Before we jump into this what I'm about to say and recommend is contrary to what you'll hear from some of the sacred cows in the traditional bow world. That's fine, sacred cows make the best hamburger!

Bow tuning is a pet peeve of mine and here's why. Back 30-40 years ago I was young, dumb, and a bit cocky. I was a AA NFAA shooter and was enjoying either winning tournaments or at least giving the big boys a run for their money. I had used a tuning method recommended by the old timers and the better shots around the area. I was just coming off a good win and the club held an annual broadhead tournament. So the morning of the tournament I unscrewed my "converta point" field tips and replaced them with the matched Bear Razorheads and got ready to show everyone how it was done.

Shot a few warm up shots (field tips) on the practice range then off to the first target, it was 60 yards. I watched in horror as the broadhead made 20 foot circles enroute. Long story short, I had no prayer of getting anywhere close beyond 15 yards and even at that range it was like an arbitrary 1 foot circle. That set me on the quest to learn about good tuning.

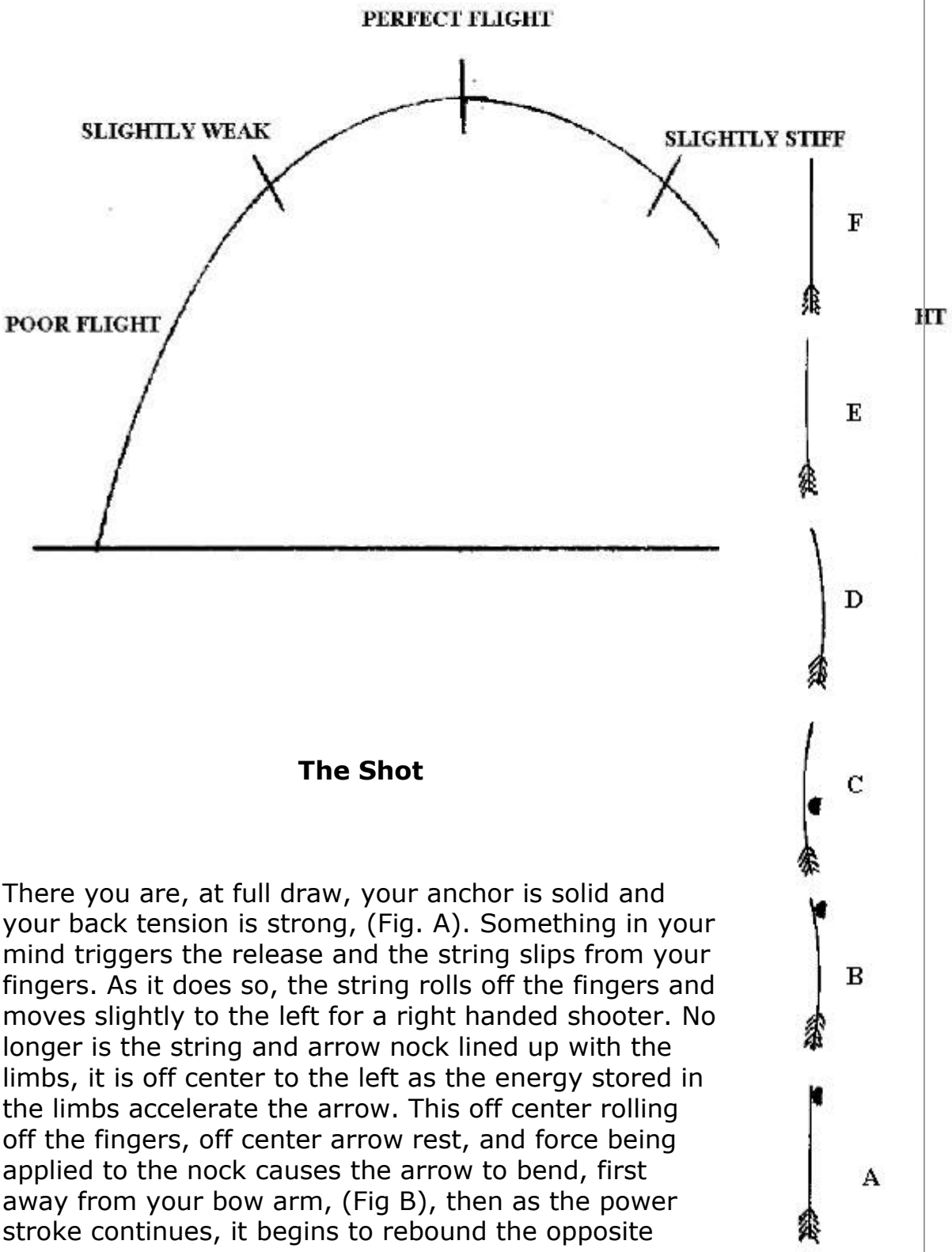
How many have simply switch over to broadheads the night before hunting the next morning? How many change a string or add a bow quiver, fling a few field tips and call it good? All of this is asking for trouble.

One of the reasons many folks enjoy shooting traditional equipment is it's simplicity. A bow with no mechanical parts that aren't glued on. No set screws, no micro adjustments, fiberoptic sights, just not much there to go wrong. But you still have to "tune" your equipment if you want to get the best accuracy and performance potential. The methods and techniques for tuning traditional bows is the same as it is with compounds. The same laws of physics apply. The big difference is you don't have the easy adjustments that are built into compounds so other remedies have to be used. The closer to center shot a bow is, the wider range of spines it can shoot well because it gives you the option to adjust the centershot. That DOES NOT mean you want it as close to center as possible. Just because a bow can shoot arrows at the low or high end of the spectrum, doesn't mean we should accept marginaly adequate arrow flight around the edges. Somewhere in the

middle of that range is going to be the best arrow spine combination that will be more forgiving of human errors and conditions you are likely to encounter in the field. Taking the time to tune your equipment is time well spent. "Simple" does not mean "easy". Hunting and shooting conventional equipment is a challenge, so is tuning them properly. If you want equipment that's easy to tune with little effort, you should be shooting a compound.

