Leadscrew Alignment Math, Version 1.0

By R. G. Sparber

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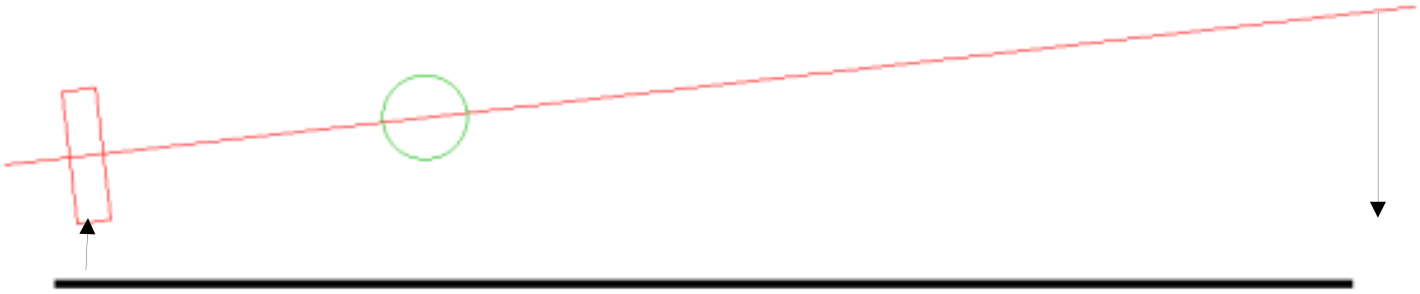
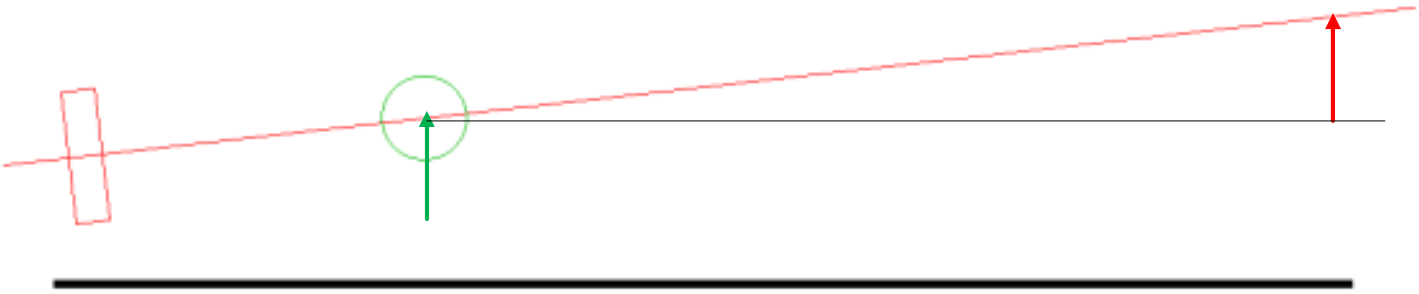


Recently I had to adjust a leadscrew so it was horizontal. The green circle represents my pivot point. I was able to push up on the bearing block, shown as a red rectangle which caused the far end to swing down.



Say I could zero my height measuring instrument at the pivot point (green arrow). It would then be easy to move over to the end of the leadscrew (red arrow) and take a reading. Rotate the leadscrew until the reading went to zero.

But what if I was unable to reach the pivot point?

