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BALLISTICS FOR BEGINNERS

A COWBOY'S APPROACH TO BALLISTIC SOLVERS.

BY TODD HODNETT

I have been shooting pretty much all my life. At 47 years old, I've racked up just over 40 years of experience shooting long guns. That experience has been peppered with failures to achieve goals that I set, but with those failures has also come the knowledge of where my best-laid plans and efforts went awry.

As I was growing up in the Texas panhandle, guns were a natural part of my life. I lived 20 miles out in the country and had a prairie dog town close by, so target practice was a daily sport. Without a formal shooting background, I thought serious knowledge of ballistics was way over my head.

Experience has taught me otherwise. Ballistics is really pretty easy to understand with some effort and the use of the proper tools. I tell my students that the ballistic solvers we'll discuss here are probably the greatest tools a long gunner could ever have. However, they are tools, not crutches. We still must have the ability to perform the task without their use. However, given the opportunity, we should always use this wonderful technology.

DEFINING OUR TERMS

In the past, the only way we could replicate the accuracy of the data from a ballistic solver was to shoot every 100 yards out to our limits and write down our dope. Dope stands for Data On Previous Engagements. We would copy all this information into a data book along with the environmental conditions and anything else we might learn on the range or in the field. This process created a reference for use

under similar conditions in the future. The data book was our predictor of bullet impacts when faced with variable ranges, density altitudes and wind holds.

Most people think they don't understand ballistics and that it is over their head. This is why we use ballistic solvers. Let the ballistic solver, with all of its crazy algorithms, do the math for us. All we have to do is understand the basics and plug in the correct parameters.

Here are some of the parameters that we need to know:

- Density altitude
- Bore height
- Bullet weight
- Bullet diameter
- Ballistic coefficient
- Twist rate
- Muzzle velocity
- Zero range

Now for a simplified and quick look at each.

Density altitude (DA) is the amount of drag on the bullet caused by the density of the air. At higher altitudes or as the temperature gets hotter, the amount of drag decreases on the bullet. Most shooters understand this and realize that the drop of their bullet will be less under these conditions. Some never think about the effect of wind being less under these same conditions. We derive our density altitude from a handheld weather station such as the Kestrel. The Kestrel is an exceptional tool and now has a ballistic solver inside of it.

Bore height (BH) is the distance from center of the bore to center of the scope. This is easy to measure and not critical to get exactly dead on.

Bullet weight (BW) measured in grains is usually found printed on the ammo box.

Ballistic coefficient (BC) is the numeric value we give the bullet based on its efficiency in flight or how well it maintains velocity. This number is usually given to us in a G1 drag-scale number. Depending on which drag scale the ballistic solver is using, we can derive a more correct number.

Twist rates allow the solver to accurately estimate spin drift. Spinning the bullet gives us the gyroscopic stability we need, but it can cause the bullet to drift at longer ranges.

Muzzle velocity is usually gathered from a chronograph, but there are other accurate ways of measuring muzzle velocity.

Last, we need to know the range at which our rifle is zeroed.

GETTING STARTED WITH SOLVERS

Acquiring data by shooting every 100 yards or meters is a method still used by a lot of people. I disagree with this approach, as it allows for too much human error. If the shooter is doing a good job shooting, this can be a very accurate way of establishing one's dope. However, it will require many shots, at some expense, and it will consume a lot of time. Using a ballistic solver, we can get the same data with minimal rounds fired in just a few minutes.

Once our gun is zeroed, we enter all of the requested data into the ballistic solver. Our next move is to start with a target at or just before the bullet goes into trans-sonic flight (say, 800 meters for the 7.62 NATO) and then shoot the suggested elevation drop given by the ballistic solver.

Now we need to true our solver to the rifle we're shooting, which means that we have to make the computer match what we're seeing on the range. We do this by changing the MV to get the desired result. In the Horus Atrag solver, there is a page just for this. Horus was the first to offer this option, and it is a very simple process in the Atrag solver.

The first step is to find how far the bullet drops at the greatest distance we can fire before the projectile

Here, a Marine is putting his ballistic PDA and Kestrel weather station to good use. With the effective use of these two tools, it is possible to have all of your rifle's data with any load you choose under any conditions with just a few minutes of work.

The data book is dying. Though it was the best option we had for a number of years, modern technology and real-world experience both decisively demonstrate that ballistic solvers are much more effective and efficient.

The Kestrel portable weather station is crucial for effective measurement of weather conditions. Changes in pressure and temperature both significantly impact the trajectory of the bullet, so it is critical that we measure them accurately.

goes trans-sonic. For the .308, this is about 800 meters. In our ballistic solver we have the algorithm the bullet is flying on. Once we match where our rounds actually impact at 800 meters to what the solver is telling us, we have trued our rifle to the solver. We now have the capability to calculate the correct drop at ranges in between and ranges farther out.

