

# Laporte County 4-H Shooting Sports Archery



## **4-H SHOOTING SPORTS: ARCHERY**

1. The archery project is open to any Laporte County 4-H member
2. The archery project is for recurve and compound bows. The club will provide basic recurve shooting equipment and safety equipment. Members wishing to shoot compound bows must provide their own bow and arrows. Crossbows are not permitted.
3. There will be a fee of \$5 per member. This fee will cover insurance and equipment expenses and will be collected before the 4-H member will be allowed to participate.
4. Parent must sign a participant waiver form before 4-H member will be allowed to participate.

### **Basic Requirements**

1. All members must complete a record sheet.
2. All 1st year members must take Archery Lesson 1: Archery Equipment, Safety and Range Commands and Archery Lesson 2: Developing Proper Archery Shooting Form.
3. Junior Olympic Archery Development (JOAD) program skill qualification rounds will be shot under tournament like conditions (See Appendix 1). Members must participate in at least two tournaments or shooting sessions and should increase 1 skill level each year that they are in the program.
4. Members are encouraged to do projects at a level that reflects their age ability.

## EXHIBIT REQUIREMENTS rev. 2008

- Grade 3: Make posters of range rules, archery safety principles, eye dominance, or archery tackle with parts identified. (Lesson 1)
- Grade 4: Develop a poster or diagram showing the steps of good archery shooting. ("Nine Steps to the Ten Ring", Lesson 2)
- Grade 5: Made a ground quiver with a bow support for range use. Document your work on a poster.
- Grade 6: Create a model, poster, or diagram of proper sight shooting form or sight adjustment or of proper form for instinctive shooting with a high anchor.
- Grade 7: Exhibit a bowstring you've made on the bow for which it was made. Document your work in a notebook or on a poster. Include pictures of the process and product.
- Grade 8: Compare advantages and disadvantages of instinctive and sight shooting techniques. Include pictures of targets shot using each technique. Exhibit in a poster or in a notebook. (Lessons 3 & 4)
- Grade 9: Exhibit fletched arrows or a bow rack you have made for use with recurve or compound bow. Document your work in a notebook or on a poster.
- Grade 10: Illustrate bow tuning problems and correction with a series of targets and illustrations or  
Examine the physics of arrow flight and display the importance of tuning to achieve optimum performance. Display in a notebook or on a poster.
- Grade 11: Exhibit a notebook or journal with scores, comments, and notes on a series of 3 archery events in which you have participated -or- Research an archery game and write its rules, course of fire, and history. Exhibit in a notebook or on a poster.
- Grade 12: Compare trajectories of several bows with equal draw weights but different designs or different draw weights and the same design. Present the results as graphs and discuss them in a notebook or on a poster. Sample targets may be included.
- Grade 10-12: Design and construct an archery item that can be useful to you while participating in archery. Examples include but are not limited to quivers, bows, bow or arrow cases, tree stands, etc.

### Notes:

All projects must meet State Fair requirements and LaPorte County 4-H Project Handbook requirements. Projects not meeting these requirements (size, orientation, poster with no stiff backing or not covered with clear plastic, etc.) will receive a PARTICIPATION ribbon.

## Shooting Sports State Requirements

Create an exhibit that shows the public what you learned in shooting sports education this year. Exhibits must be displayed horizontally, sized 22" x 28", mounted on a firm backing (foam-core board or other), and covered in clear plastic or other transparent material. Be sure to include a label with your name, grade, and county. Title your exhibit with one of the following: archery, hunting, muzzle loading, pistol, rifle, shotgun, or shooting sports. You can use a subtitle, if you wish.

### Important Notes:

For the safety of all fairgoers, do not include any of the following in your exhibit:

firearm                      live ammunition                      usable ammunition                      bow                      complete arrow                      arrowhead

Any ammunition or arrows used in your exhibit must be completely inert (unusable).

- Projects involving firearms, bows, arrows, ammunition, may be exhibited as a photographic display on a poster or in a notebook following grade level guidelines. Notebooks must include detailed information about how the project was completed with photographs documenting the work. Photographs are encouraged as they help the judges see the progress and the finished product. The notebook must include research, planning, costs, and an explanation of how the final project will be used.
- Handmade items must include information explaining how the project was made and its intended use.

Level: Grades 3 through 5 (May have one State Fair entry per county)

### Exhibit

Display a poster showing what was learned in the 4-H Shooting Sports project.

Level: Grades 6 through 8 (May have one State Fair entry per county)

### Exhibit

Choose one of the following options.

Exhibits **MUST** meet the size restrictions or be presented in a notebook. All exhibits, other than posters, must include an explanation of costs (time and money) and procedures.

1. Poster
2. Small project or model no larger than 18 x 18 x 36 inches.
3. Notebook, showing how a shooting sports item was made, or project completed. Include pictures of the item or project.

Level: Grades 9 through 12 (May have one State Fair entry per county)

### Exhibit

Choose one of the following options. All exhibits, other than posters, must include an explanation of costs (time and money) and procedures (your research, planning, and how you will use the finished product).

1. Poster
2. Project or model (any size) and explanation of costs and procedure.
3. Notebook, showing how a shooting sports item was made, or project completed. Include picture of the item or project and explanation of costs and procedures.

Level: independent Study: Grades 9-12, on State Fair entry

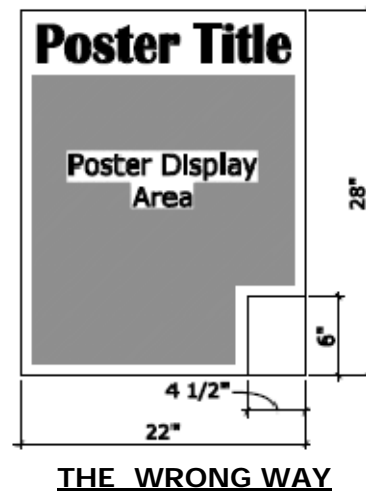
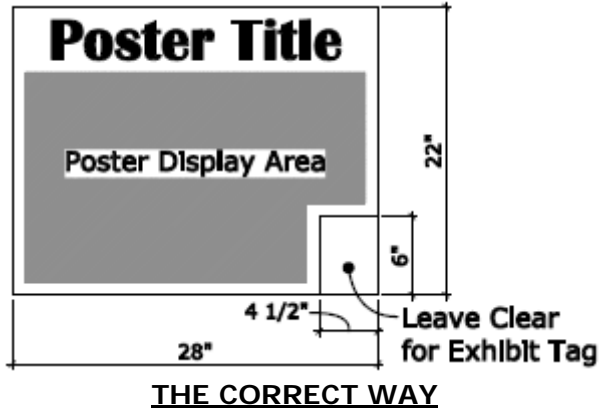
### Exhibit

Advanced topic – Learn all you can about an advanced shooting sports topic and present it on a poster. Include a short manuscript, pictures, graphs, and list of the works cited to describe what you did and what you learned. Title your poster, "Advanced Shooting Sports."

Mentoring – exhibit a poster that shows how you mentored a younger 4-H member. Include your planning, the time you spent, the challenges and advantages of mentoring, and how the experience might be useful in your life. Photographs and other documentation are encouraged. Title your poster, "Advanced Shooting Sports – Mentor."

## POSTER CONSTRUCTION REQUIREMENTS

1. POSTER BOARD – Use white when required. Colored is acceptable when not specified. Be sure to check individual project requirements. All posters must be 22" x 28" unless otherwise specified. See diagram for proper horizontal position.



2. Mounting adhesives – the best is rubber cement (leaves no marks – won't wrinkle paper) – double stick tape is best for leaves – white glue should be used only in cases where wrinkling or damage will not occur.
3. Colored pencils – the best are soft leaded – are easy to color and blend easily – strokes will not show if handled properly – hard leaded pencils are less expensive but are more difficult to use. (Can be purchased at art stores).
4. Labels – We have found that plain 3" x 5" file cards work exceptionally well – they have a smooth finish, are sturdy enough for gluing and removing smudges.
5. Still Backing – any material that will keep the poster from bending forward will work – examples – plywood (this may get heavy), masonite (1/8" thick – found to work well and could be used year after year), foam board, insulation board or heavy cardboard (freezer box). The backing must be the same size as poster board.
6. Acetate or clear plastic covering – this is required for all posters to keep them clean before judging and while fairgoers finger them. Comes in various sized (3, 5, 7.5 and 10 mil.) and in rolls or sheets.
7. Plastic tape – not necessary but makes attaching covering to stiff backing easy – available in many colors (cloth or plastic) and available at discount stores – approximately 1 1/2" wide.
8. Leave room on lower right-hand corner (6" high x 4 1/2" wide) for county exhibit tag. Label poster with name, project, division and club.