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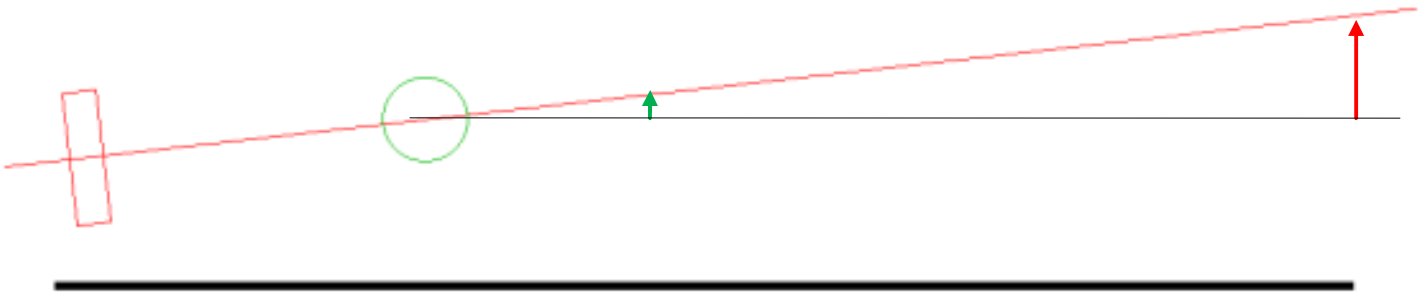
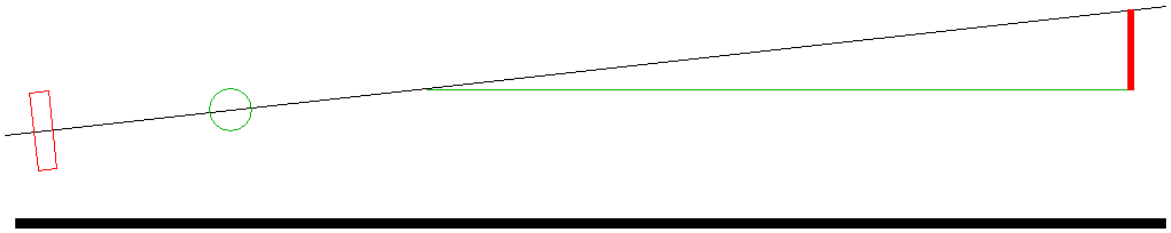
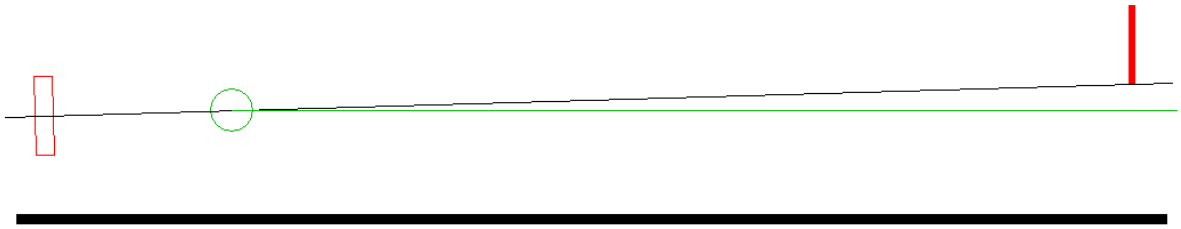


Say I had to zero my instrument at some distance from the pivot point and then move to the end of the leadscrew for my second reading. Rotating the leadscrew until I again see zero isn't going to work. This is because my zero point is not at my pivot.