The Bell Curve

Take a look at the tuning bell curve. For any given bow, arrow, archer combination, there will be a "best" arrow, point weight, and centershot, that will give the best flight characteristics. To each side of the "best" are arrow combinations that most folks would consider adequate arrow flight quickly dropping off to unacceptable arrow flight. The farther away from the best combination, the more critical a good release and form become. They will shoot great if "I do everything right". If we screw up with equipment tuned on the edge, we'll miss further then if the equipment was tuned very well. We'll still miss, just not as far! For every group we shoot, part of that is caused by our errors and part could be from tuning. Lets eliminate the tuning part leaving only our human flaws to cause misses. The key to tuning is to find that arrow in the middle ground. So...How do we do that? Let's take a look at the shot....



The Shot

There you are, at full draw, your anchor is solid and your back tension is strong, (Fig. A). Something in your mind triggers the release and the string slips from your fingers. As it does so, the string rolls off the fingers and moves slightly to the left for a right handed shooter. No longer is the string and arrow nock lined up with the limbs, it is off center to the left as the energy stored in the limbs accelerate the arrow. This off center rolling off the fingers, off center arrow rest, and force being applied to the nock causes the arrow to bend, first away from your bow arm, (Fig B), then as the power stroke continues, it begins to rebound the opposite

direction, (Fig C), away from the riser. As the arrow clears the bow, it goes through several more cycles of this oscillation, (Figs D,E,F) dampening with each cycle until they cease. This bending during the shot is called archers paradox and explains why a bow with no arrow shelf at all can still shoot a properly matched arrow straight, even though it's not even close to the centerline of the bow. It is NOT a left to right wagging, it's an oscillation. You can not "see" paradox happening. If you can "see" a wiggle or wobble, that is screwed up tuning, not paradox. Many factors effect this paradox and all must be in "tune" or harmony with each other or bad things start to happen. In a well matched system, these oscillations are equal and cancel each other out so as the arrow stabilizes in line with the direction it was originally pointed. If the arrow is too weak or stiff, the null points of those oscillations are out of line from where they were originally pointed, causing the arrow to plane off line in that direction, away from where it was pointed. This mis-matched situation may be hardly noticeable with field tips, target points, or narrow broadheads but wide broadheads will magnify the problem greatly! Let's take a look at the factors involved with properly tuning your equipment and adjustments to make that will get them flying correctly.

Arrow Spine

How much the arrow bends during the shot is determined by how much force the bow applies to the back end of the arrow, how far off center the arrow shelf is, how stiff the arrow is (spine), and how clean your release is. Arrows also paradox vertically and is influanced by bow tiller, bow hand position, and nock point on the string. Arrow stiffness or spine is measured in pounds and gives you a ballpark guess for matching arrows to your bow. Arrow spine is measured by supporting the arrow in 2 points, 26" apart and hanging a 2 pound weight in the center and measuring how much it bends. For example, if the arrow bends .520 inches, that spines for a 50 pound bow at a 28" draw. Does that mean if you have a 50 pound bow and you buy 50 pound arrows that they are matched and will fly like darts? Not at all! This just gets you to a starting point. Much is left to do and understand before that's going to happen.

A common misunderstanding is confusing arrow spine with arrow weight. They are not related and are two different things. Don't fall for the marketing ploy that so and so's bows are so powerful they require a 10 or 15 pound heavier spine to shoot well. That's a bunch of BS and has less to do with the power of the bow and more to do with how

close to centershot the bow is, as we will see later.

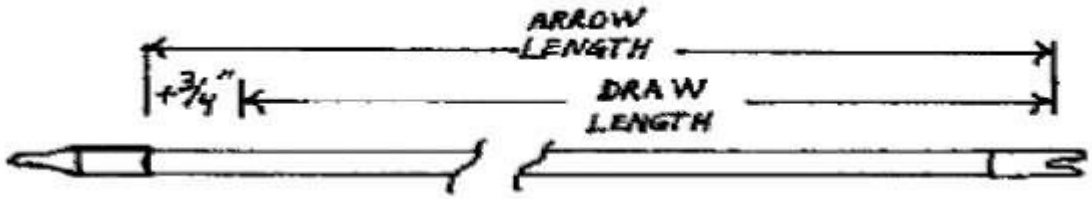
Draw Length and Weight

Most bows draw weight is measured at 28" unless marked otherwise. The amount of force applied to your arrow that is going to make it bend is determined by the draw weight of the bow at your draw length. To measure your draw length, draw the bow and have someone mark the arrow on the back side (the side away from you) of the bow or clip a clothes pin on the shaft and slide it down the shaft till you reach full draw, then measure from the throat of the nock to that point. This is your draw length. Beware! AMO draw length is measured to the low point of the grip plus 1.75" to account for variations in riser thickness but measuring to the back will get within a 1/2" or so. Finished hunting arrows should be at least 3/4" longer than your draw length to provide clearance for your broadhead. A little extra length doesn't hurt anything at hunting ranges and can help in the tuning process later. If the bow is marked 50#@28" and you draw 26", your arrow is not going to see 50 pounds of force. Most bows will increase or decrease about 2-3 pounds per inch above or below the weight/length it is marked depending on it's draw weight. Now, just because it is marked 50#@28" doesn't mean it is! I have seen them mis-marked by 7 pounds or more plus, if you are drawing the bow into the region of the draw force curve where it is stacking, the draw weight can vary more than 3 pounds per inch as will heavier or lighter bows. If in doubt, you need to get your bow weighed on an accurate scale at your draw length. Arrow length also influences how the arrow behaves, short arrows act stiffer during the shot than long ones, even if their deflection on the spine gauge is the same. A rule of thumb is add or subtract 5 pounds of spine for each inch above or below 28", and add 5# if you are using a high performance string. Add 5# for each 20-30 grains you go above 125 but this is non-linear.

