on the Wicked Edge - blade curves

Posted by mark76 - 08 Nov 2012 13:26

Clay has written a few times already why the sharpening angle does not change on the straight part of a blade when using the WEPS (here and here). And in a brilliant post Anthony Yan recently even proved this mathematically.

However, this is all on the straight part of the blade. I wanted to know what the angle is on the curve towards the tip. As most of us probably know, the sharpening angle does change on this part of the blade.

Obviously the angle change depends on the form of the tip. Therefore I wanted to know what theoretically the maximum angle change is.

I thought this would involve some pretty complicated mathematics. But when I elaborated it, it appeared to be more simple than I initially thought it would be. The outcome is that if you are sharpening a blade at an angle *x*, the maximum angle change is:

x – arctan(tan(x)/sqrt(2)).

So, for example, at an angle of 25 degrees, the maximum angle change is about 6 degrees.

You can read all about it on my blog .

I am curious for your comments. Even though it involves high school mathematics only, my high school trigonometry is quite rusty ☺
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Re: Angle changes on the Wicked Edge - blade curves

Posted by mark76 - 10 Nov 2012 09:23

Thanks for your comments! It's a fascinating subject, these angle changes. Ever since Clay brought it up for the first time, people have been learning new things about it. (And new misconceptions have arisen ☺
.)

Curtis made a good point:

While it is correct that the angle doesn't change along the straight portion (that's well established), I don't think it has anything to do with the stone rotating around the guide rod.

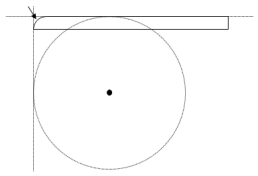
You’re completely right. The angle not changing along the straight portion of the blade has nothing to do with the stone rotating around the guide rod.

Phil also made a good remark in the blog comments:

Your proof will work in the specific case that you talk about, but is not valid for different placements of the blade in the clamp.

Well, yes and no. The angle changes I calculated are indeed only valid for the shape and clamp position of the blade in this case. However, I chose this case for a reason: I wanted to know what the *maximum* angle change along the tip curve could be.

I therefore chose a blade shaped in such a way that the end of its tip points straight down. (The curve of the tip makes a 90 degree angle.) And the only way to clamp this blade in such a way that the sharpening angle at the end of the tip would be the same as along the straight portion of the blade, is the position I used in my blog:

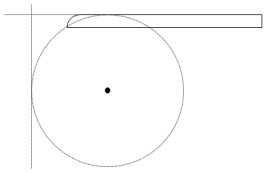


The following statement by Curtis is not correct for the blade shape of the case under discussion, although it may be correct for other blade shapes:

Since the knife can be clamped at any location... you can move the knife back so that the tip follows the circle, which, if I understand your diagram would mean a 0 degree change.

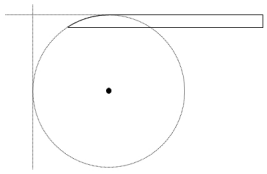
Phil made a similar remark in the blog comments.

It is not possible to postion this blade in the clamp so that the end of the tip (or even any part of the tip curve other than its exact beginning) coincides with the circle. If you would position the blade so that the end of the tip touches the circle, you would be basically not be sharpening the end of this tip at all:



However, please recall that I chose this blade shape for a reason. In many cases it is possible to position the knife in such a way that at least part of the tip curve “almost” coincides with the circle. In that case there is (as) little (as possible) angle change at that part of the curve. This is basically what you do when you try to find the sweet spot .

And in special cases (when the tip curve follows the exact circle) it may be possible to position the blade in such a way that the entire tip curve coincides with the circle:



In that case there is no angle change at all along the entire tip curve.

So the following summarizes what I did and why.

- We all know that the angle of a blade remains constant along the straight portion of the edge. We also know that the angle usually varies along the tip curve. The way in which this angle varies along the tip curve depends on the exact blade shape, the position of the blade in the clamp and the sharpening

angle along the straight portion.