### Introduction

Archery equipment has been used by hunters and warriors since prehistoric times. The bow could be shot at long ranges, allowing the shooter to stay away from potentially dangerous animals or enemies. Archery target shooting is also old. Without a doubt, even cave dwellers held contests to see who could shoot the best.

Early bows ranged from simple staves of wood that were shaped for better performance to strongly recurved bows that were reinforced with horn, bone or sinew to increase toughness, speed or cast. Bows were designed to meet specific needs. Those to be used while standing or walking were much longer than those used while riding horseback. Thus, the **English longbow** was a far different design than the short, **recurved bows** used by the Mongols and the Turks.



Modern American archery dates from the middle of the 19th century. As the war between the states came to an end, many people who had to live off the land were denied access to firearms. They relied on bows to live. The Compton brothers wrote of their experiences with the bow during that period. When Ishi, the last Yana Indian, taught the art of making and hunting with archery equipment to Art Young and Saxon Pope, those men began to popularize bowhunting. The rebirth of archery in the United States began.

Developments in materials and engineering produced a number of advances in archery equipment. Fiberglass was used as a more resilient substitute for wood. Laminated bows used the strength and cast of fiberglass and the lightness of wood to increase the speed of the bow. Designs changed, adding cast by reflexing or recurving the limbs. Still later, mechanical advantages were added as compound bows were developed and their limbs were fitted with eccentric wheels, cams or even cammed limb tips to make the bows faster still.

During this time, other parts of the archer's equipment were also changing. Arrow material changed from wooden dowels to fiberglass, aluminum or graphite tubes. **Fletching**, once mainly turkey or waterfowl feathers, now includes both hard and soft plastics. Strings went from woven strands of waxed linen to Dacron, Kevlar or Fastflight strands with monofilament servings. Strange looking devices were added to shorten the draw length, balance the bow for accuracy or assist in sighting.

Archery moved into the age of technology, but it continues to be a sport involving hand-eye coordination, consistency and the need for practice to become proficient. Archery remains a sport with relatively slow projectiles shot over relatively short ranges. Basic knowledge and awareness of common safety considerations are necessary for safe, responsible and enjoyable use of archery equipment. Let's look at some archery equipment and ways for using it safely.

## Archery Safety

Arrows are dangerous until they come to a complete stop. The entire flight path, from release until the arrow stops must be clear and safe. This is the same as having a safe field of fire with a firearm. As with firearms, the arrow should only be pointed in a safe direction. Unlike firearms, however, straight up is not a safe direction. An arrow shot straight up poses an extreme danger, while a bullet shot straight up poses very little threat. The arrow is much more dangerous than a high powered rifle in that situation.

Archery equipment is designed to penetrate with a heavy, relatively slow projectile that has a large amount of momentum. Even target bows have enough momentum to drive an arrow through a human being. Arrows produce very little shock (hydrostatic shock) on impact, but they penetrate much more effectively than rifle bullets. That fact can easily be demonstrated by shooting both types of projectiles into a container of sand or a hay bale. Unlike firearms, archery equipment has multiple points of potential danger to the user or persons standing nearby. The point of the arrow, the arrow's nock, the tips of the limbs, the nocking point indicator and the string and/or cables of the bow all are capable of producing an injury. Faulty, inadequate or mismatched equipment can also pose a threat to safety.

Bows and arrows can be dangerous penetrating weapons, or safe, exciting and entertaining recreational arms. The difference lies in the mind and the control of the user. While the arrow remains on the string and the string is in your fingers, the arrow is under your mind's control. When the string is released your control comes to a stop and the laws of physics take over.

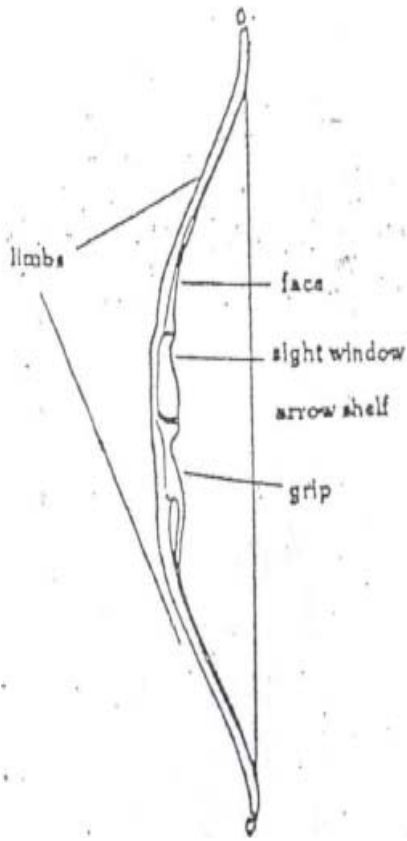
Archery equipment must be treated with respect and care. All the principles for safely handling firearms apply to archery equipment as well. The user alone is responsible for safe, responsible and appropriate use. If any doubt exists about the absolute safety of a shot, do not release the string. The safety of archery is in your hands. So it is essential that simple principles of safe shooting be accepted and enforced. Many of the principles of safe shooting can be summarized in these simple statements.

1. Always be absolutely sure that the path to the target and beyond is clear.
2. Never point a drawn arrow at anything you do not intend to shoot.
3. Always be absolutely certain that the target is clearly visible, safe to shoot and appropriate.
4. Always be aware of the danger areas at the ends of the arrow and the tips of the limbs.
5. Place an arrow on the string only when you are ready to take a shot.
6. Always treat your archery tackle with the respect it is due. Never fool around with it.
7. Never use archery equipment while your mental ability is impaired by fatigue, distractions or the influence of any drug.
8. Always exercise caution when retrieving arrows or removing them from a target.
9. Always be sure that all archery tackle is in perfect working condition and free from damage before it is used.
10. Always abide by the strictest codes of behavior and ethics applied to the archery sport in which you are participating, including specific range rules.

Perhaps you can think of others that might be added.

# An Orientation to Archery Tackle

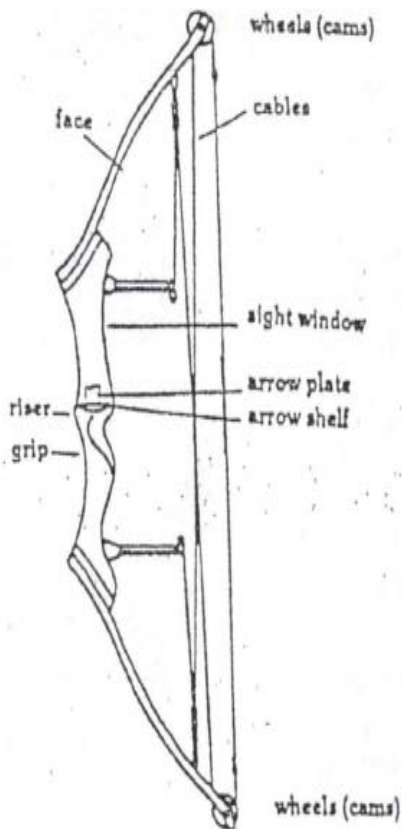
## Bows



A bow consists of a handle or grip, a center section (riser) and a pair of limbs. The grip or handle is usually shaped to permit the bow hand to seat well. Just above it is a cutout area known as a sight window. The sight window is on the left hand side of the bow for right-handed shooters and on the right side for lefties. The arrow shelf is at the bottom of the sight window. It normally is not used to support arrows in modern bows. Instead, an **arrow rest** is positioned just above the shelf. The portion of the rest that lies along the side of the sight window is called an **arrow plate**. Sometimes it is adjustable. Often shooters install a spring-loaded plunger or button to aid in tuning the bow. The entire riser section may be constructed of the same materials as the limbs, or it may be a separate piece of wood or metal. The limbs are usually solid fiberglass, graphite, or laminated glass and hardwood. Conventional bows (recurve bows and longbows) have nocks at the end of each limb to hold the string in place. Compound bows have **wheels** or **cams** at the tips of the limbs. They also have cables and some other items not found on the conventional bows. The part of the bow that faces the shooter is called the face or belly of the bow. The part that faces the target is called the back.