Choosing Arrows

Before we can start tuning, you've got to have arrows to shoot. Wood, aluminum, or carbon arrows will shoot well and is personal choice. The most important consideration with arrows are spine, straightness, and weight. Spine and straightness are of primary importance. 30 or 40 grains weight variation at hunting ranges will make little difference in point of impact so is #3 in importance. At 20 yards, most folks would see little if any difference with 100 grain variation, however....If the weight variations cause variation in spine, you've got problems. Spine

and straightness, however, can not be compromised especially with broadheads. Be aware if you are going to shoot competition that arrow material restrictions may apply in certain classes. Arrow length should be your draw length plus 3/4", but.....For tuning purposes, we want to start with shafts about 2" longer than needed in the finished arrow.



Arrows that are going to be shot off the shelf, as most folks do, need to be fletched with 5" or 5 1/2" feathers if broadheads are going to be used, and in either a left or right helical twist. The twist doesn't make any difference but all your arrows should be the same. Some feel they get better clearance shooting left helical if right handed and vice versa. 5" fletchings for broadheads are the accepted norm but there can be benefits to using shorter fletching. It's not a hard rule, well tuned you do not need much fletching.

Wood arrows are considered by some to be more traditional, especially with longbows but they have their drawbacks. Good wood arrows are not cheap, even more expensive than aluminum. Building them yourself won't help much if you are as picky with them as I am. If I get 18-24 arrows out of 100 shafts, I'm lucky. First they must be matched closely in spine and weight, second they must be straight, and third they must be sealed well so they do not warp from moisture! A source I recommend for quality wood arrows is Old South Traditional Arrows.

Click HERE to see take a look.

Aluminum arrows are great, very straight and consistent spine. Spending a little more on XX75 or XX78 shafts will save you money in the long run as they do not bend or break as easily as cheaper aluminums. Aluminums are noisy to shoot and just carry around however. Carbons are straight, tough, and can be expensive! Lots of people really like them. For the safety of your bow most recommend your arrows weigh 8 to 10 grains per pound of draw weight. Up to 12 or 14 grains/pound for hunting larger game. A good rule of thumb is to shoot as heavy an arrow as you can and still live with the trajectory for

the ranges you'll be shooting. Bows are more efficient and quieter the heavier the arrow is but slower.

ARROW SELECTION CHART

Arrow Length Aluminum/Wood
From string groove in nock to back of point

Bow weight at your draw	25"	26"	27"	28"	29"	30"	31"
30 lb			1616/25lb	1616/30lb	1716/35lb	1816/35lb	1816/40lb
35 lb		1616/25lb	1716/30lb	1716/35lb	1816/40lb	1816/40lb	1916/45lb
40 lb	1616/25lb	1716/30lb	1716/35lb	1816/40lb	1816/45lb	1916/50lb	1916/55lb
45 lb	1716/30lb	1716/35lb	1816/40lb	1916/45lb	1916/50lb	2016/55lb	2016/60lb
50 lb	1716/35lb	1816/40lb	1916/45lb	1916/50lb	2016/55lb	2016/60lb	2018/65lb
55 lb	1816/40lb	1916/45lb	1916/50lb	2016/55lb	2016/60lb	2018/65lb	2018/70lb
60 lb	1916/45lb	1916/50lb	2016/55lb	2016/60lb	2018/65lb	2018/70lb	2020/75lb
65 lb	1916/50lb	2016/55lb	2018/60lb	2018/65lb	2020/70lb	2020/75lb	2117/80lb
70 lb	2016/55lb	2018/60lb	2018/65lb	2020/70lb	2020/75lb	2117/80lb	2216/85lb
75 lb	2018/60lb	2018/65lb	2020/70lb	2020/75lb	2117/80lb	2216/85lb	2219/90lb
80 lb	2018/65lb	2020/70lb	2020/75lb	2117/80lb	2216/85lb	2219/90lb	2219/95lb

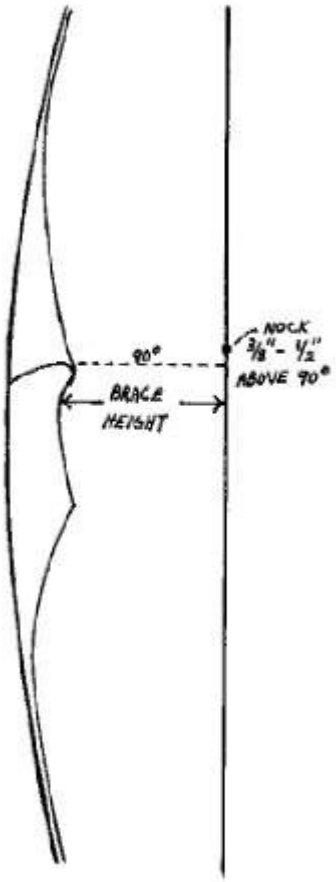
Once you have decided what arrow material you want to shoot, follow the chart to get the size you want. We'll talk more later about the balance (FOC) but if you want to shoot a high FOC, go up 1 or 2 spine sizes depending on how much weight you want up front. Keep in mind, charts are just starting points. No charts or rules of thumb on shaft length and point weight will result in a perfectly tuned set up unless by pure dumb luck. Time and effort will always be needed to dial them in. You need to think about what weight tips you want to shoot. The chart is averaged for 125 grain tips, increase spine if you want to shoot heavier points and vice versa. Fine tuning of arrow spine can be done by going up or down in point weight, arrow length, and adjusting the side plate thickness on your bow. A heavier point will make the shaft weaker and a lighter point will make it stiffer. If you get arrows that are too stiff or weak in spine, you may be forced to either shoot a heavier or lighter point than you wanted, adjust your centershot, or have to buy new shafts if all else fails.

