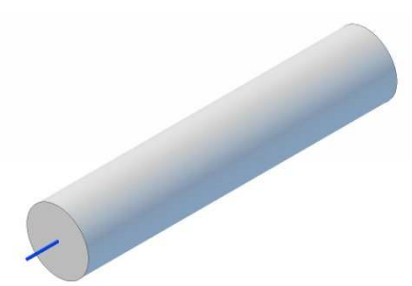
True Enough (Lathe Accuracy)

By R. G. Sparber

Overview

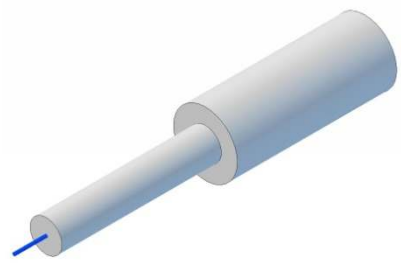
I often hear people new to our hobby voice concern about the ability of their 3 jaw chuck to center the work. There are times when this is essential but often it really does not matter. I will deal with the case where it doesn't matter. Then I will talk in general about other error sources that cause the turned part to come out wrong.

The Perfect



A good starting point is to see how my lathe would work if everything was perfect. I would have a perfect 3 jaw chuck holding a perfectly round piece of stock. My bearings would have no play so my center of rotation would not shift position over time. Additionally, my cutter would remain a fixed distance from the center of rotation as I move it along the part.

As the chuck turns, my stock will turn such that the center of the stock is exactly aligned with the lathe's center of rotation. The thin blue cylinder sticking out the end of my perfect piece of stock is my center of rotation. I can't draw it to scale because, since it is perfect, it would be a line with no thickness so impossible to see.



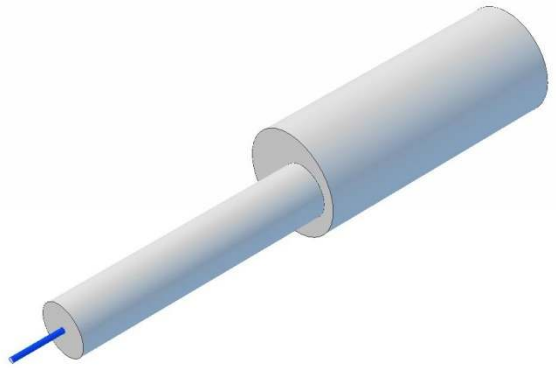
If I move my cutter into the part and then parallel to the center of rotation to the left, I will reduce the diameter of my stock. As you should expect, if everything is perfect, the results will be perfect. The reduced section will have its center perfectly aligned with the center of rotation and therefore

[1] You are free to copy and distribute this article but not to change it.

perfectly aligned with the uncut stock. Enjoy the theory because no such lathe, chuck, or stock exists.

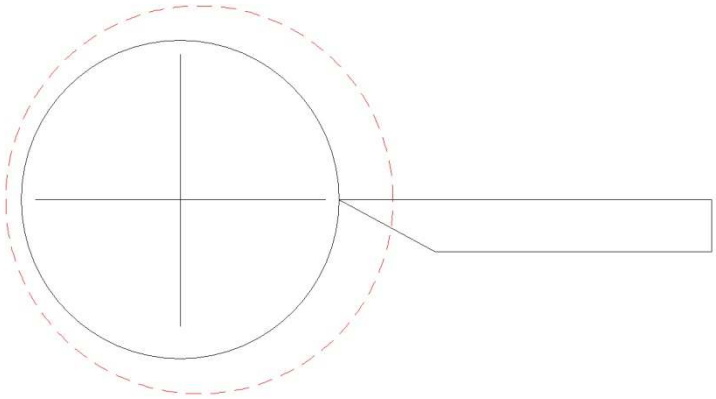
The Non-ideal Chuck

Let me swap out my ideal chuck for a real chuck. This real chuck does not hold my perfect round stock perfectly. Yet the chuck is mounted on a lathe with perfect bearings so the center of rotation is still a line with no thickness.



I will again use my cutter to reduce the diameter. The stock's center is not aligned with the center of rotation because my chuck is not perfect. Yet the turned down section ***is*** perfectly aligned. What is going on here?

The answer comes from the fact that my cutter is a fixed distance from the center of rotation as I move it along the part.



All error in the chuck translates into variation in the depth of cut. The dashed red circle is the original stock. The black circle is the part just cut. The center of rotation is the intersection of the two lines.

The original (perfect) stock is made imperfect because the chuck did not center it on my center of rotation. But my perfect bearings hold my center of rotation from moving relative to my cutter and my cutter rides perfectly on the ways of my lathe. The result is a perfectly cut cylinder. Any further cutting of features will also be perfectly aligned with the center of rotation.

