RING SIGHTS PO Box 2108, Salisbury, SP2 2BX, UK

**EUROPEAN SMALL ARMS SYMPOSIUM 1989**

**Royal Military College of Science, Shrivenham**

# MODERN SMALL ARMS DESIGN FROM THE Point of View of the Sight Designer

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Sights have been the Cinderella of small arms neglected by the designer since he is necessarily concerned over all the other problems associated with them. When I started to research sights for LAW 80 I could not find any recent long term work on direct fire sighting for handheld weapons. The call for papers for this Symposium did not include any mention of sighting. So I thought that I should stand up and be counted at the risk of being vilified by all you small arms experts. I am grateful to the organisers for letting me have my say.

The traditional layout of a rifle put the sights on top of the barrel which, of course, had to be in line with the eye. This was convenient for firing over a parapet but meant that to transmit the recoil to the shoulder the stock had to be at an angle. So, on firing, the muzzle kicked upwards.

At any sight setting the trajectory intersected wiht the sight line very near the muzzle and at the chosen range. In between the trajectory lay well above the sight line. To achieve adequate accuracy elevation had to be applied to the sights usually on the backsight leaf.

Since World War Two the trend has been to put the barrel in line with the shoulder to improve the transfer of recoil to it.

But the eye is still above the shoulder so the sights have to be above the barrel on some sort of projection. The M16 has a handle, the MAS two stalks, the SA 80 a zeroing mount. This enables us to make the sight line intersect with the trajectory at intermediate points. Now we can optimise this match and, with current 5.56mm ammunition, avoid the need for setting range out to 300 metres since the strike will only hit about 8cm low at 300 metres and about the same high at the vertex. The trajectory will intersect the sight line at about 75 and 275 metres. The optimum height of the sight line above the barrel is _ of the gravity drop at the maximum range required; for 5.56mm ammunition this is about 8cm which, fortunately, is about where the eye comes when shooting standing. Ask yourself a question - if the time of flight could be further reduced would it be advantageous or not? The gravity drop would reduce, the barrel would rise and it would not be in line with the shoulder!

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Once the barrel is in line with the shoulder a bull-pup design can be adopted. The muzzle now is too close to the eye for accurate shooting with open sights since the sight base is too short and the foresight difficult to focus simultaneously with the target. The rifle designer and the user are pushed towards an optical sight, in some cases most reluctantly, and so the rifle design may suffer.

Jumping in with both feet and admitting that an optical sight is here to stay liberates the rifle designer from many constraints. The barrel becomes independent of the sighting. The customer can get a choice of sights; so can the man in the field. John Barlow's EM2 rifle was the precursor of this using a unit power telescopic sight. More recently Steyr took this road with their AUG rifle incorporating a 1.5 x telescopic sight from the start. The barrel length can be chosen to suit the particular operational requirement. Alternative sight mounts can be fitted by changing the receiver.

The eye must be, to some extent, placed in line with the sight. Open sights require this to be done precisely, optical sights have an "exit pupil" the diameter of which varies with the type of sight. The firer uses his neck to get his eye in the right position but of course a man with a long neck gets closer to the sight than a man with a short one (I remember firing the SLR when it was first issued to my regiment about 1960 - I have a long neck and chipped my glasses on the backsight as I fired).

The firing position changes this too. So we need an optical sight with a large enough exit pupil and a tolerant eye relief. Many telescopic sights require the eye to be fairly precisely positioned; this is OK for one's own civilian rifle but for a common use military rifle it is inadequate. We need a large exit pupil and eye relief which are not constraining. This is not achieved easily in higher magnification sights. The lower the magnification the more tolerant the sight becomes; x 4 is less tolerant than x 1.5 while unit power (i.e. no magnification) is best of all from this point of view.

Compact telescopic sights get more expensive; if a longer sight can be accepted it is cheaper. The x 4 SUSAT on SA 80 is dearer than the 1.5 long telescope on the AUG. Some consider the AUG ugly but it sells well.