Practice field tips need to be matched to the weight of the broadheads you want to shoot. Most broadheads suitable for hunting with

traditional bows are 125 gr. and up. For tuning purposes, I'd recommend at first buying an assortment of 125 grain, 145 grain, and 160 grain or more field tips to be used in the tuning process. Don't buy your broadheads yet until we find out what weight is going to fly best with your arrows.

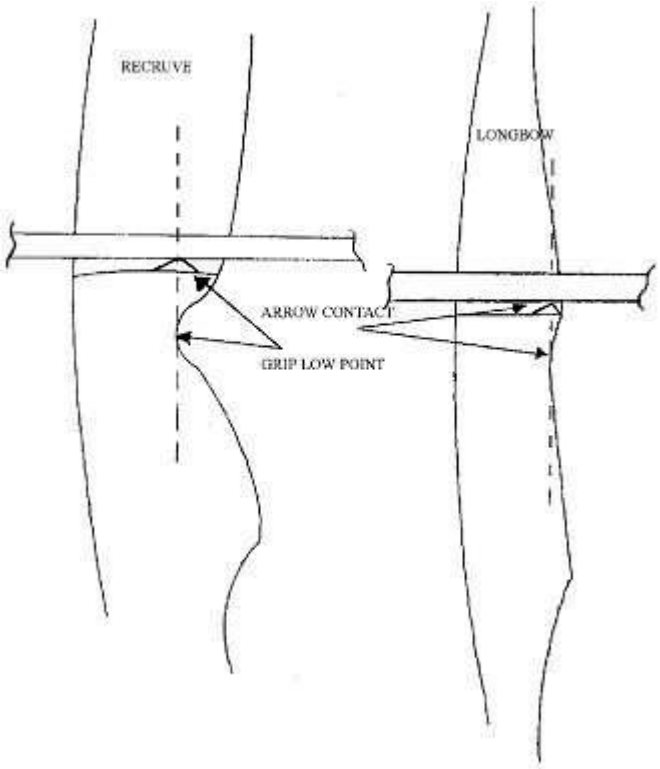
Arrow nocks should fit the string without being too loose but at the same time, too tight can cause all kinds of arrow flight problems and you can lose as much as 10% of your horsepower! When nocked, you should be able to point the arrow straight down without the arrow falling off. It should fall off with a light tap on the string. If your nocks are too tight, fold up some 150 grit sandpaper and run it through the nock until it fits properly. The soft foam emery boards work well also.

Initial Bow Setup



First it must be understood that ANYTHING you do to the bow effects tuning so it is important to set the bow up EXACTLY the way you intend to use it. If you tune your bow and then later add a bow quiver, it changes the tuning, change string silencer styles or position, changes the tuning, add limb covers or tip protector, changes the tuning.....Granted some changes are so minor that we aren't good enough shots to detect but the changes are there none the less so it is better to check your tuning to be sure. Several tiny changes can add up to make a good shooting bow shoot poorly and you scratch your head wondering why? So, if you are going to hunt with a quiver, put it on, fill it full of arrows, minus one....Exactly the way it will be when that trophy buck comes to visit....String silencers, put them on...In most cases, place the silencers at the 1/4 points. Measure from where the string just touches the limb to the other point where it just touches the limb, divide by 4 and place the silencers there.

Your arrow rest? Extremely important for good arrow flight. Shoot off the shelf or use an elevated rest. Really it's personal choice but as a rule, instinctive shooters like to have the arrow as close to the hand as possible, that means shooting off the shelf. Many gap/point of aim shooters prefer an elevated rest. Either way, the point your arrow contacts the bow should be directly above the pressure point/low point in the grip. Many arrow shelves are not designed to do this so you need to build up the shelf with layers of leather, the rug side of Velcro, or something to get the contact point in the correct place. See the figure below:



If the contact point is in front of or behind the low point in the grip, it makes the bow less forgiving to torque. It creates an underdraw or overdraw condition. They can be shot well that way with good form but they can be shot better if the contact point is in the proper place. The shelf material should provide some cushioning. The rug side of Velcro works well as does seal skin, or spongy leather. Your side plate in the sight window should be adjusted so when you line up the string down the center of the limbs, a nocked arrows tip will be 1 to 1 1/2 shaft diameters left of the string for a right handed shooter. If possible. If the bow is "cut to center" or not quite center, this may not be possible.

In that case use as thin a side plate as you can with the contact point straight above the low point of the grip. Bows cut "centershot or past center" are desirable ONLY from the standpoint it gives you more left/right adjustment capability. Not that they should be shot that way. Bows that are adjusted too close to centershot requires a much higher spined arrow than it's draw weight. This is not as forgiving as one adjusted with the arrow left of center using arrow spines closer to the bows actual draw weight. Not that they can't be shot well, they just can't be shot as well.

Next, set the brace height at the low end of the bowyers recommendation, just twist or untwist the string to set the brace height. Install a nock point 1/2" to 3/4" above 90 degrees. Now with arrows that you think are going to be close to the correct spine, take the bow out and start shooting it. If the string is new, you want to run 75 or 100 arrows through it just to stretch the string until it settles. Re-adjust the brace height to the low setting again if necessary. Shoot 3 or 4 arrows and pay attention to any hand shock, vibration, and noise. Put 4 or 5 twists in the string and shoot 4 or 5 more arrows, again paying attention to vibration and noise. Keep doing this until the bow starts shooting smooth and quiet, if you go above this brace height, it will start getting noisier and vibration again so drop back down. Once the best brace height is found, measure it and write it down somewhere so if the string stretches more, you can re-adjust it without going through this process again.