- In some special cases it it possible to position a blade in such a way that there is no angle change along the entire tip curve. Thus, the minimum angle change is 0 degrees.
- I wanted to know what the maximum angle change was.
- I therefore picked a blade with the most extreme tip shape: a tip with a 90 degree curve. I positioned this knife in the clamp so that the angle change on one spot of the tip curve (the end) would be 0 degrees.
- I then calculated what the maximum angle change would be on this tip curve. It is x – arctan(tan(x) /sqrt(2)), where

x

is the sharpening angle along the straight portion of the blade.

Thus we can conclude that the angle change on the tip curve is somewhere between 0 and x – arctan(tan(

x

)/sqrt(2)). The exact angle change at each spot on the tip curve differs per shape and clamp position of the blade.

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Re: Angle changes on the Wicked Edge - blade curves

Posted by cbwx34 - 10 Nov 2012 11:43

Thanks for the reply... this really helps clarify things. I know when I read your original blog post, a quick read makes it sound like there is X degree of change along the tip. (I can imagine how that would play out if another forum thought that) 🙂

Since you also didn't indicate that it was possible to move the blade horizontally, not knowing this could really confuse the issue, when related back to the WE.

Maybe you could add the part you wrote here, into your blog? Sure ties it all together nicely.

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Re: Angle changes on the Wicked Edge - blade curves

Posted by mark76 - 10 Nov 2012 17:56

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cbwx34 wrote:

Thanks for the reply... this really helps clarify things. [...] I can imagine how that would play out if another forum thought that.

That's another reason I love this forum more than any other forum on knife sharpening, even if it's not directly about the WEPS 🙂

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Maybe you could add the part you wrote here, into your blog? Sure ties it all together nicely.

Good idea. Just got to find the time. (The ideas for this blog post were in my head for more than half a year...) Only then I'll post a link on Knifeforums or Bladeforums

Thanks for your comments and questions, the others too! Really helped me in clarifying my ideas.

And please continue asking critical questions, also on this topic!

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Re: Angle changes on the Wicked Edge - blade curves

Posted by mark76 - 14 Nov 2012 08:14

Is there a maths specialist here? I'd like to know whether it is possible to further simplify arctan(tan(x)/sqrt(2)). Arc tangens of tangens sounds like it could be simplified...

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Re: Angle changes on the Wicked Edge - blade curves

Posted by Geocyclist - 14 Nov 2012 19:50

I don't think so. With the brackets you are taking the arctan of tan(x) divided by sqrt(2). Or written differently you are taking the arctan(y) where y = tan(x)/sqrt(2)

If written this way it could be simplified: (arctan(tan(x)))/sqrt(2) = x/sqrt(2)

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Re: Angle changes on the Wicked Edge - blade curves

Posted by mark76 - 15 Nov 2012 04:16

Geocyclist wrote:

If written this way it could be simplified:

Thanks for your reply Geocyclist! But it ain't written that way... It's slightly more complicated, which is why I wondered. But you also think it cannot be simplified any further?

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Re: Angle changes on the Wicked Edge - blade curves

Posted by mark76 - 12 Mar 2013 10:04

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Guys, it took a while, but I have written a revised version of the article. It now incorporates your comments (thanks!) and its scope is much broader. And hopefully the article is now easier to comprehend.

You can find it here: moleculepolishing.wordpress.com/2013/03/...wicked-edge-revised/

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Re: Angle changes on the Wicked Edge - blade curves

Posted by Geocyclist - 12 Mar 2013 17:42

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I am glad I get to be the first to comment on this. Your write up is simply brilliant.
(I tried to give more than 1 karma, but this doesn't seem possible).

To close the loop how do we apply this the real world? I know with infinite blade shapes, etc. it may not be possible to write a single formula for this, but I think some reasonable generalities can be drawn, especially if we consider "traditional" blade shapes like clip points and exclude extreme shapes for the sake of simplicity.

1.) To minimize the angle change mount the tip within the radius, or to say it a different way the same distance from the pivot as the flat edge of the blade, i.e. like Curtis's photo above with the tape measure. I guess the question is how well does the curve of the blade fit to a circle? If you mount the tip this way then the angle on the tip and flat will be equal. Will this "minimize" the difference of angle change along the curve or make it worse? From figure 1 this depends on how well the blade shape fits to a circle.