## Bow Strings

Almost all modern bow strings are made from a continuous strand of Dacron or some other string material looped several times. Thus, when one strand of string is broken, the entire string is broken. Most strings have loops on both ends to fit the string nocks or other means of attachment to the bow. Those loops are protected by windings of heavy thread known as **servings**. A middle serving, often of monofilament, protects the string from wear where the arrow and the fingers touch it during shooting. The middle serving should have one or more nocking point indicators (metal, plastic or thread) to locate the arrow in the same place on the string for each shot.





## Arrows

The projectiles or **arrows** are tubes or bolts of wood, fiberglass, graphite or aluminum. The stiffness or **spine**, of these shafts is matched to the **draw weight** (strength) of the bow. The end of the arrow that is placed on the string has a **nock**, usually a plastic device with a notch that holds the string. The other end has some type of point, depending on the type of shooting being done. **Target points** are usually conical or bullet shaped. **Field points** usually feature a point with an elongated and somewhat thinner tip than the main body of the point. **Broadheads** usually have two or more cutting edges attached to a central ferrule. Several other types of points are also available, but they used by more advanced archers.

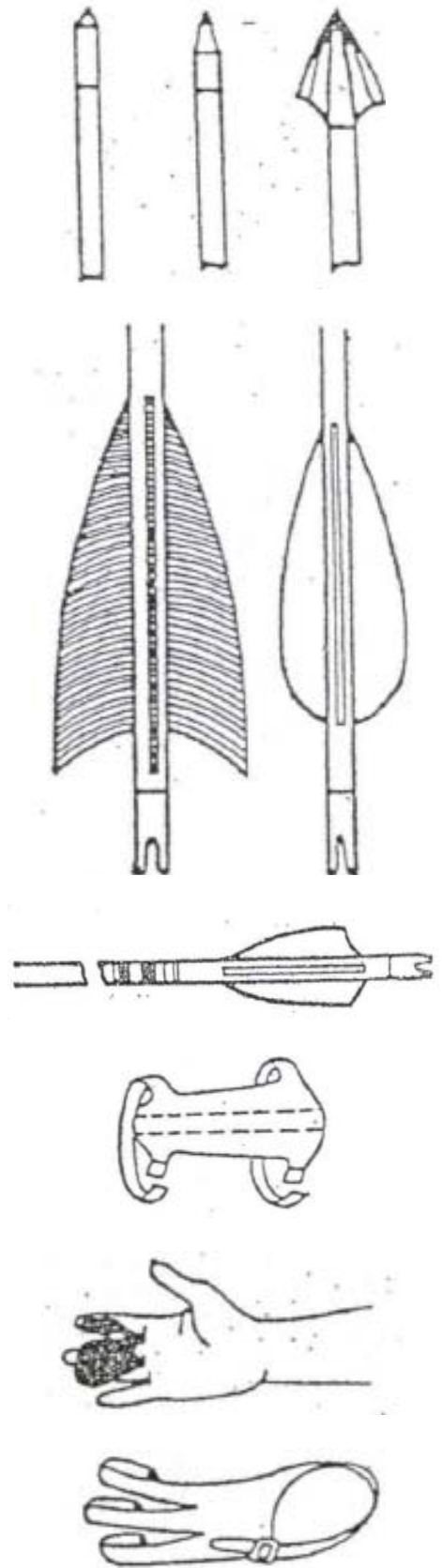
Near the nock, the arrow is equipped with some type of **fletching**. Usually the fletching consists of three shaped feathers or plastic vanes, but some arrows use four or even six vanes or feathers. The fletching may be straight, slightly angled or helical, depending upon the intended use. Its purpose is to help stabilize the arrow in flight. Hunting arrows usually have at least three large vanes or feathers. The fletching on target arrows may be much smaller. **Flu-flu** arrows have massive amounts of fletching to limit the flight distance of the arrow.

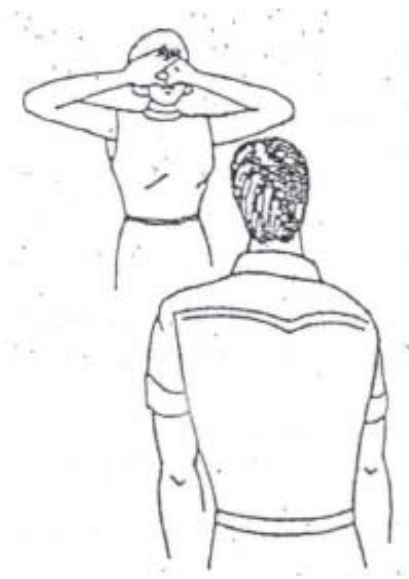
Just beyond the fletching, the shaft may be marked with a pattern of painted stripes, called **cresting** or a signature. The cresting is used either to decorate or to identify the ownership of the shafts. Many target archers, and a few bowhunters, mark each arrow individually so they can watch for differences in performance between them.

### Other Accessories

The beginning archer needs a few other items to be fully equipped. An **arm guard** is needed for the bow arm. It should be worn on the inside of the arm between the wrist and the elbow. Arm guards come in a wide variety of types, but all of them help to reduce the pain of string slap (usually an indicator of poor shooting form) and to keep the clothing out of the string's path. Several types of gear are used on the string hand. Archers use **finger tabs**, **shooting gloves** or **mechanical releases** to hold the string. All have merits and drawbacks. For learning purposes, a finger tab is recommended. The tab is worn on the inside of the index, middle and ring fingers of the dominant or string hand. Most tabs are have a split that lines up between the index finger and the middle finger to permit split finger shooting. A single finger attachment is used on the middle finger of the shooting hand most times.

Many types of **quivers** are available. For the first few trips to the shooting line, your "coach" will be the quiver, handing you the arrows one at a time. Later we will switch to using ground quivers. As you progress, you will want to get a quiver (or quivers) that match your shooting needs.





## Eye Dominance

Before you learn to shoot, you need to determine your eye-dominance. *Fact Sheet 3: Determining Eye Dominance* provides more information about it and ways to test it. Pick a partner to help test for eye dominance. Stand facing your partner about 2 meters (6 feet) apart. Place your thumb over the other and cross your fingers over the fingers of the other hand, leaving a small triangle. Raise both hands together, keeping both eyes open and the head straight toward your partner. Look at your partner's nose through the opening. The partner should note which eye can be seen through the opening. Now, keeping the nose in the opening, bring your hands slowly back to your face. Your partner should watch for and "cheating" where the hands seem to wander from eye to eye. The eye that your hands return to is your dominant eye. Now switch roles and try it again. Do not be concerned if your handedness and eyedness are different. A significant minority of the people in the world are cross dominant.

Your best shooting will occur when the dominant eye is on the same side as the drawing or string hand, and the "off" eye is on the same side as the bow hand. All directions will be given using those terms. The handedness of the bow is determined by holding it as you would when shooting. The sight window is on the opposite side of the bow from its handedness. That is, a right-handed bow (for a right-eyed shooter) will have the sight window cut into the left side of the bow and be held in the left hand. Once you have selected a bow that is appropriate to your eyedness, discuss its parts with your partner. If you need help, ask a parent or junior leader for assistance or advice.

## Stringing and Unstringing Bows Safely

There are many ways to string or unstring bows. Most compound bows are simply left strung all the time, but recurve bows are usually unstrung between uses. Two methods that *should not* be used are the **push-pull** method and the **step-through** method. The push-pull technique is fairly gentle to the bow but has too many dangers for your eyes. We do not recommend it, even when it is done properly. The step-through method is less dangerous to the archer, but potentially damaging to the bow. We do not recommend it either.

Use some type of bow stringer. They are inexpensive to buy or make, and they save both eyes and bows. Try stringing and unstringing the bow you have selected several times while being observed by your partner. Do NOT draw and release the bow without an arrow on the string! Dry firing a bow is dangerous both to the bow and to the shooter.

# Range Procedures

Like other forms of shooting, archery operates under controlled conditions to ensure the safety of all participants. Everyone, not just the Range officer or line captain, is responsible for safety. Any unsafe condition must be brought to the attention of the person in charge IMMEDIATELY. All range commands, whether verbal, visual or whistle must be obeyed immediately. Small groups may be controlled with simple voice commands, but larger groups or tournaments are better addressed with whistle, horn or light commands. For our purposes, keeping the commands as close to those used in other shooting sports is best to avoid confusion.