Now we can get to some serious tuning.

TUNING METHODS

There are several tuning methods out there, however, in my opinion, the bare shaft "Planing" method or the broadhead planing method is the best and here is why.....In a well tuned/matched bow arrow and archer combination, very little fletching on the shaft is needed with target points. The arrow balances forward of the center so if launched in a perfect straight line, the tail of the shaft will follow the point. Fletching on the shaft has one purpose...to counteract and stabilize errors in the shafts flight path caused by the shooter not launching it straight. Not being launched straight can be caused by equipment tuning but mostly with flaws in our form and it's difficult to tell the two apart. Some bows due to their tiller and geometry combined with shooter quirks, will never ever shoot a shaft straight consistantly. Therefore it's futile to even try. The "kick" or shaft angle method you'll read or hear about relys on looking at how an arrow flies through the

air or what angle it sticks in a target. Truth is the best shooters can not shoot a perfectly tuned shaft "straight" and trying to do so will result in frustration or over spined condition when you've done the best you can do.

The goal here is to eliminate equipment flaws leaving only our own poor shooting as an excuse! Remember the bell curve above? You can get inside the acceptable range by luck or trial and error but our goal is the middle and to do that we must use the planing method. So do we have to bare shaft tune? No, not at all. Using the planing method with fletched WIDE broadheads works the same way. Broadheads, the bigger the better, magnifies the tuning problems the same as bare shafts do so you can see problems and correct them.

The key ground rule in tuning is to only change one variable at a time, then analyze the results. If you change two or more variables, and your arrow flight gets a little better or worse, you don't know which change caused the results and creates even more confusion. Do you have to have good form as some suggest? Not at all. The better groups you can shoot the better shot you are, but that is true no matter how good your equipment is tuned. What the planing method does is separate form flaws from equipment flaws. One is fixable, the other is not. And lastly, never make adjustments based on the flight of just one arrow, base your adjustments on the average between several arrows, especially wood arrows where spine consistency and straightness can be a problem. Basing your adjustments on the average of many arrows helps remove the flaws in our form leaving only equipment problems to deal with.

The detailed descriptions below are for a right-handed shooter. Up and down adjustments with the nock point is the same if you are right handed or left handed. Left or right adjustments however are reversed. For explanation purposes, all discussion will be for right handed shooters. If you are left handed just reverse all left/right indications.

BARE SHAFT PLANING

Some how, bad information has been passed down from archer to archer for many years on the correct method to bare shaft tune. Some might be familiar with, or heard of a technique of bare shaft testing that requires getting close to your target and analyzing nock left/right/up/down patterns for tuning purposes; That is not a good

method and causes great confusion! Bare shafts sticking in a target at an angle or flying through the air sideways can be caused by shooter as well as equipment and you can not tell the difference reliably. The correct way is bare shaft "planing"; Determining adjustments based on bare shaft groups in relation to identical fletched shafts at longer distances. A fletched shaft always goes close to where it's pointed, bare shafts or wide broadheads will not. Nothing in your form can cause this to happen. So by "reading" the relationship between bare shafts or wide broadheads we can fix tuning issues while not allowing form issues to confuse us.

To get started you've got the shafts you want to tune. Many will try several different shafts and that's OK, but do not try to draw comparisons in what you see between them. It'll drive you crazy. Best bet is pick a shaft size and do what's necessary to tune them.

Your bow should be set up exactly the way you intend to hunt with it. All silencers installed, brush buttons, arrow rest, bow quiver, ect.... Install field tips of the same weight as the broadheads you want to shoot if you have a choice. Depending on how well you selected your shaft size, you may be forced to shoot tips heavier or lighter than your desire.

NEVER BARE SHAFT BROADHEADS! Field tips/target points only. Broadheads will act like fletching on the wrong end and wild flight can result.

Now to get started, step back 15 or so yards and start shooting 3 or 4 bare shafts mixed with 3 or 4 identical fletched shafts aiming for a spot. Odds are they are not going to fly very well so we need to start making adjustments to straighten them out. You are going to make adjustments based on where the groups are in relation to each other, not on whether the nocks are kicking one way or another. IGNORE SHAFT ANGLE! It is irrelevant.

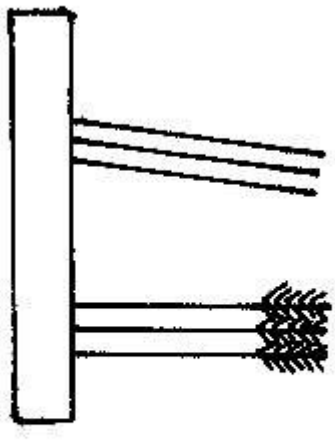
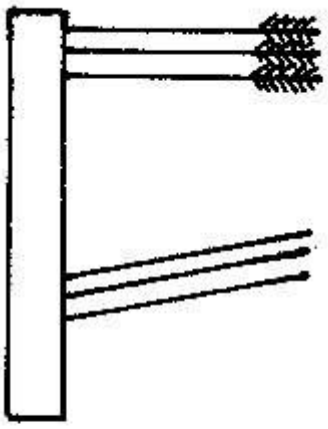
We want to take care of any up/down problems first. If the majority of your bare shafts are grouping high or low of where the majority of your fletched arrows are, the nock point needs to be adjusted. Ignore left and right problems at this time. If your bare shafts are grouping lower than you fletched shafts, lower your nock point a tiny bit, maybe 1/32" and shoot several more arrows. If you lower your nock point all the way to zero and they are still grouping low, your nock point was too low to start with and the back of the arrow is "kicking" off the