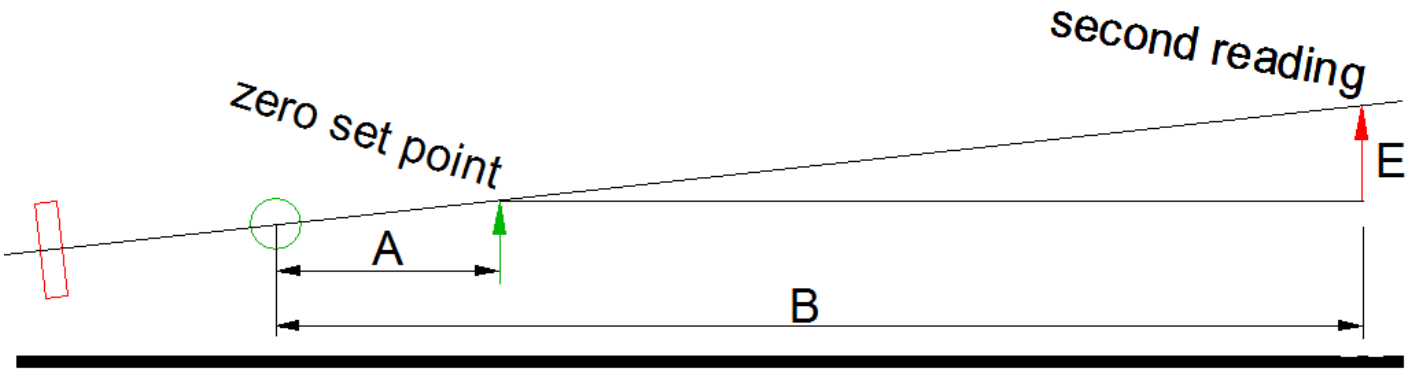


The upper figure shows the leadscrew before rotation. It sits at the top of the thick red line. This line represents the displacement shown on the instrument. The bottom figure shows the leadscrew after rotation. It now sits at the bottom of the thick red line. The horizontal green line in this bottom figure runs through the pivot point and shows that more rotation is needed.

But how much rotation do we need to level the leadscrew?

You could move the instrument back to the zero point and start the cycle again. Each iteration would move the leadscrew closer to horizontal. I find that rather tedious, especially since we can calculate the total movement right from the start.

I will present the answer first. If you want to understand how I got it, the supporting math will be in the appendix.



Measure the distance from the pivot point to the location where the measuring instrument is zeroed. Call this distance "**A**". Then measure from the pivot point to the location of the second reading and call it "**B**".

Calculate the correction factor, ***k***

$$k = 1 + \frac{B}{(A - B)} \qquad (1)$$

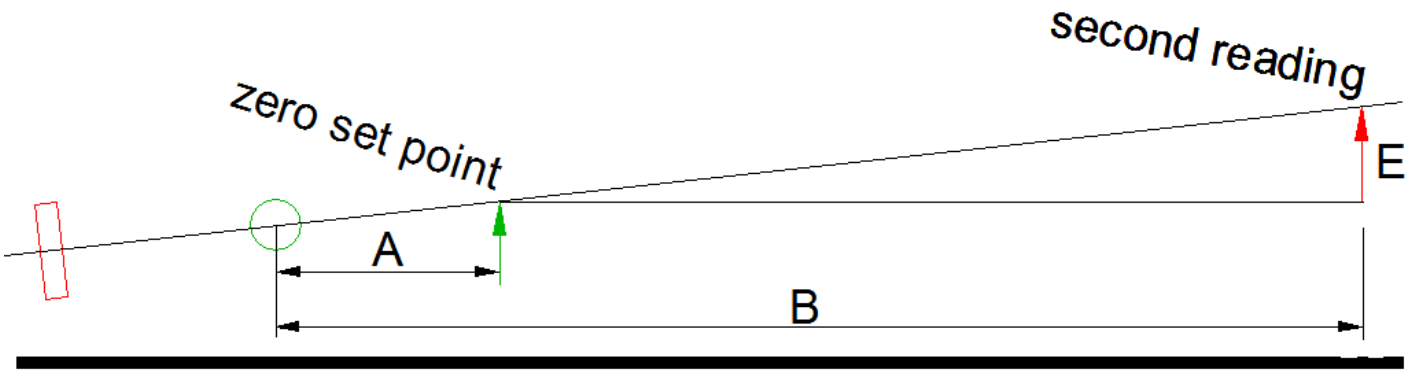
Save this value because you will need it any time you need to repeat this alignment.

The alignment is done in four steps. First zero the instrument at the zero set point. Then, move over to the second reading location. Call this reading "**E**".

Third, swing the leadscrew until the instrument reads zero at the second reading location. Forth, move an additional distance, ***g***, where

$$g = k\,E \qquad (2)$$

Lets test this out with real numbers. That might help make things clearer.



I measured "A" and found 1.5 inches. "B" was 4.5 inches. Using (1) I get

$$k = 1 + \frac{B}{(A - B)}$$

$$k = 1 + \frac{4.5}{(1.5 - 4.5)}$$

$$k = -\frac{1}{2}$$

I zeroed my DTI at the zero set point. Say I read 0.042 inches at my second reading point. Call this reading E.

$$g = k\,E \qquad (2)$$

$$g = -\frac{1}{2}\,(0.042)\ inches$$

$$g = -\,.021\ inches$$

I first move my DTI needle from its present location back to zero. Then **g** says to continue moving until we are at -0.021 *inches*.