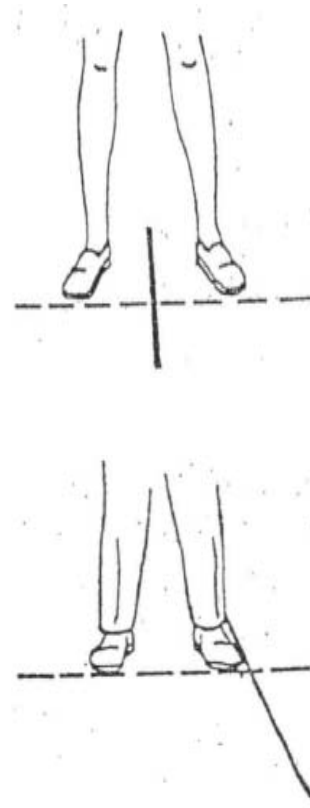
Verbal Command	Whistle Command	Action
Shooters to the line.	One blast	Shooters come to the shooting line and straddle it
Make ready.		Shooters prepare to shoot
Is the line ready?		"Ready" or "not ready"
Commence firing.	One blast	Shooters begin firing
Round is complete	Two blasts	Shooting is complete
Prepare to score arrows	Two blasts	Move forward to score arrows
Cease fire!	Multiple blasts	Immediately STOP shooting – unsafe condition
Retrieve your arrows	Two blasts	Follow line captain to the butts, wait for scoring or pull arrows *

NOTE: The line captain ensures that all shooters have returned to the ready area before returning from the butts.

\*In tournament shooting the archer must remain at least arm's length away from his or her arrows until they have been told to pull them by the scorer.

Several modifications apply in field shooting. Rather than straddling the line like in target archery, the shooter toes the shooting line or stake. In addition, when retrieving an overshot arrow, the archer should place their bow directly across the face of the target to let following archers know that someone is down range and possibly in the line of fire. Some archers use an arrow stuck upright in the target butt as an indicator, but the bow is a surer sign.

In both types of shooting, archers should be far enough apart to ensure they do not interfere with one another. We will be spacing ourselves about 2 meters (6 feet) apart since our first shots will be made using the bow as a shelf for the arrow while nocking it. Later, as you become more skilled at handling your equipment, we can reduce the spacing between shooters to about half that distance. At that point, the arrows will be placed on the string while the bow is held more or less vertically. Arrows are never nocked until the command to shoot is given, and bows are never drawn except during live firing or on command.



## Conclusion and Summary

That concludes the lesson on archery equipment and safety. Are there any questions?

## Developing Proper Archery Shooting Form

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### Objectives

Participating youth and adults will:

Demonstrate and practice the fundamentals of proper archery shooting form.

Understand and apply the "10 steps to the 10 ring" when shooting.

Successfully shoot groups using instinctive shooting methods.

Establish mental and physical skills leading to consistently good shooting form.

Demonstrate proper form through "coaching" other shooters.

Have fun while learning.

### Roles for Teen and Junior Leaders

Demonstrate proper shooting form.

Demonstrate form faults for correction by participants.

Serve as on-line assistants.

Serve as line captains or range officers.

Provide positive reinforcement of proper form for students with form faults

Assist with locating overshot and undershot arrows.

### Parental Involvement

See Roles for Teen and Junior Leaders above.

Provide or coordinate transportation to the range.

Serve as coaches for one or two "coach-pupil" pairs on the shooting line.

Provide or coordinate refreshments.

Assist with developing exhibits or coordinating summary activities.

### Best Time to Teach

Any time of year

### Best Location

Range space (indoor or outdoor) is required.

### Time Required

Approximately 1 hour

### Materials/Equipment

- light recurve bows (15 to 30 percent Left-handed)
- matching arrows (26 to 31 inch lengths)
- finger tabs
- arm guards
- large target butts
- small stick-on dots (aiming points)
- ground quivers (*see Fact Sheet 7: Ground Quivers*).
- posters showing shooting steps
- shooting line, tape or materials to make one.
- whistle (if group size warrants)

### References

*National Archery Association Instructor's Manual*, third edition. P. Baier, J.

Bowers, C.R. Fowkes and S. Schoch.

National Archery Association of the U.S. Colorado Springs, CO. 1982.

*Archery: Steps to Success*, K.M.

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*Archery: A Planning Guide for Group and Individual Instruction*, J.W. Smith,

ed. American Alliance for Health, Physical Education, Recreation and

Dance, Reston, VA. 1972.

\* 4-H and Youth Development Specialist, Texas Agricultural Extension Service.

# Lesson Narrative

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## Introduction

Successful archery shooting is easy, but people tend to make it hard. Intense concentration and good muscular development are essential. The ability to remain relaxed is also very important. To most people the combination of intense concentration and relaxation seems impossible. Like the archer's paradox where the arrow must bend in order to fly straight, both concentration and relaxation are necessary for top performance.

Like other types of shooting with single projectiles, archery requires that the shooter be relaxed and comfortable. Since concentration on the sight or the target is critical to success, the tasks required to fire a shot must be practiced until they can be done without conscious effort. Once they become routine, the mind is free to focus on hitting the mark. This process involves the archer developing consistent form from shot to shot. As the consistency in form improves, consistency in shot placement improves. By focusing on the elements of good form we will make consistently good shooting easier to develop. Some steps will feel strange or even uncomfortable at first. However, they have been proven successful over many years by archers from all over the world.

No matter what kind of archery you select, the basics of proper shooting form are the same. By developing sound, consistent form early in your shooting development, you can reach higher levels of achievement in the chosen sport.

## Archery Basics

Only a few steps are required to shoot an arrow successfully. You must take a proper stance, grip the bow properly, nock an arrow, grip the string properly, raise the bow arm to shooting position, draw, anchor, aim, release and follow through. That seems simple enough, but the mind cannot cope with that many things all at once. These steps must become established, well-practiced habits. Once you have a fixed shooting routine and good shooting form, the mind can be set free to concentrate on the target or the sight pin for more precise shooting.

## Stance

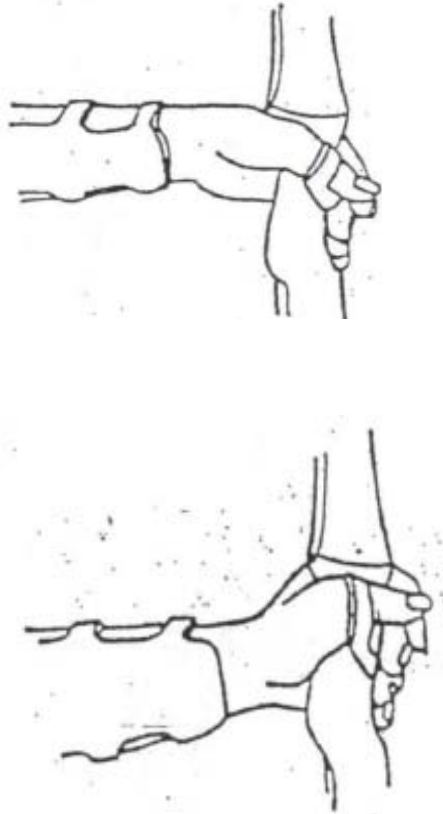
A good shooting stance involves a relaxed, erect posture. The feet should be straddling the shooting line, shoulder-width apart. A line drawn across the tips of the toes should point to the center of the target. Some people find that moving the bow-hand foot back a few centimeters (up to about 6 inches) is more comfortable, but that may cause some problems in keeping the rest of the body in line. It forces muscles to work, increasing the potential for fatigue and inconsistency. Lines drawn through the hips and through the shoulders should also point to the center of the target. The head should be erect, relaxed and rotated toward the bow-hand side.

Pick a point as a target, establish an imaginary shooting line and try getting into this stance with your partner's assistance. Once you are

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comfortable, switch roles, repeating the exercise until both of you feel comfortable.