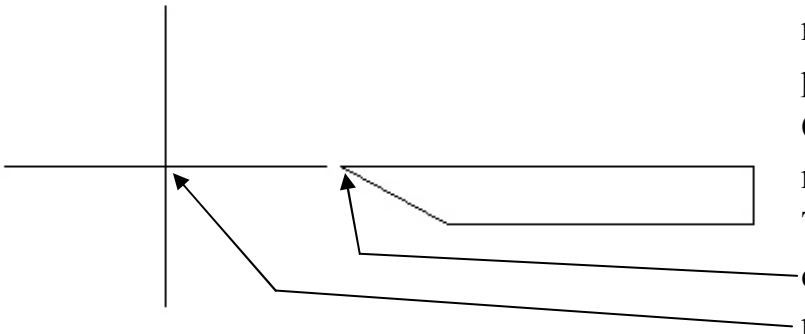
All turning will remain perfect until the part is removed from my non-ideal chuck. Then it will be impossible to put it back into this chuck to do more perfect turning. You will never be able to put the part back into the chuck perfectly which means

that the new center of rotation will not be located exactly where the old center of rotation appeared.

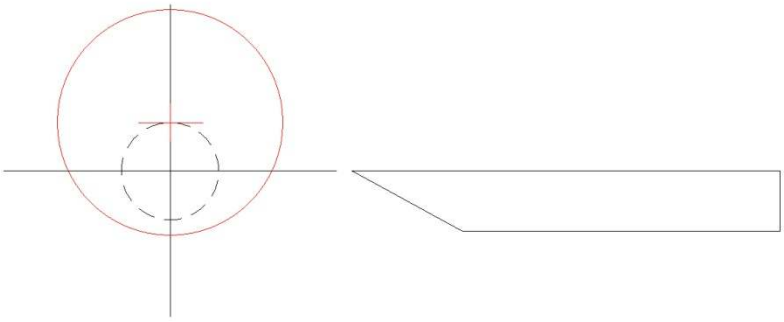
The take home message: Don't remove the part from the chuck until you are done turning all features.

Back to reality

My intention is not to write a full treatment on lathe errors. I'm just not that knowledgeable. But I can point you in the general direction. Let's go back and visit all of those things I set to ideal and consider how they affect my work when they are non-ideal.



The move from ideal to non-ideal bearings is a particularly nasty one. Consider the center of rotation in our ideal case. The distance from my cutter to the center of rotation is constant over time. In other words, it doesn't bounce around. If my cutter is 1" from the center of rotation, I will get a 1" radius cut into the stock.

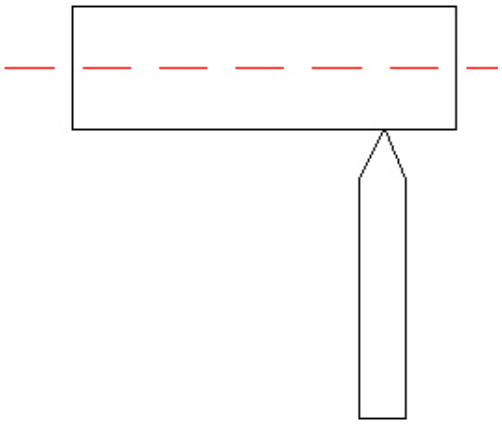


With non-ideal bearings, my center of rotation will be somewhere within an area. The dashed black line represents the bounds of this area. Do understand that this is an extremely exaggerated view. A lathe this sloppy would be unusable.

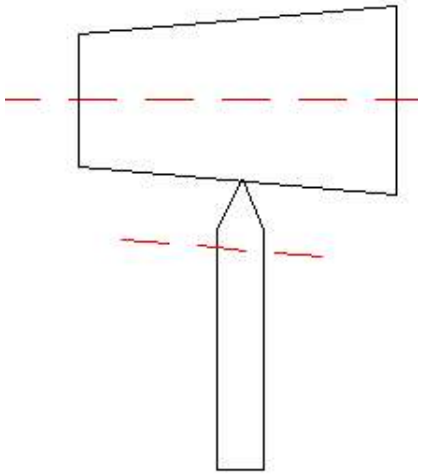
Just to keep things clear, let me assume that the center of rotation moved from its ideal position to the point marked with the red cross. The resulting surface cut by my tool would be defined by my red circle. Now think about what the real case

when the center of rotation would bounce around within the dashed circle. The resulting surface would not be round and the surface finish would not be smooth.

There is no way to compensate for this kind of error because it changes with time.



The last bit of our ideal world to toss is the alignment of the cutter to the center of rotation. In the ideal case, the distance from the cutter to the center of rotation is constant as I move along the part. The result is a cylinder of uniform diameter.



But what if the cutter followed a path that was not parallel to the center of rotation. Say it got closer as I moved to the left. My part would end up with a taper. Now, there are plenty of cases where you want a taper but most of the time this is a bad thing. Fortunately, as long as this error does not change over time, it can be minimized. The causes of this error are beyond the scope of this article as they involve advanced topics like minimizing twist in the lathe bed and head alignment.

The take home message here is to monitor for taper and ask for help on how to minimize it.

Conclusion

To get the most from your lathe, you must learn its error sources. Some of these sources, like non-ideal 3 jaw chucks, only matter if you must remove a part and put it back in later. Other sources, like loose bearings or a twisted bed, require attention to minimize their effect.

What Next?

For those new to our hobby, make lots of chips and ask questions when the results confuse you. If anything in this article confuses you, please let me know so I can fix it. For those with lots of experience, please feel free to comment and send me corrections to this article. All of us are smarter than any one of us.

Rick Sparber

rgsparber@aol.com