(This document is compiled from multiple postings to the National Match forum (http://www.usrifleteams.com/forums) by Art Neergaard, owner of ShootingSight LLC)

I'm 47, I've got 'old eyes' (presbyopia), had trouble seeing the target and front sight clearly, and I started stringing my shot groups out vertically (sound familiar?). I went from shooting in the low 190's at 600 yards one Fall, to shooting in the low 170's next Spring right around the time I turned 44. I'm an engineer, a photographer, and I know a little about optics. I've done a lot of research, started a company, and filed a patent to solve this issue - and I have the solution.

To see a clear sight picture, you need two things:

1. You need depth of field sufficient to reach from your front sight to 600 yds.

2. You need a natural point of focus which is at the right place. Depth of field extends in front of, and behind your point of focus. You want to be able to focus at a point between your front sight and your target, such that the depth of field beyond that point touches 600 yards at the same time as the depth of field in front of that point touches your front sight. Also, you would like to focus at that point while your eye is in the relaxed state, this is why I call this point your natural point of focus.

If you have these two things, it allows you to see both the front sight and the target clearly at the same time.

I'll address these in reverse order.

Your ideal point of focus is not at your front sight. It is actually a little more than 4 feet from your eye. Based on mathematical depth-of-field calculations, if you can focus at 4 feet, your focus is balanced between 24 inches and 600 yards, so you will get the same focus on your front sight and your target.

Now, let me talk about your natural point of focus. Natural point of focus is exactly the same as your natural point of aim. You can point your rifle anywhere you want, but if your body is in the wrong position so that you need to exert muscular force to hold your rifle on target, you will be unstable, and if you try and hold position too long, you will begin to tremble. You want to achieve your natural point of aim so your rifle points at the target when your muscles are relaxed. Focus is the same thing. The lens a healthy eye wants to focus at infinity when it is relaxed. In order to focus at objects close to you, you need to change the focal length of the lens in your eye. There are two ways to accomplish this: either the muscle in your eye needs to exert force to squeeze the lens in the eye, to bring your focus up close, or else your second option is to add a corrective lens in front of your eye. Young shooters go for the first option, because it is easier. However, as you get older, and the lens in your eye gets stiffer, the muscle has to work harder to squeeze the eye lens, and sometimes it can't. This is why you can't read clearly - your eye cannot focus as close as it could when the lens was soft.

So for old guys, instead of exerting the eye muscle, simply add a corrective lens. Now your eye can stare at the target all day long, and not get fatigued, because the muscle in your eye is relaxed. Your eye has achieved its natural point of focus. Theoretically, someone with healthy young eyes will also benefit from having a lens to get them to their natural point of aim. They never do it, because their eye muscle is strong, and the lens is soft, so it's not much of a muscle strain to just exert the eye to focus at this distance, but even if the strain is small - it is still a departure from your natural point of aim, and even young eyes will fuzz if you stare at the target too long.

To achieve this natural point of focus I recommend several things:

1. Determine your natural point of focus distance (what photographers call your hyperfocal distance) where your focus will be balanced between the front sight and the target.

For most people this will be 2x the distance from your eye to your front sight. For an AR, this is around 44", for an M-1/M-1A it is around 64". The exact number depends on head position, so you might want to verify, but these numbers are close. Hold your rifle up and aim, and have a helper take a tape measure, and measure from your eye to the front sight, then double that number.

2. Go see an eye doc for a checkup. Basic vision exam costs $40 at Sam's or WalMart, it's painless, they take walk-ins without an appointment, and the eye doc at my Sam's is cute. They are likely to tell you the same thing I just did, but on the off chance there is an underlying problem, best get their opinion, rather than trust some guy on an internet forum to practice medicine on you...

3. While you are there, ask for 3 very specific things:

- Ask for your distance correction in your shooting eye while testing for sensitivity to 1/8 diopters. Most docs simply test you to the nearest 1/4, which is fine for walking around focus with eye glasses, where you are looking at a variety of distances. For shooting you are looking at very precise distances, so testing to 1/8 is useful (1/8 diopter is typically the smallest step in focus the human eye can distinguish)

- Ask for the distance to their eye chart. For all practical purposes, the eye chart is effectively at infinity, however many eye docs have it at 25-30 feet away, which is actually 1/8 diopter from infinity, so if you are sensitive to focus at the 1/8 diopter level, knowing the distance to their eye chart lets you mathematically compute your true infinity correction

- Ask them to test you for your optimum correction, at a 1/8 diopter sensitivity, for a distance which is exactly 2x the distance from your eye to the front sight. For an AR, the front to rear sight is 20", and you hold your eye perhaps 2" from the rear sight, for a total of 22". You therefore want the eye doc to test you at 2x this distance = 44". For a longer barrelled rifle, this distance will be slightly more. This 2x the distance to your front sight represents what photographers call your hyperfocal distance, where your focus will be

balanced between the front sight and the target. If necessary, take this printout with you, they will understand what it means

Bottom line: get yourself a corrective lens that lets you focus at your hyperfocal distance while your eye is relaxed.