## Bow-hand Grip



Two types of grips are used by the majority of archers. Both of them are relaxed, allowing the bow to move freely on the release. For those of you who are afraid of dropping the bow, either use a sling or lightly touch the tip of the thumb to the tip of your index finger. The grips share several common elements. Both are begun as if extending the hand in a handshake. The hand is held vertically, and the bow fits into the U-shaped opening between the thumb and the fingers. The wrist remains in direct alignment with the forearm. The elbow is rotated out, so that the forearm can move readily toward the center of the chest when the elbow is flexed. A high-wrist grip allows the bow's handle to seat only in the web between the thumb and the forefinger. In this grip the wrist remains straight, aligned with the forearm both horizontally and vertically. The low-wrist grip allows the muscles controlling the hand to relax. This causes the hand to rise above the forearm and the bow handle to seat against the palm of the hand. This grip is similar to having a completely bedded rifle barrel. Like that situation, perfect and consistent bedding of the bow's grip gives very consistent shooting performance. Slight changes from shot to shot, however, produce changes in the point of impact. On the other hand, the high-wrist grip is similar to using a free-floated rifle barrel. The only point of contact is well established, and the bow does its own seating in the hand. Most target archers use a low wrist because they get better performance with it. Many hunting archers use a high wrist because it is less sensitive to slight differences in hand position or pressure. Try both of them with your partner, drawing the bow only one inch.

## Nocking an Arrow

You will learn two ways to nock an arrow. The first is only for learning ease. The second is for accepted target shooting etiquette. We will practice both styles without placing the arrow on the string. Be sure you are standing at least 2 to 3 meters (6 to 10 feet) away from other groups and that the arrows are never pointed toward another person. Rotate the upper limb of the bow toward the string hand so that the sight window is up. Using the sight window as a shelf, slide an arrow forward. Rotate the arrow until the index vane (cock feather) is up (facing away from the sight window). Draw the arrow back to the string. Although we will not actually nock the arrow now, the nock is positioned below the single nocking point indicator (toward the lower limb tip) on the middle serving. Some shooters prefer to use two nocking points, placing the arrows on the string between them. Try this several times with each partner.

**The tip of the arrow should be pointed down range during the entire nocking process.**

Next, hold the bow almost vertical, canted slightly toward the string hand. Rotate the string slightly (just enough to allow hand to clear it) toward the string hand side. Grasp an arrow near the

fletching and reach forward, placing it on the arrow rest. With the arrow on the rest, draw the nock back to the string. Again, be sure the index vane or cock feather is positioned away from the sight window.

## Setting a Hook

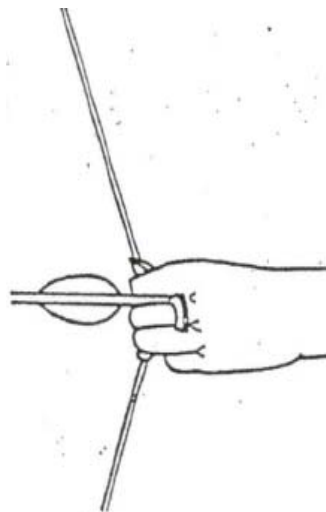
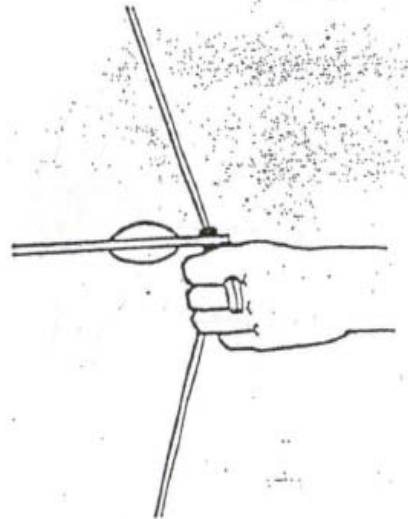
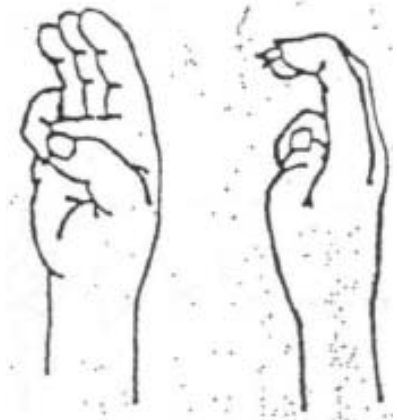
The string hand uses hooked fingertips to draw the string and the arrow into position for a shot. The back of the hand should remain flat throughout the drawing and shooting sequence. An easy way to ensure that is to use a three-fingered salute. Hold the hand upright, palm forward. Bring the little finger of the drawing hand toward the center of the palm and hold in place with the tip of the thumb. That keeps the hand flat. Next, bend the remaining three fingers into a hook. This approach is used with either a tab or a shooting glove.

The fingers may be placed on the string several ways. The most commonly used approach is to place the index finger above the arrow and the nocking point indicator and the remaining two fingers below it (split-fingered or Turkish draw). Another common approach is to place all three fingers under the nick (Apache draw). It is very effective for short range shooting, but carries some risk because the nick is placed very close to the dominant eye. In either case, the fingers are placed on the string at about the last joint of the fingers. A slightly deeper grip, almost to the second joint, is quite acceptable when using a tab. Tabs give more consistent results than gloves with most shooters.

The problem known as "finger pinch," where the arrow lifts away from the rest, is commonly caused by curling the hand during the draw. It can be cured by taking a slightly deeper grip on the string (almost to the second joint) and/or by folding the little finger and the thumb into the palm of the drawing.

## Extension to Shooting Position

Once the stance and hand positions are established with a nocked arrow, the entire unit is brought into shooting position at the same time. Start with the bow arm extended about 15 degrees from the body and on a line toward the target. The forearm of the string hand should be aligned with the shaft of the arrow, and the finger hook should be set on the string. Moving the arms from the shoulders, bring both arms up to shooting position. The bow arm should be fully extended and pointing at the target. The forearm of the sting hand should be in line with the shaft of the arrow, and the arm should be extended forward. Many instinctive archers will extended and draw in the same motion, coming to their anchor point as the bow arm settles at full extension. Use two steps here to avoid developing form faults.









## Draw

Pull the string back toward the anchor point. At beginning of draw, the upper arm muscles flex the elbow. Then the elbow is drawn back using muscles of the shoulder and back. The draw should be a smooth motion, keeping the forearm in line with the arrow shaft.

## Anchor

We will use a high-anchor point in this session. Most archers anchor the tip of the index finger against the corner of the mouth of the canine (eye) tooth on the dominant side. Often a secondary anchor point is used. The thumb may be placed along the angle of the jaw or behind the ear, or it may be nestled against the back of the jaw bone. Since the anchor point establishes the location of the "rear sight" even for instinctive shooters, it is essential that the anchor point be consistent. Later we will establish another type of high anchor and a low anchor for use with sights.

## Aiming

In instinctive archery, aiming is simply an intense concentration on the target. Pick a tiny spot and concentrate all your attention on it. As in rifle shooting, releasing before you are satisfied with the hold or waiting too long during the aiming phase will lead to large groups and inaccurate shooting. Experienced instinctive archers pause briefly, perhaps a second or two, to be sure of their hold before releasing the string. Although this is not a true sight picture, the archer does form a mental image of the proper relationship between the bow and the target. Throughout the aiming sequence, the string hand should remain firmly locked to the anchor point. Try coming to an anchor point without equipment right now.

## Release

A proper release is achieved by simply relaxing the fingers of the drawing hand while pulling the string-hand elbow back slightly. To feel a live release, hook the fingers of one hand into the hooked fingers of the other hand. Holding the hands across the center of your chest, putt with both hands. Note that this requires you to use your back muscles, just as in drawing a bow. Relax the fingers of the drawing hand. The elbows rotate back quickly for a few centimeters (inches). This is exactly what should happen in a live release. The fingers of the shooting hand should flow along the side of the face. The bow should rock forward at the same time. Your partner will be watching for a live release by observing the position of your hands during the follow through.



## Follow Through

A proper follow through is essential to consistent, accurate shooting with all types of equipment. Archers must pay particular attention to follow through. The bow arm and string arm should maintain their positions until the arrow is in the target. Fatigue is the prime factor in improper follow through.

