A PHYSICS PROFESSOR'S VIEW OF BALLISTICS
PART II

By Bert Blanton

We talked in the first part of this little discussion of "ballistics" about the fact that bullet drop was totally determined by the time in flight of a bullet and did not depend upon bullet weight. How much it drops at a particular place in its journey is totally a function of how long it has been out of the barrel at that time.

We said that its time in flight was determined by its initial velocity (muzzle velocity or MV) minus any wind drag or other impediments along the way. We know intuitively from aircraft and missiles etc that flat nosed bullets will have more drag than pointy nosed bullets and therefore slow down faster. We know intuitively that any bullet will have more drag flying along in a thick fluid than it will have in a thin fluid and therefore slow down faster in a "thick" or "dense" atmosphere.

Manufacturers attempt to share with us an indicator of the wind drag of various bullets by comparing their bullet to a "standard" low drag bullet. Most use a previous government sponsored bullet test at the Aberdeen Proving Grounds for their comparison. They take the drag test data from their bullet and divide it into the drag of that standard bullet. Since the standard bullet has very little drag they nearly always have a little number divided by a bigger number and get a decimal. They call it the "Ballistic Coefficient". A bullet with a BC of 1 has exactly the same drag as that standard bullet. A bullet with a BC of 0.500 has twice as much drag as the standard (1x divided by 2x=0.5).

Flat nosed bullets like my old 30-30 ammo has a BC of about 0.186. (I have always had to use flat or round nosed bullets in my lever guns due to the danger of the bullet setting off the primer in the bullet ahead of it in the tubular magazine). That has hurt my ballistics in years past because of the higher drag of those bullets. The new Hornady LEVERevolution rubber tipped pointed bullet for my 30-30 has a BC of 0.330. Now we are getting somewhere.

So how much does this air drag amount to? At 100 yards it has not had too much effect. At 400 yards, I am beginning to really care about it. Read on…….

Below are 2 tables from Hornady's web site with the same initial velocity bullets but different drag characteristics (BC). They are identical except one has a BC of 0.425 and the other a BC of 0.241. They both start out at MV=3000 ft/sec but at 200 yds one is going 2565ft/sec and the other is only going 2259ft/sec. At 400 yds they are going 2169 and 1639 ft/sec respectively.

Why do I care about this? Two reasons: 1) the trajectory of the slower bullet degrades more rapidly (more bullet drop) and I have to work harder to know where to aim to hit my targets at various distances. 2) The "energy" of the slower bullet is falling off faster. As a target shooter I don't care about energy. I only have to make a little scratch in the paper. If the bullet bounces off the plywood behind, I don't care.

As a hunter, you do care. It is mostly the energy factor that brings down your animal. There can be lots of arguments about bullet mushrooming, splintering, weight retention etc but we are not going to get into that. Suffice it to say that to kill your game you MUST have enough energy to penetrate the animals hide and then plow through enough tissue to render his physiology inoperative. First and most importantly you must have sufficient "penetration". Penetration is attained by having enough bullet "inertia" to overcome skin and tissue resistance. Inertia is found by multiplying mass times velocity. Faster is more inertia. Heavier (more mass) is more inertia.

In the ballistics world they use "kinetic energy" (KE) as an indicator which is VERY similar to inertia and is found by multiplying weight (mass) times velocity squared. This indicates the importance of velocity since it is squared in the formula. BOTH weight and speed are important for penetration. A fast moving light bullet can penetrate. A slow moving heavy bullet can penetrate. A fast moving heavy bullet will really penetrate. Big bore rifles for big game only push their bullets at 2000-2500 ft/sec but they use 400-500g bullets. (They would push them faster if they could avoid damaging the shooter with recoil or the rifle and shooter with material damage). FYI, this writer shot water buffalo with a NATO 7.62x51 (.308 cal, 146g, MV=2300 ft/sec, BC unknown) from 830 yds and the bullets bounced off of them (well, they didn't go down, anyway). They have 1 1/2" thick skin. I also was unable to penetrate truck sheet metal from this same distance and could not disable them adequately. I could, however, penetrate wooden sampan structures and they sank.

Back to the two tables below: Both bullets start off with energy of 3597 ft-lbs. At 400 yds the energy of the first bullet is 1880 ft-lbs and the other bullet only has 1073 ft-lbs. The faster bullet has fallen 25.9" and the slower 34". Which would you hunt dangerous game with?

30 CAL. (.308" DIA.) 180 GRAIN SPIRE POINT
SECTIONAL DENSITY: 0.271 BALLISTIC COEFFICIENT: 0.425

RANGE (YARDS)	MUZZLE	50	100	200	300	400	500
VELOCITY (fps)	3000	2887	2777	2565	2362	2169	1985
ENERGY (ft.-lb.)	3597	3331	3082	2629	2230	1880	1574
100 YD. ZERO	-1.5"	-0.2"	0.0"	-3.0"	-11.3"	-25.9"	-47.8"

30 CAL. (.308" DIA.) 180 GRAIN ROUND NOSE
SECTIONAL DENSITY: 0.271 BALLISTIC COEFFICIENT: 0.241

RANGE (YARDS)	MUZZLE	50	100	200	300	400	500
VELOCITY (fps)	3000	2803	2614	2259	1933	1639	1385
ENERGY (ft.-lb.)	3597	3139	2731	2040	1493	1073	767
100 YD. ZERO	-1.5"	-0.2"	0.0"	-3.6"	-14.1"	-34.0"	-67.0"

Now for SERIOUS marksmen:

What about this thick/thin fluid affecting bullet drag? (FYI Leaves or grass **really** affects drag). The air is "thinnest" (less dense fluid=less drag) at high temperature, at low barometric pressure, and high humidity (water vapor in the air actually reduces the density of the air). So on hot days your bullet drag is less. On low barometer days your drag is less. At high altitude your drag is less. On humid days your drag is less. Hornady says that out to about 200-300 yards you don't really need to worry about correcting this as a practical matter.

What about wind? A tail wind will speed your bullet up. A headwind will slow it down. A crosswind will cause it to drift left or right. The shorter time the bullet is in flight, the less effect wind has on it! Answer=Use a FAST bullet. Otherwise look up crosswind effect for your round and estimate a correction for your estimate of the wind. I know, this is for real marksmen. Go to the range a lot! The wind blows in Oklahoma and this could make a differnce in your shooting.

Another factor that we reloaders get uptight about is your powder. ALL powders have different pressure characteristics/burn rates under different conditions. Most powders generate less pressure in cold temperatures. Less pressure means slower muzzle velocities. Slow muzzle velocities mean more bullet drop and less energy. This effect is normally less than the other things we have been talking about but some powders are more sensitive than others. Plan on slower MV and slightly more drag when it is cold out (that is when hunting occurs most).

Try to zero your rifle under hunting conditions. If you are going to Colorado elk hunting or Africa Cape buffalo hunting, take enough ammo and make plans to re-zero your rifle when you get there. If you are going predator hunting in February in Oklahoma, wait for a very cold day to zero your rifle. Brrr! You may see me out there testing my reloads!

Enjoy your shooting and good luck with your hunting. The fact that you are reading this means you are interested in more and more knowledge or insight about your sport.