2.) It is agreed that the angle stays constant along the flat edge of the blade. Is it also correct to say it does not matter how the blade is mounted when it comes to the flat portion ONLY. For example, I normally mount the flat portion parallel to the base. If I mounted the spine flat against the depth stops so that the flat edge was not parallel it wouldn't change anything ONLY in respect to the angle along the flat edge.

3.) Taking into account #2 above, you could get a better fit of the curve of the blade and the tip by adjusting the mounting angle. Is that correct? My thought is I can get a better fit by sliding the blade back to get the tip closer to the radius. Alternatively you could improve this by also tilting the tip down. ("could" - I know it ultimately depends on the blade and every knife is different). By tilting down I am thinking the tip will move closer to the radius.

Again, great job, this should go on the Wiki. "Finding the Sweet Spot 301"

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Re: Angle changes on the Wicked Edge - blade curves

Posted by cbwx34 - 12 Mar 2013 23:46

Dammit Geocyclist, you made my head hurt with this one.

I think #2 is correct, you can tilt the blade up or down. At first I thought it was incorrect, because wouldn't tilting the blade change the height in relation to the pivot? But then I realized that "parallel" is actually a relation to us (or the ground), and not the pivot. In other words, if I mounted the blade at a 20 deg. angle, but then tilted the whole WE 20 degrees, the blade would essentially be "parallel" again, the relationship never changes between the knife and the pivot.

So, with that in mind, in reference to #3, I don't think tilting the blade will make the curve fit any better, since, with respect to the pivot, tilting the blade doesn't change the relationship between the pivot and the blade.

To put it another way, if I look at Mark's drawing correctly, tilting the blade would also "tilt" or move the circle too, since it's based on the blade's position. It wouldn't stay in the same place while the blade moved.

Is that right? Seems so in my head (but at one time I thought the angle **had** to change along the straight part.)

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Re: Angle changes on the Wicked Edge - blade curves

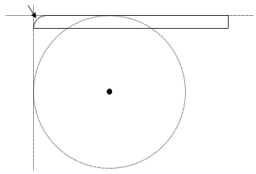
Posted by mark76 - 13 Mar 2013 08:23

Thanks for the kind words, Geo. You make some interesting points.

You're completely right about point #2! I knew that, but I never realized it so well: I always try to clamp a blade in horizontally, but that is not necessary! And indeed, as you note in #3, you may be able to get a better fit on the tip curve by not clamping in the blade horizontally. Tilting the blade down doesn't matter for the straight portion of the edge, but it may matter for the tip. I have to experiment with this! (And you too ☺).

Calculating the exact sweet spot is a challenge... Obviously it depends on the blade shape. It also depends on what exactly you call the sweet spot.

For example, in figure 1 of the blog post (see below) I positioned the knife such that the angle change at the end of the tip would be 0 degrees. The distance from the pivot point to the straight portion of the blade is *not* the same as the distance from the pivot point to the end of the tip (which, as someone wrote in another thread, is the recommendation in a book that treats guided angle systems). The distance from the pivot point to the straight portion of the blade is the same as the distance from the pivot point to the vertical line that touches the end of the tip.



However, there are two big buts:

- This only works for the "theoretical" knife shape used here. Most knives don't have a tip that at the end points 90 degrees down. In fact, the angle change is the largest at the point indicated by the arrow In the above figure. Here the knife points about 45 degrees down. And many knives have a tip that about ends at 45 degrees… Here the angle change at the end of the tip could be made smaller by moving the knife slightly inward.
- Even for the knife in the figure the question is what the sweet spot is. At the end of the tip the angle change is 0 degrees and I calculated the angle change at the point indicated by the arrow. Call the angle change at the end of the tip *a* and the angle change at the point indicated by the arrow *b*. It might well be that it is possible to position the knife in such a way that abs(
a-b
) is smaller than
b

. I’m not sure, but intuition says this. Intuition also says that were only talking tens of degrees

For practical advice: I think it is a good idea to start to clamp in the knife such that distance from the pivot point to the straight portion of the blade is the same as the distance from the pivot point to the vertical line that touches the end of the tip. Depending on the blade shape it is then probably a good idea to move the blade slightly inwards.

What “slightly” is?... Food for thought. Fortunately the sharpie trick still works.

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