

# Bow Tuning

## Centre Shot

Version 0.3

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### Setting the Centre Shot

When you release the arrow at full draw, there is no way a human can get their fingers out of the way of the string before it starts to move, it's just too quick. So the string actually rolls off the finger tips causing the tail (nock) of the arrow to move slightly left for right handed archers (opposite for LH).

The arrows trajectory will then be parallel to the bows "Median Plane" (a straight line from the String through centre of the bow to the target). And so for a right handed archer we set the aim of the arrow (centre shot) slightly off centre to the left (to the right for a LH archer).

This whole process can take some hours and you really need to be methodical about what you do.

### Where To Start

You should be a reasonably competent archer to start tuning and should be able to create a reasonable group of arrows up to 40 metres. You'll also need a target to yourself.

### The Button

To start set your plunger button to a medium stiffness. What's medium? The button can go from really soft, to almost solid and you want it half way between those extremes. With buttons like the Beiter button you also get 3 springs, so select the mid-sized spring and set the adjustment mid-way on the threaded barrel.

The button on a recurve bow will move in a few millimetres due to the bend in the arrow at release and helps keep the force of the bow down the centreline of the arrow.

## Limb Alignment

Next we want to make sure everything is straight and that the string runs through the centreline of the riser.

Fix the bow in an upright position, the best way to do this is to use a rip-clutch or clamp on the longrod. This means you're not putting any pressure on the limbs. If you don't have either of these but you have stabilizers with side rods you can prop the bow on the back of a chair that's facing away from you, just rest the side rods on the back of the chair and the longrod on the ground or seat.

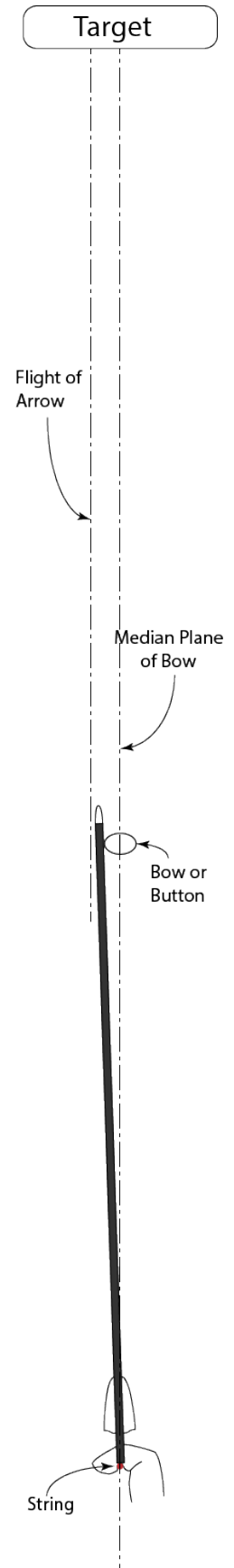
The important thing is to get the bow upright, so that you can see the string from one limb tip to the other in as much a vertical line as possible.

Standing behind the bow, visually align the string down the centreline of the limbs, you can use the back of the limb bolts on the riser as a guide (you can also use limb gauges but don't rely on them just on the tips of the limbs), you can also use masking tape on the limbs with the centre marked by a pen. What you want to see, is that the string runs centrally down the limbs and through the riser. You might need to adjust the limb alignment (if you can), to get the string central in relation to the riser and limbs.

## Sight Alignment

The quick way to do this is to centre the windage adjustment of your sight, then flip the sight around so that it's facing backwards and make sure that the sight pin is in line with the string. As long as the sight is attached square to the riser, and most are, then this is good starting point. It's also an opportunity to check that your sight guide is vertical and that the sight runs parallel to the bow string by moving your sight block up and down its full travel and making sure that the sight pin remains aligned with the string. if it drifts to one side or another adjust the sights vertical guide to keep it true.

When you're finished, flip the sight around to the front again.