## Shooting the First Arrow

For now, the emphasis should be is on shooting consistent groups using proper shooting form. We are not using a target face because scores are not important at this stage. In fact, they may distract from our real purpose. Let's have the first flight of shooters and their coaches to the line. Space yourselves about 2 to 3 meters (8 to 10 feet) apart, with the coaches holding the arrows and standing on the string-hand side of the shooter. Shooters should be wearing their arm guards and finger tabs and should be straddling the shooting line. We are going to shoot the first arrow "by the numbers."

1. *Coaches, is the flight ready?*
2. *The flight is ready*
3. *Take your stance.*
4. *Nock an arrow*
5. *Set your hook on the string.*
6. *Raise the unit to shooting position.*
7. *Draw to your anchor point.*
8. *Focus on the aiming dot.*
9. *When ready, release and follow through.*
10. *You may shoot the other two arrows when you are ready.*
11. *When you have finished, place your bow on the ground quiver (or "ground" it) and take one step back off the line.*

Repeat this process with reversed roles before retrieving the arrows.

Only one member of each group should retrieve arrows. Follow the range officer to the butts. Be careful not to step on or hurt yourself on undershot arrows. Do not go behind target for overshot arrows until those in the targets are pulled, then we will all search together.

Remember to pull all arrows straight back to avoid bending them. To remove an arrow from the matt, place one hand on the matt with the thumb and the rest of the hand supporting it. Grasp the arrow near the matt and pull straight back while twisting the shaft slightly. After all the arrows have been retrieved, return to the shooting line.

## Shooting Groups

Now that all of us have had a chance to shoot "by the numbers," let's see if we can shoot some tight groups. Remember to concentrate on the same point throughout the series. We are not concerned with where the group is, but rather with its size. Consistent form produces smaller groups. Coaches, watch for the elements of form we have been practicing. Keep your comments positive. Reinforce what to do, not what might have been done wrong. We will shoot about three ends of three arrow each before we take a short break.

## Moving Groups to the Aiming Point

We can move the group to the center of the target once you are able to produce groups. Simply shoot a group, then place another aiming dot on the opposite side of the original one and the same distance out. That is, if the center of your group is a 7 o'clock to the dot and about 10 inches out, place a new dot at 1 o'clock and about 10 inches out. Focus your attention on the new aiming point and see where the group hits. Use trial and error to move the hits to the center of the original target.

## Summary Activities

1. Once shooters are successfully shooting groups and hitting about where they are looking, attach balloons to target butts with short pieces of string. Let the shooters try breaking them. To add challenge, each coach-pupil pair could shoot as a team, keeping track of the number of balloons broken and the number of arrows shot.
2. Try moving the firing line and allowing the shooters to compensate for the change in flight path taken by the arrows. In this case, be very careful not to get beyond the average ability of weaker shooters. You want to keep all the arrow on the target.
3. Divide the participants into smaller groups. Have each group discuss elements of good shooting form, things they learned about archery today and elements of form they want to improve.

## Exhibit and Sharing Ideas

1. Develop a set of posters or diagrams showing the steps of good archery shooting. Display them or use them to give a demonstration on archery technique to another group or club.
2. Make a ground quiver with a bow support for range use.
3. Shoot several groups using different anchor points to illustrate what happens to group size and placement. Label each group, and be prepared to discuss the reasons for the placement and size.
4. Illustrate how to move a group of arrows to a new point of impact.
5. Start a shooting journal to help improve your shooting. If you already one, list some of the things you learned today.

## Archery Form Analysis

Name:	Evaluator			
<b>Stand</b>		Good	Fair	Poor
Feet Straddle Line				
Toes Form Straight Line to Target				
Side Toward Target				
Good Posture				
<b>Nock</b>		Good	Fair	Poor
Index Feather Away from Bow				
Nock on Nocking Point				
<b>Extend</b>		Good	Fair	Poor
Bow Between Thumb and Base of Index Finger				
Bow Hand Relaxed				
Bow Elbow Straight and Rotated Downward				
Bow Shoulder Down				
<b>Draw</b>		Good	Fair	Poor
String in Crease of Distal Joint of All Three Fingers				
Drawing Arm Elbow at Shoulder Level				
Drawing Hand and Wrist Straight and Do Not Change				
Thumb and Little Finger Relaxed to Center of Hand				
Body Straight				
<b>Anchor</b>		Good	Fair	Poor
Index Finger Touching Under Jaw				
String Touching Nose and Chin				
Teeth Together				
Shoulders Down				
<b>Tighten / Hold</b>		Good	Fair	Poor
Drawing Hand Straight				
Bow Hand Relaxed				
Bow Vertical				
Back Muscles Tightened				
<b>Aim</b>		Good	Fair	Poor
Breathing has stopped				
Everything still for at least two seconds				
<b>Tighten/Release</b>		Good	Fair	Poor
Arrow stays stationary or moves back a little				
Drawing elbow stays at shoulder height				
Drawing hand moves along neck				
Bow arm stays in position				
<b>Afterhold</b>		Good	Fair	Poor
Stays in position until arrow hits target				
Head does not move				
<b>Equipment</b>		Good	Fair	Poor
Nocking point 1/8" above perpendicular				
Nocking point fits arrow nock properly				
Kisser button properly positioned and tight on string				
Sight settings marked for 20 and 30 meters				

Comments:

Date:

## Instinctive Shooting with a High Anchor

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### Objectives

Participating youth and adults will:  
 Demonstrate ability to shoot effectively using instinctive shooting techniques and proper form.  
 Practice the elements of safe, responsible and accurate archery shooting in a coach-pupil context.  
 Demonstrate ability to shoot groups and move them to the desired point of impact without the aid of sights.  
 Have fun while learning.

### Roles for Teen and Junior Leaders

Serve as line captain, scorer or assistants.  
 Demonstrate shooting technique and ways of corrective the point of impact.  
 Observe coach-pupil teams to reinforce elements of proper shooting form.  
 Assist shooters having particular difficulty.  
 Prepare balloons or other materials for the fun shoot.  
 Conduct, score or officiate at the fun shoot.

### Parental Involvement

See Roles for Teen and Junior Leaders above.  
 Arrange or provide transportation to the range.  
 Arrange for or provide refreshments.  
 Give personal examples of shooting experiences.  
 Participate in the fun shoot, giving both coach and pupil a chance to teach an adult.

### Best Time to Teach

Any time of year

### Best Location

Any safe shooting range, indoor or outdoor

### Time Required

Approximately 1 hours (lesson may need to be repeated several times)

### Materials/Equipment

- light recurve bows (15 to 30 percent left handed)
- target arrows matched to the bows in 26- to 31-inch lengths
- arm guards
- finger tabs
- target butts
- target pins
- large targets
- shooting line or materials for one
- whistle
- pads and pencils for scoring
- materials needed for fun shooting

### References

*National Archery Association Instructor's Manual*, third edition. P. Baier, J. Bowers, C.R. Fowkes and S. Schoch. National Archery Association of the U.S. Colorado Springs, CO. 1982.

*Archery: Steps to Success*, K.M. Haywood and C.F. Lewis. Leisure Press, Champaign, IL 1989.

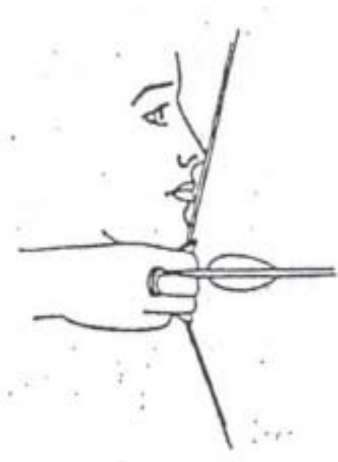
*Teaching Archery: Steps to Success*, K.M. Haywood and C.F. Lewis. Leisure Press, Champaign, IL 1989.

*Archery: A Planning Guide for Group and Individual Instruction*, J.W. Smith, ed. American Alliance for Health, Physical Education, Recreation and Dance, Reston, VA. 1972.

\* 4-H and Youth Development Specialist, Texas Agricultural Extension Service.

## Lesson Narrative

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We learned the fundamentals of good shooting form last session. This time we will apply those fundamentals to instinctive shooting. Instinctive archery shooting is similar to throwing a ball. The ball is not aimed; it is merely thrown while concentrating on a target. Sometimes it is thrown with amazing accuracy and speed. The instinctive archer uses a similar style. Intense concentration on the exact spot he or she intends to hit, along with experience, results in hitting the mark without obvious aiming.