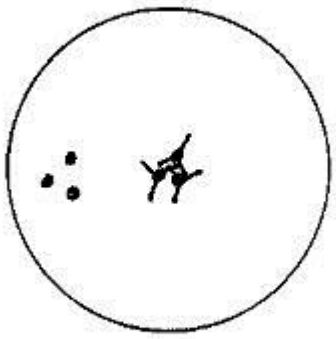
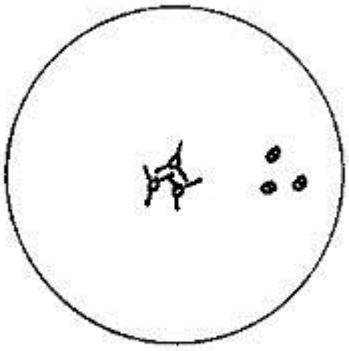
shelf, giving a "low" indication! If they impact (group) higher, raise your nock point. What you are looking for is the bare shafts to group slightly lower then the fletched shafts.

Now it's time to work on any left/right problems. If the majority of your bare shafts are grouping left of the majority of your fletched shafts, your arrows are too stiff. To correct this you have several options. The easiest is to increase point weight one step and try again. It's possible you may have to go from a 125gr tip to 190gr or more to get good flight! Another option if you have a thick side plate on your arrow shelf in the sight window is to reduce the thickness of that side plate, moving the arrow closer to centershot, and test again. It's also possible you may never get good flight if they are way too stiff and you will be forced to get new shafts of a weaker spine or use a very heavy point weight. Hopefully that won't be the case. If the majority of your bare shafts group right of your fletched shafts or tend to scatter with no pattern, they are too weak. Reduce your tip weight and try again, or build out your side plate further away from center. You can shorten your arrows 1/2" at a time which will make the arrow stiffer. Keep in mind overly stiff gives the SAME indications and cutting will make it worse. NEVER EVER CUT ARROW SHAFTS UNTIL YOU VERIFY WITH POINT WEIGHT. In other words if you want to shoot 125 grain heads, only cut if 100's shoot well and 125's shoot weak. Again if the problem can not be corrected, new shafts of a higher spine may be needed. Remember to never base adjustments on one or two shots, shoot many shots mixing bare and fletched shafts and average the relationship between the groups. For example if 5 bare shaft shots went left of the fletched shafts, and one went right, adjust for a shooting left indication. Change only one thing at a time and evaluate the results. Changing from a 2018 to a 2117 for example is TWO CHANGES, not one! You have changed spine and centershot due to a change in shaft diameter.**Any changes you make to the bare shafts, make the same changes to the fletched shafts! The bare and fletched shafts must be identical.** Once you are getting fairly satisfied, step back to 20 yards and start shooting several fletched shafts and bare shafts....Repeat the tuning process from as far away as you feel comfortable.

A properly tuned set up, bare shafts and fletched shafts will group together out to 70 yards or more. Expect the bare shaft groups to be somewhat larger then the fletched groups for obvious reasons! The better your form is, the tighter the groups will be and the farther away you can maintain good groups, and finer tuning can be accomplished.

The most forgiving arrow to shoot will actually show a slightly weak/slightly high nock point indication. In other words, at 20 yds or more, bare shafts grouping a little low and right is perfect because fletching makes a shaft react slightly stiffer. Totally confused? Here is an overview:

Reason: Nock point too low Remedy: Raise nock point	 NOCK POINT LOW
Reason: Nock point too high Remedy: Lower nock point	 NOCK POINT HIGH

Reason: Over spined (stiff) Remedy: Heavier point, or thinner side plate, or longer shaft, or switching from a Dacron string to a DF-97 or Fast Flight, or weaker arrows.	 STIFF SPINE
Reason: Under spined (weak) Remedy: Lighter point. or thicker side plate, or shorter shaft, or switch from a DF-97 or FF string to Dacron, or stiffer arrows.	 WEAK SPINE

I can't emphasize this point enough……Make one small change at a time and evaluate the results. If things got worse, you went the wrong way!

Fine Tuning Broadheads

For the hunter, this is the bottom line, broadheads that fly true and straight where you look every time! It would be nice to think that with all the tuning you have done to this point that you could just glue on matching weight broadheads and get perfect arrow flight, that rarely

happens but you should be close! The blades of a broadhead try to plane and steer the arrow so any small tuning problems that were not detected prior will be magnified greatly. I can't emphasize enough how important it is to shoot your broadheads and correct any flight problems BEFORE YOU GO HUNTING WITH THEM! After tuning and practicing with your broadheads, be sure to re-sharpen them to a razor edge.

If a person is so inclined, you do not have to tune your arrows with bare shafts and field points. A person can go straight to broadhead tuning. Bare shaft tuning using the planing method is useful to either get close to the correct broadhead weight, so you don't have to buy a bunch of broadheads, or if you are only going to target shoot with target or field points and never shoot broadheads. This broadhead tuning method and the bare shaft planing method are exactly the same thing for the same reasons.

For tuning purposes we should use the biggest/widest/nastiest broadheads possible. If you try to do your tuning with very narrow broadheads you will not be tuned as well as you could be. Once you are tuned up with wide broadheads you can change over to narrower heads of the same weight with no problems. However if you tune up with narrow heads then try to switch over to wider heads, you'll find you wasn't as well tuned as you thought you were. I prefer to use Snuffers for tuning, then I can go to any matched weight narrower head I desire depending on the game I'm after.