Too much magnification can spoil the rifle's performance. At the UK Army Rifle Association meeting in 1988 only 54% of hits were achieved in snapshooting at 100 metres with the x 4 telescope. At a FN night trial of telescopic sight, open sight and unit power sight M.Kops got 9 hits on 10 targets in nearly pitch darkness with all three sights. But he took 1m50s with the telescope, 1m13s with open sights and only 50 seconds with the unit power sight. Overall the six shooters the unit power sight got more hits quicker.

These results are due to the difficulty of pick-up with magnification. The view of the target scene is not what the firer has been seeing when he chose the target to engage; he has to adjust his mental picture. The higher the magnification the more adjustment and the longer it takes. Unit power sights do not change the scene and are quicker.

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Reflex collimator sights, my own baby, are cheaper and smaller and different having a bright graticule instead of a dark one. Being unit power they are extremely tolerant of eye position especially with regard to eye relief. All the optical sights solve the focussing problem with short weapons since the graticule is focussed at infinity i.e. at the target. It is as if the foresight was on the end of an invisible barrel and you just put the muzzle on the target.

Once the small arms designer accepts the idea of a small optical sight he is liberated from the old layouts. FN has realised this in their P90 you have just heard about. No need for a long sight base - make the gun compact. Why do we have guns so long anyway? With a unit power sight a small pistol can be aimed accurately; come to our display tomorrow to see a sample target shot with a 2" barrel pistol at 100 metres - the width zone is narrower than that of SA 80 at the same range. What does the soldier want, especially the non-infantryman? A compact weapon effective to 300 metres which is easy to carry, easy to put in a vehicle, easy to shoot from a vehicle or outside. The pistol needs to grow up, the rifle needs to grow down. The calibre could be reduced once we accept that the machine gun does not use the same ammunition and this would give us more rounds per pint. (Think about this: it is not more pints per round).

The current generation of rifles is out of date before we have re-equipped with it. The P90 shows the way forward.

Enough of this love-making! (Old Russian joke).

For accurate shooting the sight must be zeroed to the gun. As we have seen with the compact weapons expected in the future the sight and its zeroing must be compact, robust and reliable not all easy to achieve. The zeroing can be part of the sight assembly or part of the gun. If each sight is individually zeroed to a gun then it cannot be transferred to another weapon without rezeroing which is often not convenient in action. But if the weapon carries the zeroing arrangements, and sights are set up aligned with a datum in production, any sight can be put on any weapon without rezeroing. The Royal Navy use this approach, for example on the 20mm, and the military should consider it now that image intensifier sights are in general use. It means that the sight mount must be designed into the gun from the start. One possible solution is to put the sight interface on top or alongside the standard sight and aligned with it in production. Then when the standard sight is zeroed so is the datum and other pre-aligned sights can be put on to the datum and shot successfully. Who will be the first to do this? I bet that there is an example of this in the Pattern Room now opening at Nottingham.

Up to now I have talked about supersonic weapons. Once we go subsonic with grenade launchers and riot guns any idea of matching sight line to trajectory becomes impossible. So we have to set a tangent elevation and, if hits are to be achieved, this elevation must be set quite accurately. This means measuring range in some way.

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We are back to the Lee-Enfield rifle I used in my youth and making out range cards, all very well for World War One! Can we do better? An optical sight can estimate range by stadia i.e. measuring, in angular terms, the length, range and, hence, the tangent elevation to use. We have done this, for a riot gun, using the width of a man at selected ranges. Each pair of stadia lines has an elevation graticule line associated with it. Results were satisfactory. A more sophisticated method would be to associate the sight with a laser rangefinder but this we have not done practically.

I want to end by encouraging all you small arms users, marketers and designers to consider the sighting problem from the start of the concept. If you do this the eventual weapon will be more effective in the hands of the soldier and it will have a better chance of selling into wider markets. The sight is an essential part of the weapon package. Its research and development must match the whole R & D programme instead of being tacked on at the end (or in some cases afterwards). No one type of sight is perfect for all military conditions. Each customer will need one suited to his environment. Finally I should urge you to keep an open mind and not to accept old and, maybe, outdated concepts and beliefs.

Cinderella, come out of the ashes and go to the ball! You might find someone to mate with.