The hands and eyes work together during the concentration phase of the shooting sequence to point or aim the arrow at its target. This is similar to a shotgun shooter pointing at the intended target without obvious sight awareness. Unlike the shotgunner, however, the archer cannot be satisfied with simply "being close." The single projectile needs to strike precisely where it is intended for a good hit to be made. Practice is the key to success with instinctive shooting, and learners should be shooting fairly well after a short period of time.

Let's review the elements of good shooting form from last lesson. The archer needs to take a comfortable and relaxed stance. Feet should be about shoulder-width apart with a line through the tips of the toes pointing to the target. Both the hips and the shoulders should be in line with the target as well. The head should be erect and turned toward the bow-arm shoulder.

The bow hand holds the bow very lightly, with a handshake-like grip. The elbow of the bow-arm is rotated outward. The string hand is flat and the fingers are hooked at the first and second joints. The nocked arrow is situated with its index vane or cock feather facing away from the sight window. The nock is located between the index finger and the ring finger on the drawing hand.

Both arms are rotated into shooting position from the shoulders. The drawing hand is pulled back by flexing the elbow, then drawing it back with the shoulder and back muscles until the fingers are firmly locked to the anchor point.

After a brief pause at full draw to check alignment, the string is released by relaxing the fingers while pulling that elbow back. The fingers flow along the side of the face and the bow rocks forward slightly. The shooting position is held until the arrow is in the target.

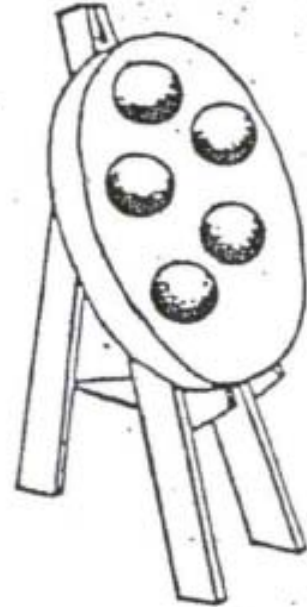
Consistent form produces consistent groups, and groups can be moved by changing the point of concentration on the target face. Let's limber up by shooting a few groups on a target that has only an aiming dot on it.

\*\*\*\*\*Conduct active shooting session now.\*\*\*\*\*

Let's put up a target face and see if we can shoot some reasonable scores at this distance.

\*\*\*\*\*Conduct active shooting session now.\*\*\*\*\*

How many of you had groups that increased in size when we went to the larger target face? Why do you think that happened? One of the reasons is that we have a larger aiming point now than when only the small dot was used. Another is that you tried to move your point of impact during the shooting session, sometimes before you had established a group for reference. Remember to concentrate on only a small spot and to keep that spot consistent through each end. Once a group placement has been established, you can move your group to the gold rather easily.



Remember that practice alone does not make perfect. Perfect practice makes perfect. Every archer needs to concentrate on consistent and proper form until those elements become fixed. Even then, they should be reviewed frequently. Those principles of good marksmanship apply to all sorts of shooting: target, hunting or just for fun. Go ahead and shoot one more end. Coaches, let's record the scores on this one.

\*\*\*\*\*Conduct active shooting session now.\*\*\*\*\*

Now let's shoot a couple more ends to see if we can improve on that score. We are looking for personal improvement, not the highest gross scores.

\*\*\*\*\*Conduct active shooting session and analysis now.\*\*\*\*\*

Now let's lighten up a little and try shooting just for fun. The object of this first game is to see who can break the most balloons. We will start back here and work our way forward after every rotation. Each shooter gets one arrow at each station.

\*\*\*\*\*Play game.\*\*\*\*\*

Let's try a little wing shooting. These special arrows are called flu-flus. They are designed to limit the flight distance of the arrow, and they are sometimes used in shooting small game or game birds. We will be shooting this disc target, called a bow bird. Shooters will stand on the shooting line. I will call the toss. Try to hit the target at the peak of its climb (it is almost still for a split second at the point). Be sure to take only shots that are completely safe. Non-shooting participants should be alert for any dangerous situations and call out "Cease Fire!" or "No!" if they see any potential for a dangerous shot. (This target can also be rolled to simulate a rabbit. Balloons released on the ground in a light breeze do the same thing.)

\*\*\*\*\*Play game.\*\*\*\*\*

We have been pretty good at hitting a small target. How would you like to try one that is about 50 feet in diameter? There is one small catch. The target is a long way away and it is flat on the ground. The object is to see how close to the stake with the flag on it you can shoot an arrow. This is called clout shooting, and we will look more closely at it when we try different archery games.

We have had a lot of fun today, and you have come a long way in your shooting. Remember the steps in good archery shooting. Continue to practice good form each time you shoot. Remember that perfect practice makes perfect and that consistent form brings consistent results. Next time we will try a different anchor point and a different shooting style, using pin sights to help in aiming.

## **Summary Activities**

1. Have small groups repeat the steps of good archery shooting form, reinforcing the steps to the 10 ring with each other.
2. Conduct a shoot, using one or more of the games listed above. Let participants shoot within their known accuracy range, and be sure that all of them have a reasonable chance for success. Try multiple events if time permits.
3. Discuss form with the group, letting each one discuss parts of the action they find difficult. Also discuss what steps they might take to correct and practice that form.

## **Exhibit and Sharing Ideas**

1. List some of the things you learned today in your shooting journal.
2. Record your scores at various distances and in all the events you tried today. Enter them in your shooting journal with the date, location and any comments you might want to add.
3. Tell someone who is not in the 4-H Shooting Sports Program about your experiences with instinctive archery shooting. Record their reactions and your own feelings about the sharing time in your shooting journal.



## Shooting with Sights

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### Objectives

Participating youth and adults will:

Demonstrate ability to shoot effectively using simple pin sights and proper shooting form.  
Practice the elements of safe, responsible and accurate archery shooting in a coach-pupil context.  
Demonstrate ability to shoot groups and adjust the sights to move the point of impact to the desired location.  
Have fun while learning.

### Roles for Teen and Junior Leaders

Serve as line captain, scorer or assistants.  
Demonstrate techniques.  
Observe coach-pupil teams to reinforce elements of proper shooting form.  
Assist shooters having particular difficulty.  
Prepare balloons for the fun shoot.  
Score or officiate at the fun shoot.

### Parental Involvement

See Roles for Teen and Junior Leaders above.  
Arrange or provide transportation to the range.  
Assist with locating overshot arrows.  
Arrange or provide refreshments.  
Share personal shooting experiences.  
Participate in the fun shoot, giving both coach and pupil a change to teach an adult.

### Best Time to Teach

Any time of year, but after instinctive shooting has been learned

### Best Location

Any safe shooting range, indoor or outdoor

### Time Required

Approximately 1 hour (may be repeated several times)

### Materials/Equipment

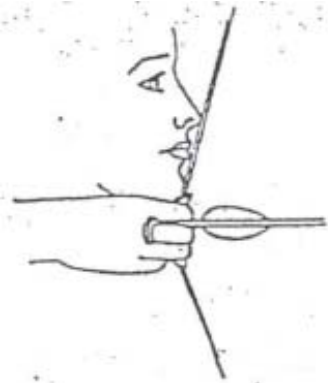
- light recurve bows (15 to 30 percent left handed)
- Target arrows matches to the bows in 26- to 31-inch lengths.
- arm guards and finger tabs
- roll of masking, electrician or duct tape.
- Long dressmaker's pins with enamel or plastic heads.
- felt-tipped pen for marking sight settings
- target butts
- target pins
- large targets
- shooting line or materials for one
- whistle
- pads and pencils for scoring
- materials needed for fun shooting

### References

*National Archery Association Instructor's Manual*, third edition. P. Baier, J. Bowers, C.R. Fowkes and S. Schoch. National Archery Association of the U.S. Colorado Springs, CO. 1982.  
*Archery: Steps to Success*, K.M. Haywood and C.F. Lewis. Leisure Press, Champaign, IL 1989.  
*Teaching Archery: Steps to Success*, K.M. Haywood and C.F. Lewis. Leisure Press, Champaign, IL 1989.  
*Archery: A Planning Guide for Group and Individual Instruction*, J.W. Smith, ed. American Alliance for Health, Physical Education, Recreation and Dance, Reston, VA. 1972.