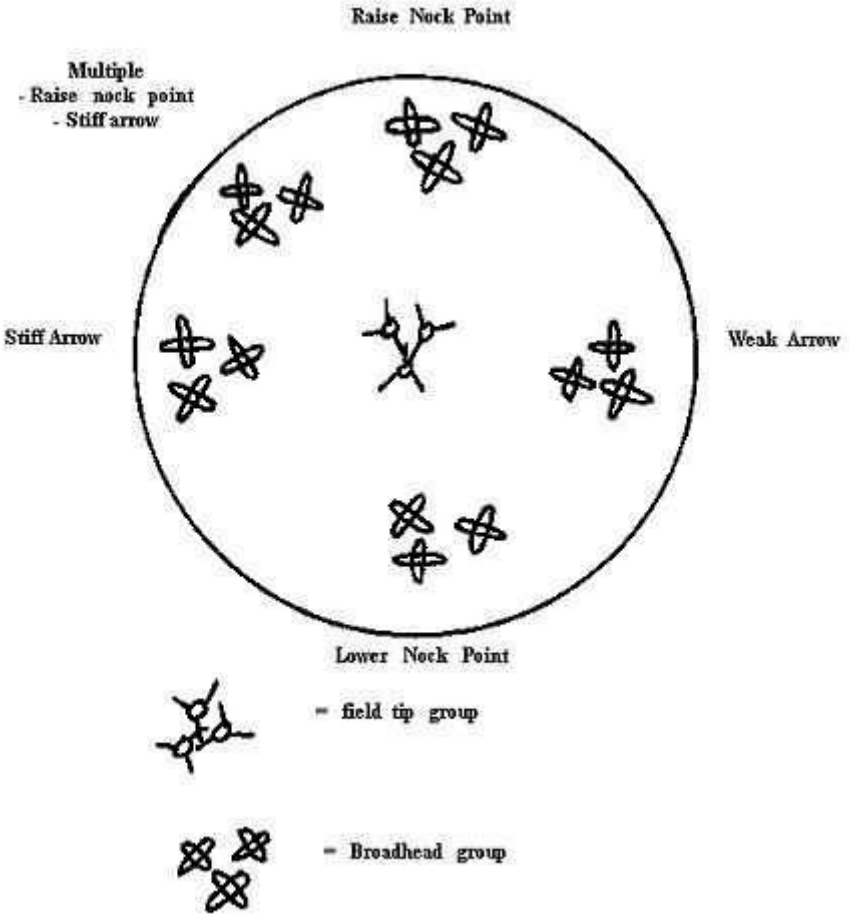
The first step in tuning your broadheads is installing the broadheads. Straightness is a must, spin them on a flat table or in a cresting jig to check for wobble. You can spin them on the tip but the very tip can be filed slightly off center showing a wobble that won't cause a flight problem or vice versa. Your fletching should be helical and a person should strive to have enough stabilization without having too much. 3-5" fletching is way more than enough for the biggest broadheads. If you are going to shoot very narrow broadheads, 4" or even 3" is plenty depending on your center of balance. More fletching makes the arrow stabilize quicker if the arrow is disturbed but at the expense of rapid energy loss and less bow clearance when we screw up a release

In theory, the orientation of the blades to the fletching or your sight window should make no difference but....I feel they should at least all be the same from arrow to arrow and I mount 2 bladed heads horizontal and 3 bladed heads "V" up. I do this for two reasons, most

folks mess up a release more often than any other mistake. This results in more side to side "kick" than normal and a 2 bladed heads mounted horizontal will not plane as badly, arrow rotation due to helical fletching starts slowly so the arrow is flying for several feet before full rotation starts. The other reason I mount my heads this way is I don't like anything sticking up into my sight picture that isn't there normally when I'm practicing with field tips. Let's get shootin...

Remember the arrows must be identical in every way other then the points. Our goal here is to get your broadheads and field tips grouping together from as far away as you dare to shoot. That is the tuning test....If you can stack wide broadheads, bare shafts, and field tips in the same group from as far away as you can shoot a group, you are well tuned. If you can't, you have tuning problems period.

Get back 20 or so yards from a suitable broadhead target and start shooting field tips and broadheads at random at a spot. Take a look at the diagram below:



If most of your broadheads and field tips are grouping together, but one broadhead strays once in awhile, check to see if it is the same one that strays. Look for mis-aligned broadhead, nock, or bent shaft. If it's a different arrow each time that strays, slightly increase your brace height with 2 or 3 twists in your string, make small adjustments here, it usually doesn't take much. If that doesn't work, decrease the brace height slightly. A brace height adjustment usually gets rid of occasional flyers and small spine problems caused from tuning, but won't do much for the "human" caused flyers however, just ignore them.

If all your broadheads are grouping together but somewhere other than with your field tips, slight nock point changes and spine changes will bring them in just as if you are shooting bare shafts.

Some general rules for all tuning.... Make all adjustments one at a

time and small, evaluate the results before making more changes. If you make a change and things get worse, put it back and go the other way! If you make a change and don't see a change, odds are you went the wrong way. Go slow and methodical.

Once you get them grouping together at 20 yards, if you want to fine tune even better, wet the feathers of your broadheads until the feathers are matted down, repeat the process! Having that huge buck show up with matted feathers after a rain storm, is not the time to find out you have tuning problems!

Now what do I do?

First, measure your brace height and nock point height, write them down somewhere. This will save you tremendous time later on. It's also not a bad idea to take that string off and use it as a spare. Get another identical string, set it up, go through the tuning process again. Next, practice, practice, practice, sharpen those broadheads and go hunt something!