## Basic Arrow Alignment

The centre shot alignment is not the same for everyone, we don't all look the same or shoot the same, so we'll do a basic alignment first based upon suggested norms, then you'll refine it by shooting some arrows.

1. Nock an arrow to the string and place it on the rest.
2. Keeping the string visually aligned (as described in Limb Alignment), determine the position of the arrow point with respect to the string. You need to focus your view back and forth between the string and arrow point.
3. You need to initially set the arrow given the following guidelines.

For arrows with a parallel shaft (aluminium Arrows, ACC's), it is suggested to align the right side of the point to the left edge of the string (vice versa for left handed archers). For Barrelled arrows (ACE's X10's), the recommendation is that the tip of the point is aligned with the left edge of the string (vice versa for left handed archers), so not quite so much offset with barrelled arrows. You can't see if an arrow is barrelled you can only tell by their manufacturers information.

4. To adjust the arrow alignment, physically screw the button in and out to adjust the position of the arrow on the bow.

## Centre Shot Refinement (Walk Back Test)

The bow is basically ready to shoot now and it'll work but it might need a bit more work to get it shooting consistently at various distances. You might for instance find that the arrows start to hit left or right the further away you shoot, resulting in you needing to make windage adjustments to get the arrows back in the centre. This is because the flight of the arrow is not parallel to the median plane of the bow.

## Prepare The Range

Set up a target boss at 40M (swap all the measurements for yards if you work in old money) and create a target about 30cm from the top using something like a Hit-or-Miss face. Next place shooting markers every 5M back to the shooting line.

# Shoot

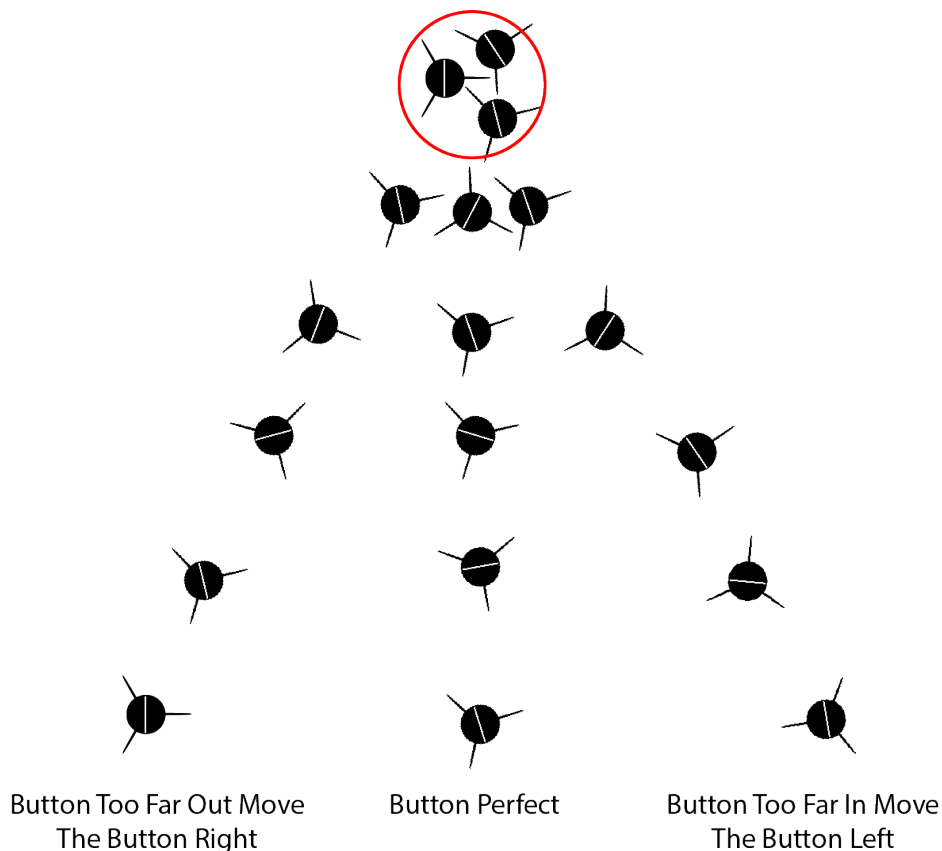
It's even better if your arrows are numbered for this test and that you shoot them in order so you can see where each one hits.

