- THE SCIENCE OF SHOOTING (PART 5) -

WHICH METAL IS BEST FOR SHOT

We saw in Part 4 of the Science of Shooting that it's the **drag-force to mass ratio** which slows a piece of shot down.

$$deceleration = \frac{aerodynamic\ drag}{mass} = \frac{F}{m}$$

Increase the amount of aerodynamic drag on a piece of shot and it will slow down at a faster rate. Conversely, make the piece of shot heavier and the shot will keep its speed for longer, increasing both your hitting power and effective range.

What you need to keep in mind that mass is actually the density (ρ) of an object multiplied by its volume (v).

$$mass = density \times volume$$

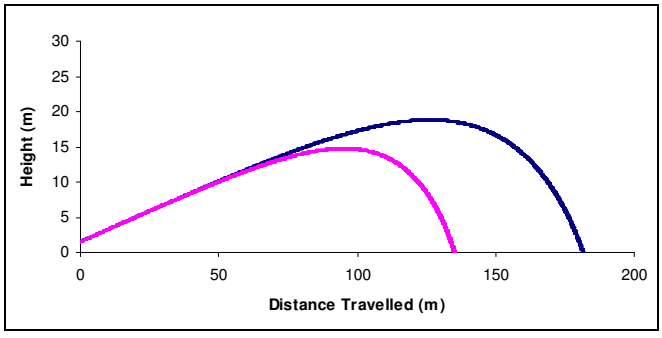
"But $7^1/_2$ shot is always the same size" you say. Well yes, that's correct, but it doesn't have to have the same density. Using these equations, we can rewrite the relationship between deceleration, aerodynamic drag and mass:

$$deceleration = \frac{aerodynamic\ drag}{density \times volume}$$

Now for a bit of revision on fractions: if we increase the aerodynamic drag value (ie. the number on top which your school teacher would have referred to as the *numerator*) then the value of our fraction gets bigger, which means the shot slows down at a faster rate.

But if we increase **either** the density or volume of the piece of shot (being the bottom number of the fraction which is usually called the *denominator*) then the deceleration decreases and our shot keeps its speed for longer.

This is why you need a larger size of steel shot to have the same hitting power as a smaller piece of lead shot. To put it simply, steel shot slows down faster in air because it doesn't weigh as much!



As you can see, the 7½ steel shot (pink line) doesn't fly nearly as far as the 7½ lead shot (blue line) does.

But there's a more damning statistic to be heard. At a distance of 30m (the earliest point at which most shooters could possibly acquire a clay target), steel shot of $7^1/_2$ size will have lost 76% of its energy (hitting power). In comparison, the lead shot will have lost only 63% of its hitting power. This is an approximate 20% difference in hitting power at the point of impact. The steel shot will also take a marginally longer time to reach its target (about 0.02 sec).

In summary, for steel shot to give a similar ballistic performance to lead, it needs to be larger – much larger. This means that number $7^1/_2$ lead shot is equivalent to number 3 steel shot, hence by using steel shot you'll get significantly fewer pellets in your shell and will be thus less likely to break the target. Damn those tree-huggin' hippies!!!

So now that we can see that steel is no good, is anything better than lead? Well, yes in fact ... but it'll cost you. There are many metals which are much denser than lead, but they can be pretty rare (and thus expensive).

The table below shows the relative densities of the various metals which are also theoretical candidates for the production of shot. The recent world prices (2007/2008) of some metals are also included just to show you how they *generally* get more expensive as they get denser.

Metal	Density (kg/m^3)	Cost ($A per kg)	Hitting Power (%)*	Range (m)
Iridium	22,650	14,000	61	351
Osmium	22,610	13,000	61	350
Platinum	21,460	70,500	59	336
Rhenium	21,020	8,500	58	331
Plutonium	19,840	-	57	317
Gold	19,282	32,000	56	310
Tungsten	19,250	42	56	310
Uranium***	18,950	90	55	306
Mercury **	13,536	22,000	44	236
Hafnium	13,310	-	43	233
Ruthenium	12,370	23,500	41	220
Palladium	12,020	16,500	39	215
Lead	11,342	3	37	205
Steel	7,860	1	24	153

* for 7½ shot size fired at a 10° elevation and speed of 1250 fps.
** only recommended for Antarctic-type climes, such as Tasmania.
*** price is for the unprocessed, impure alloy.

The table above explains why countries like the U.S.A occasionally prefer to use depleted uranium shells in tank warfare as opposed to lead – it hits much, much harder.

Unfortunately for us, due to metals typically becoming rarer the heavier they get, they become much more expensive. It's all to do with the gravitational collapse and subsequent supernova explosion of stars in other galaxies, producing the energy necessary to atomically fuse the lighter metals into heavier metals (ie. the reverse of radioactivity).

So the short of it is: only concreters and/or people who build doors for a living would be able to afford shot pellets made from heavier-than-lead metals.

Just for a little bit of trivia, uranium is the largest naturally occurring atom (plutonium for example has to be made in a nuclear reactor). However, as it's such a big and heavy atom, it can't hold itself together properly which is why it's radioactive. This explains why there aren't more of the heavier metals available – they've all radioactively decayed into smaller atoms over the billions of years for which the earth has been around.

Note that density (being the proper scientific terminology) is synonymous with specific gravity, ie. density ≈ 1000 x specific gravity.