It's important to understand that nearly all ballistic solvers are just predictive algorithms. This means they are close mathematical guesses, something a ballistician would call a predictive polynomial curve.

This is what I hate, the word "predictive." To a cowboy, that means "just close." I wanted more, and I could see the truth. The truth was where my bullet hit. All I wanted to do was have the solver correct the algorithm to where the bullet actually impacted. Like I tell my students, the bullet doesn't get to vote. When you know the actual drop at range, you will accurately know where it will impact at other ranges when using a true ballistic solver.

The next step is to realize that the BC you plug into the solver from the manufacturer is only a suggested BC. This means that even if you have a calibrated chronograph and a correct DA, you may still get inaccurate predictions at range.

It's really important to realize that the algorithm doesn't separate enough to see the deviation between suggested and actual BCs at closer ranges. Even if you had an error plugged in under the MV, BC or DA, you would still get a suggested hold that would work at closer ranges.

Even at 400 meters you can be off more than 100 fps and still only miss by about one MOA. This MOA error at 400 meters turns into more than a 30-inch miss at 800 meters.

MYTHBUSTERS

When you hear someone say that his ballistic reticle really works well, understand that it can never work at truly long range. If you did decide to dial to correct your ballistic reticle for DA, your wind hold in the reticle would still be in error.

Ballistic reticles and BDC (Ballistic Drop Compensated turrets) all have the same problem. However, they have their place and work great at limited ranges. Most commonly this is around 500 yards. "One size fits all" doesn't work for ballistics. Even if you match your ballistic reticle to the exact muzzle velocity and BC of your firearm, you will still have issues with DA if you choose to shoot at long ranges or change elevation and temp.

Let's take a look at the effects of DA on a .308. In the following chart, we'll look at the effects of DA in mil holds.

The ballistic solver works with any caliber, big or small. Once we enter in our weather conditions, muzzle velocity and ballistic coefficient, it's all science after that.

ALT	2,500 feet		7,500 feet	
TEMP	40	80	40	80
300m	1.4	1.4	1.4	1.3
500m	3.8	3.7	3.5	3.4
700m	6.8	6.4	6.1	5.9
900m	10.7	9.9	9.4	8.9

As you can see, this is not a huge jump in altitude or temp, but the effects on the bullet increase as we get farther out in range. There's nearly a two-mil shift at 900 meters with only a 5,000-foot elevation and 40-degree temperature swing. A ballistic reticle without the use of a solver can never identify or compensate for this shift. Remember, this elevation and temperature shift will also significantly impact our wind holds.

SITUATIONAL REALITIES

All ballistic engines aren't created the same. I have tested many, and, as you now understand, they all work pretty well out to short ranges but may have huge deviations at distance. The important fact to remember is that we need to always true the algorithm to be precise.

We start the truing process with knowing our DA (usually taken from a handheld Kestrel weather station). Next we need a correctly calibrated chronograph and the actual BC. If we have these three tools, a good ballistic engine will give you the correct hold without truing, but this rarely happens. This is because the BC listed on the box or posted online is often incorrect. This is the problem with computers—junk in equals junk out.

We need to understand that bullet manufacturers list BCs that may be true at 100 meters, but that is not the most accurate number to plug into a ballistic solver. If you want to find the actual BC of the bullet you are shooting, you can follow these few simple steps.

1. Set up a piece of Sheetrock or a paper target at close to trans-sonic range. With a .308, this can be close to 800 meters.
2. Shoot 20 rounds through a chronograph, and take the average muzzle velocity.
3. Place a spotter in the middle of your group.
4. Go back to your shooting position, and find the difference between where you aimed and where your bullets actually hit.
5. True, or change, the BC in the solver to match the results of what you just shot.

Years ago, while I was doing testing on some new bullets, I asked Ken Oehler about this method. He told me that I was getting the actual (not listed) BC. This is the BC that you should plug into your ballistic solver to find the correct firing solution.

One can argue a lot of points about ballistics, BCs, algorithms, drag curves and ballistic solvers, whether in a handheld device, a reticle or a BDC. Like I always say in my classes, you can't argue with where the bullet hits. The method I described here will get you the information you are looking for. Even though this cowboy approach may seem unorthodox to some, I guarantee that if you follow these instructions, you will get better results from your ballistic solver. SNIPER

This is a typical screen shot of a ballistic solver. The three top tables represent our gun's information, atmospheric conditions and target distance and speed. The bottom tables give us our holds for both elevation and wind.