Set your sight to shoot about 15 metres and without moving your sight shoot an arrow from each of the markers at the target you placed near the top. You want to shoot as well as you can at the target face and don't concern yourself with where the arrows are actually landing during shooting.

What you should see is that your first three arrows should be grouped near the target at the top, all the rest should hit increasingly lower. If you've shot well the arrows should create a pattern either straight down the target or maybe drifting left or right.

## Adjust the button

For a right handed archer, if your arrows drift right down the target then screw the button to the left about a quarter turn, to increase the amount of button sticking out of the riser. If your arrows drift left down the target then screw the button right about a quarter turn, to decrease the amount of button sticking out of the riser.



Repeat this process until your arrows fall roughly down the centre. You should not need or try to adjust your sight as you go.

When you're finished you should have a setup that will shoot where you want no matter what the distance. Then you can use your windage adjustment for what it's meant for, to compensate for wind, not poor bow setup.

## Background

You want the arrow to fly straight to the target but arrows are light and flexible, so when you release an arrow, although you can't see it (and you can't stop it) the arrow nock usually moves slightly left (for a right handed archer) and this sideways movement starts the bending/flexing of the arrow (remember this for later). There's then a lot of complex physics going on at this time including something I read called "the general moment equation for a rigid body".

$$\Sigma M_G = I_G \alpha$$

You don't need to worry about the physics but you do need to set the bow up to compensate for this slight movement and flexing and if your setup isn't right, you may well find it frustrating to get consistent sight marks and tighter groups.

## What is Happening?

I'll walk through what happens at release for a right handed archer, the opposite takes place with a left handed archer, so just swap the lefts and rights around. But it's related to the idea of the Archers Paradox – Although the arrow is not aligned with the bow/string/target it will still hit the target.

When you release an arrow at full draw, there is just no way a human can get their fingers out of the way of the string before it starts to move, it's just too quick. So the string actually rolls off the finger tips causing the tail (nock) of the arrow to move slightly left. The string starts to push the arrow forwards and the arrow bends, this is partially because the arrow (and especially the point which is heavier) wants to stay where it is (Newton's first law of motion). However initially both the Nock and the point are moving left while the shaft of the arrow moves to the right to form an arc. After only a fraction of a second the arrow bends in the opposite direction and now the arrow is no longer in contact with the bow, only with the string pushing it forwards. Just past the brace height the arrow pulls itself free of the string and the arrow is in free flight. The arrow should also bend once more before it's fully ahead of the bow and this will help the vanes miss the riser and rest. The arrow will continue to flex back and forth at the same frequency until the arrow hits the target, only the size of the oscillations will decrease over time.

This is a really great video of this happening:

<https://www.youtube.com/watch?v=wGNslUNBrEM&index=3&list=PLTJFAXqu9Ex20YREyED6GdDvcGY3IVLPI>

So it's important that arrows flex and it's impossible for longbow archers to point the arrow in a straight line from the string to the target because the bow itself is in the way. So they actually need the arrow to move and flex around the bow.

Modern recurve bows typically have a cut-out in the bow where the arrow sits on the rest, so you could point the arrow straight at the target. But you still need to make an allowance for that slight movement of the arrow to the left on release and this is why we use a plunger button to set the "Centre Shot" alignment of the arrow.

It's important for all archers as they progress, to get an arrow where draw/arrow length, draw weight and spine (arrows flexibility) all work together harmoniously. You can shoot with equipment that's not perfect but spending the effort to get the best combination for you will pay off with better scores and less fletches knocked off by your rest.