Tuning is essential to get the best accuracy and performance out of your bow. For hunting, the closer you shoot, the more critical good tuning is to getting the best penetration. Most of this is science and the better you understand the relationships and the cause and effects of all the variables, the easier it is. I hope this information will help you enjoy archery even more and remove any doubts in your equipment, putting the excuses for missing where they should be, on the shooter!

Thoughts on FOC

FOC refers to the balance point of the arrow in how far "Forward Of Center" it is. For any object to be "stable" in flight the object has to have more drag behind the balance point then in front. The further forward this balance point is the more "stable" it will be. With "Stable" being defined as it's ability to resist deflection/change in direction and how fast it will correct itself if disturbed. Disturbance and deflection from a straight line can come from many different sources. Poor releases, bow movement/torque during the power stroke, twigs/leaves, wind shear, and critter ribs/bones to name a few. Much has been written about what the FOC should be. Mostly from those who have never done any objective testing outside what over the counter store bought parts would allow or based on flawed theories/concepts. Tests done by Bob Morrison, Dr. Ed Ashby, myself,

and others shows huge benefits to shooting arrows with FOC's higher than normal.
FOC is measured by locating the center of the arrow then locating the balance point. Divide the distance it balances from center by the arrow length and that is the FOC percent. A 30" arrow that balances 3" in front of center is 10%. Normal FOC's range from 9 to about 15%. There seems to be little difference in those lower FOC's but when they start to exceed 20% good things start to happen. Penetration starts to go up even with less grains per pound of arrow weight. The arrows disturbed in flight correct faster making them more forgiving to our errors and flatter shooting down range. Smaller fletching can be used to achieve the same stability as lower FOC's with larger fletching. Consequently the arrows are quieter in flight as well. There seems to be no upper limit to the benefits. The "perfect" arrow would have 100% of it's mass in the point and the shaft would weigh zero.
If you want to play with high FOC arrows, you need to start out with arrows 1 to 2 spine groups stiffer then you would normally. Carbon arrows especially those that are tapered (like Alaska BowHunting Supplies Grizly Sticks) lend themselves to higher FOC's than aluminum or wood but there is no reason they won't benefit from it also. Brass inserts are available as well as steel broadheads adapters and field/target points are becoming available to put together recipes for high FOC arrow combinations. Internal footings made of various materials help increase the durability of shafts and eliminate weak points. Much is being learned as this is a road untraveled. I'd suggest reading Dr. Ashby's studies on WWW.TRADGANG.COM Keep an open mind and don't trust all the old rules of thumb or "common wisdom"....Try it yourself!

Thoughts on Strings

Strings have evolved over the last 60 years but it seems many of the old thoughts and beliefs have not. Once upon a time with linen, silk, and other natural fiber strings, breaking strength was the big concern. The rule of thumb was a 5:1 ratio in string strength to bow draw weight. A 250 pound test string was adequate for a 50# bow. That's about 6 strands of Dacron. Dacron had the problem of too much stretch so more strands are used. Any material will stretch less if more of it is used. They probably wanted the serving area to be thick enough to not cut into tabs or gloves. The easy way was use more strands!
Along comes modern strings with higher strength and therefore less stretch. Where we used to use 12-14 strands of Dacron with 700# breaking strength we used 10-12 strands of FastFlight that was smaller diameter with a breaking strength of 1600 pounds plus..Then

wondered why it was hard on bows. Different articles and tests have been done concerning strings but no one has done fair, objective testing to compare in an apples to apples way. They have all tested over built string to WAY over built strings. And warped their conclusions to fit a bias and agenda they had before ever starting the tests.!

In playing with the flight shooting stuff, we try to use as minimal a string as possible. Seeing where that lower limit is I'm convinced we are using strings way too strong on our bows. I know of no logical reason for doing so. If you have one you can prove in an objective way, I'd like to hear it! On a lark I took a bow I'm very familiar with and was shooting an 8 strand DF-97 string. It's 47#@29"...This is a light string by many definitions. I made a 4 strand DF-97 which has a breaking strength of 600#, way more the 5:1 standard that used to be the rule. To my amazement the bow picked up another 3% horsepower in the arrow over the 7-10% it already gained by using 8 strands of Df-97 over 12 or more of Dacron. That is the difference between a 55-60# bow but only pulling 47#. That's free performance.....For this string I padded the loops with 8 strands of Dacron and double served the finger area of the string and single served where it can rub on an armguard like normal...Compared to the 8 strand string, it was even quieter and even less vibration in the bow. We tried another bow and got the same objective performance results along with the subjective ones as well! So why on earth are we shooting poly ropes willingly??

Strings account for way more performance loss than we think or have been lead to believe. Some say lack of "stretch" results in better performance but a bow string is under max tension at brace height and drops as the bow is drawn. When it hits brace height during the shot the tension spikes but the arrow is gone when the peak is reached. How could "stretch" be a factor at all? The answers to all bow related performance questions are contained in the relationship between mass, force, distance, and time. String mass reduces performance...String thickness reduces performance. The "faster" we try to shoot our bows using lower arrow mass, the more energy lost to limb and string mass as well as aerodynamic loads. A bow string .090" thick and 60" long presents 6 square inches of frontal area. The same area as an 11/32" arrow shaft, 16" long, traveling sideways at 100 MPH!!

I don't recommend anyone try the extremely small strings the way I do because some bows may not be able to handle it if the strings aren't properly made and or the bows tips aren't designed to handle modern strings. But neither of those factors are the strings fault. To

further show where the limits are, I've shot a 4 strand DF-97 on a 55# bow at less than 2 grains per pound for dozens of shots with no damage to the string or bow. With that caution if you decide to experiment with ultra light strings, let me know your thoughts and opinions on how it goes.....

12-24-08 A little update on skinny strings. Here is a thread on Tradgang discussing others tests and opinions.

Click HERE to see take a look.