The leadscrew should now be aligned.

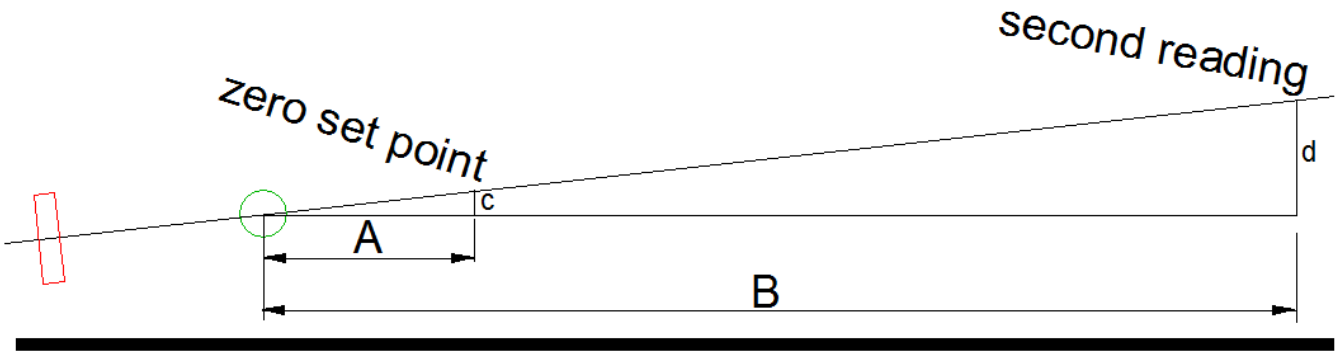
Do go back to the zero set point to verify the DTI still reads -0.021 inches.

I welcome your comments and questions.

If you wish to be contacted each time I publish an article, email me with just "Article Alias" in the subject line.

Rick Sparber
Rgsparber.ha@gmail.com
Rick.Sparber.org

Appendix



I don't know distance "c" or "d" but the DTI did give me d minus c which I will call "E". Note that right triangle Ac shares the same angle at the pivot point (circle) as triangle Bd. This means that I can use the rule of similar triangles and say:

$$\frac{c}{A} = \frac{d}{B}$$

or

$$d = \frac{cB}{A} \qquad (3)$$

I defined E = d - c (4)