In addition to your natural point of focus, you also need a big depth of field.

The idea that the human eye can only focus on one thing at a time is a myth, within some limits. From a mathematical point of view, there is only 1 theoretical perfect focus distance for a lens. That much is true. However, if the width of blur for an out-of-focus object is less width than about 3 photoreceptors on the back of your eye, the human brain cannot tell it is blurred, so there is actually a distance in front of, and behind, the 'perfect focus' distance which will also be in perfect focus. This is called your depth of field, and it applies to camera lenses, as well as eyes. For most humans, the distance between 3 photoreceptors, and therefore the smallest blur you can see is about 1 MOA.

Depth of field comes from having a small aperture. Photographers who used 35mm cameras will appreciate this from using f-stop to control depth of field. The smaller the aperture, the greater your depth of field. When you shoot, you want to use the smallest aperture you can, but not so small your image goes dim.

Here is another big myth that's out there that is wrong: if you have trouble seeing with your rifle, use a bigger aperture, so you can get more light and focus better. WRONG! In everyday life, it is true that more light helps you see better. More light causes your eye's pupil to constrict, increasing your eye's depth of field, and helping you see things that are too close to focus on. Hence, when you get a menu in a dim restaurant, or you are trying to read by the light of the TV, you can't focus. Turn on a bright light, and you can read fine. The error is in assuming this situation applies to a rifle. When you are looking through the rear aperture of your rifle, the aperture is smaller than the pupil of your eye, so the aperture and not your pupil is what controls your depth of field. Adding extra light to constrict your pupil does not help. Increasing your aperture to let in more light makes you think you will see better, but in fact you will see worse. To improve focus, you want the smallest aperture you can.

In summary, to shoot with old eyes you need to tune the right lens power for you, and use a small aperture, and you will still be able to see as well as the young guys.

Note, all this math is based on medical literature that suggests the average healthy eyeball has a focal length of 17mm. Obviously, not everyone falls right at that size, so use this math as a starting point only, you might need to tune it on the range.

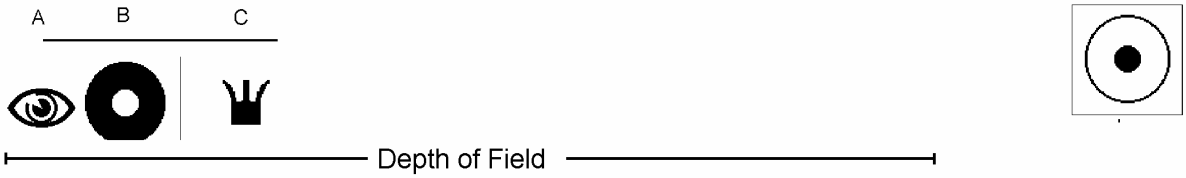
Art

Focal Distance and Depth of Field

(Depth of Field is constant based on Aperture size)

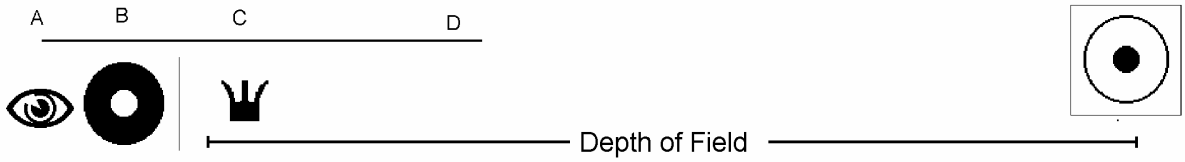
Too Short Focal Distance = A-C (Reading or Front Sight Rx)

Depth of Field is wasted behind Front sight and runs out before Target



Proper Focal Distance = A-D (Hyper-Focal)

Depth of Field includes both Front Sight and Target



Too Far Focal Distance = A-E (Infinity, ie Normal Distance Rx)

Depth of Field includes Target and beyond but too short to include Front Sight