Putting (3) into (4) I get

$$E = \left(\frac{cB}{A}\right) - c$$

or

$$E = \left(\frac{B}{A} - 1\right)c$$

or

$$c = \frac{E}{\left(\frac{B}{A} - 1\right)} \qquad (5)$$

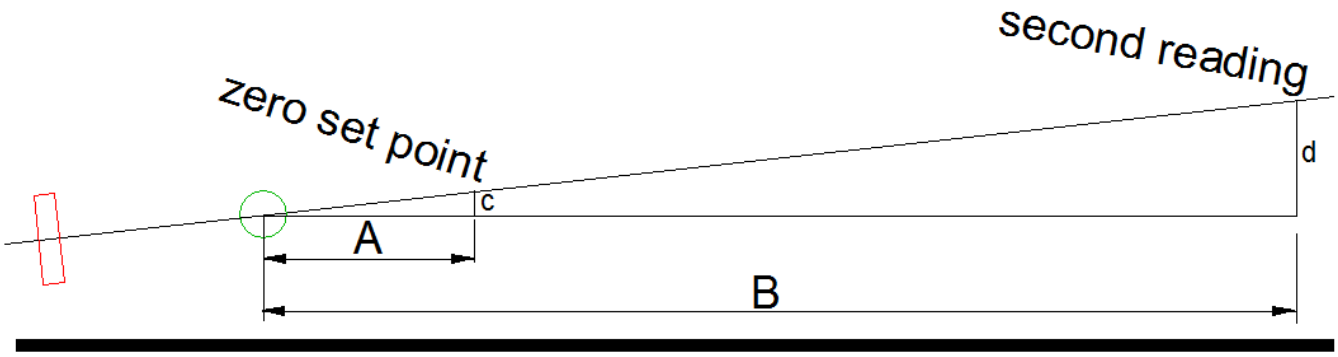
Put (5) into (3) to get

$$d = \frac{E}{\left(\frac{B}{A} - 1\right)} \frac{B}{A} \qquad (6)$$

$$d = \frac{E}{\left(\frac{B}{A} - 1\right)} \frac{B}{A} \quad (6)$$

This can be rearranged to be

$$d = \left(\frac{B}{(B - A)}\right) E \quad (7)$$

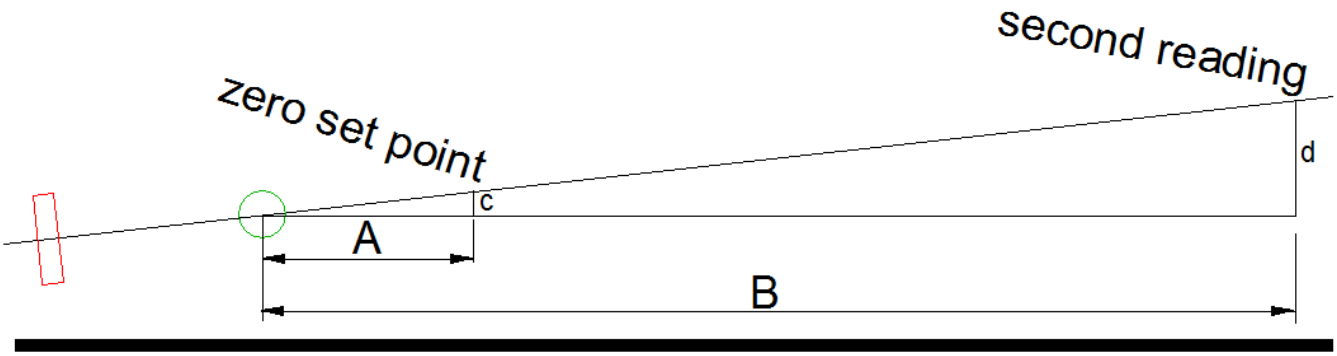


In order to align the leadscrew, I want to move a distance of -d so will multiply (7) by -1 and separate the terms into two equations

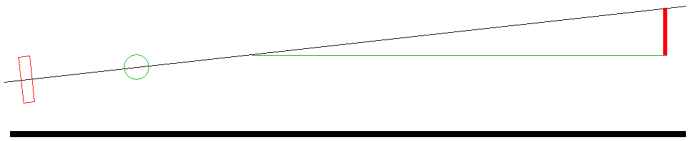
$$f = n\,E \quad (8)$$

$$\text{Where } n = \frac{B}{(A - B)} \quad (9)$$

Equations 9 lets me calculate a correction factor, *n*, that compensates for my zero set position. I then multiply *n* by my second DTI reading, equation 8, and swing the needle a distance ***opposite*** the initial deflection. This will align the leadscrew.

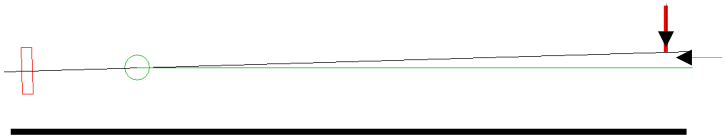


The magnitude of *n* is always greater than 1 but its sign will always be negative. This means I will always be moving from the measured value back to zero, a distance of **E**. Then I will move a bit more. Since I will first move a distance -E, I need a new correction factor that does not include this movement. This correction factor will have a magnitude 1 less than **n** of equation (9). Since n is negative, I add the 1 to reduce its magnitude



$$k = 1 + \frac{B}{(A - B)} \qquad (1)$$

The user first moves the DTI from its reading to zero by rotating the leadscrew. Then they move the leadscrew an additional distance of



$$g = k\,E \qquad (2)$$

Where E is the initial reading at the second reading point.