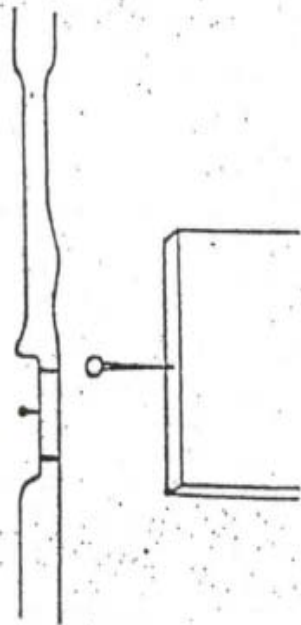
\* 4-H and Youth Development Specialist, Texas Agricultural Extension Service.

## Fundamentals of Sight Shooting



The fundamentals of shooting with sights are the same as for any other type of archery. Although they are the same, most archers change anchor points when shifting from instinctive to sight shooting. Usually the new anchor point is below the chin. This raises the rear sight (the eye), giving the shooter more room in the sight window to adjust the front sight. Hunting archers sometimes keep the high anchor because it is familiar and they shoot at short distances. Target archers competing in NAA or FITA events usually cannot set their sights for longer distances without using the low-anchor point.

The under-the-chin anchor has additional advantages. It usually requires a slightly shorter and lighter arrow than the high anchor, producing a potential advantage in arrow speed. In addition, the low anchor provides three ready checkpoints for consistent shooting. The string should touch the center of chin (that is why many chins are slightly cleft - to accept a properly drawn bowstring), the center of the lips and the tip of the nose. The string is drawn to the center of the chin with the head raised very slightly. Then the chin is lowered until the string meets the other two anchor checkpoints. As with instinctive shooting, the ideal position for the drawing arm places the forearm in direct line with the shaft. On release, fingers of the drawing hand should flow backward along shooter's throat and side of the neck. Other form elements are like those in previous sessions. Be sure you check each other on following the basics.



### Making a Simple Sight

Elaborate and expensive sights can be used, but a good teaching sight can be made from masking tape, duct tape or weather stripping foam and a dressmaker's pin. Pins with enamel heads in white, yellow, orange or red are easy to see and use. Stick a strip of tape or foam under the tape, leaving the enamel head in the sight window. A good starting point places the pin about the same distance above the arrow rest as the eye is above the anchor point. The head of the pin should stick out into the sight window about as far as the edge of the arrow is from the dominant eye, about 1.5 centimeters ( $\frac{3}{4}$  inch). This arrangement should place the arrows close to the point of aim at close range (15 to 25 yards). The sights can be adjusted by trial and error to place the group center on the point of aim.

### Adjusting the Sights

When adjusting rifle sights, the rear sight is moved in the direction the hits are to move. In contrast, archers adjust the front sight. In front sight adjustment, chase the point of impact with the sight.

Before making adjustments, the archer must know where the arrows are hitting relative to the point of aim. That means that the ability to shoot tight groups is essential. A minimum of three arrows should be shot to establish the point of impact. Use the same sight setting, anchor point and point of aim. If the sight setting places the first arrow completely off the butt or target and your form was good, adjust the sight after that arrow to get on the target. Using the "chase the arrows with the pin" approach, move the sight to the left if the hits are to the left, upward if they are high, and so forth. With the simple tape and pin sight, adjustments may need to be made by trial and error. With sights having a screw adjustment, windage (lateral right or left) adjustments can be aided by counting the number of turns in any given change and noting the resulting change. Then calculate the approximate number of turns needed to reach the desired setting. That reduces the amount of trial and error during the beginning stages of sight set-up.

Once the sights are set to your satisfaction, mark the pin and the tape with the distance and your initials. Ideally, every shooter should have a personal bow for this exercise. Several shooters can use a single bow if different pin colors are used. Repeating the entire process for each distance desired will have the bow set up for the shooting situations you are using. The rest is up to the shooter and adequate practice.

## **Using Sights for Targets and Hunting**

Using sights for either target shooting or hunting involves the same principles, but with some practical differences. Target archers often extend the sight out from the back of the bow, giving themselves a longer sight radius. The longer sight radius aids in precision sighting. Almost all target shooters use a single sight pin that is adjustable for elevation with marked locations on the sight bar for different distances. Where permitted, they may use aperture rear sights known as string peeps, levels or other devices to aid in precision sighting. Some field archers use similar techniques.

Most field archers and hunters use slightly different techniques. The extended sight bar is used much less frequently, particularly by hunters. The improvement in sighting precision does not equal the disadvantages in the field. The longer sight bar is easily entangled in vegetation, and the sight is much more prone to damage or being knocked out of adjustment in field handling. Many archers in these sports opt for a protected sight with a guard to protect the pin or pins. Considerable difference of opinion exists among hunters and field archers about the number of pins that should be used. Some use multiple pins that are color coded and pre-set for selected distances. Others use a single pre-set pin and hold over or under targets at other distances. Those using multiple pins like the precision of holding the pin on the point of aim after selecting the proper pin for the distance. Those using a single pin feel it is less confusing and requires the same amount of accuracy in judging distances. Generally, more experienced hunters choose the single pin, while target shooters who do a considerable amount of shooting use multiple pins and often a string peep.

## **Other Gear**

An aperture rear sight or string peep can improve sighting precision. The string peep can force a shooter to develop consistent form in some phases of shooting. String peeps may make sighting more difficult under low light conditions, and they may require one-eyed shooting for some archers. They are not legal under FITA rules.

Release aids are popular with many archers. The mechanical release has several advantages. They produce a clean release with a single point of contact with the string. They may help shooters attain consistent form if the drawing hand position or finger tension is a problem. Those who elect not to use a release often look at the device as excess baggage or another artificial element in archery shooting. Others find them confusing or fear they might release a shot unintentionally. The best advice for young shooters is to keep your shooting as simple as possible while learning. Once the fundamentals are established with and without sights, the shooter can experiment with other devices and styles.

## Summary Activities

1. Use coach-pupil method to check shooting form and sight adjustment on the range.
2. Let participants set the sights on their bows for the types of shooting and distances used. Consider types of shooting the archer is planning to do when selecting a sight combination.
3. Illustrate and demonstrate sight correction procedures and proper adjustment of sights.
4. Hold a club shoot with courses of fire appropriate for skill levels of the participants. Use a handicapping system or some other type of grouping to make sure the archers compete on an equal basis.
5. Hold a novelty shoot where archers can use sights if they desire.

## Exhibit and Sharing Ideas

1. Make a model or illustration and discuss arrow trajectory using personal equipment or that provided in the program (See Fact Sheet 5: Trajectory and Trajectory Experiments.)
2. Display targets shot using instinctive and sight shooting techniques. Compare advantages and disadvantages in your journal.
3. Exhibit a model, poster or diagram of proper sight shooting form or sight adjustment. Explain the processes on labels or in your shooting journal.

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## Shooting with Compound Bows

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### Objectives

Participating youth and adults will:  
Understand the functioning and variety of compound bows.  
Be able to select compound bows to fit their uses.  
Be able to match archery equipment for optimum performance.  
Develop shooting skill with compound bows.  
Have fun while learning.

### Roles for Teen and Junior Leaders

Demonstrate use of bows.  
Demonstrate trajectory curves.  
Aid shooters with equipment.  
Serve as assistant range officers or line captains.  
Score targets.

### Parental Involvement

See Roles for Teen and Junior Leaders above.  
Conduct shooting demonstrations.  
Arrange or coordinate transportation.  
Arrange or provide refreshments.  
Assist in recordkeeping, scoring or range management.

### Best Time to Teach

Any time after basic shooting form with and without sights has been developed.

### Best Location

Combination of classroom or quiet instructional area and safe shooting range.

### Time Required

1 hour

### Materials/Equipment

- Various compound bows (wheels, cams, cam limbs, overdraws, fast-flight systems)
- Archery accessories
- Personal shooting equipment
- Target butts
- Targets

### References

*Hunting with Easton Aluminum Shafts*, Easton Aluminum, Van Nuys, CA.  
*Target Shooting with Easton Aluminum Shafts*, Easton Aluminum, Van Nuys, CA.  
*National Archery Association Instructor's Manual*, third edition. P. Baier, J. Bowen. C. R. Fowkes and S. Schoch. National Archery Association, Colorado Springs, CO. 1982.  
*Fact Sheet 5: Trajectory and Trajectory Experiment*.  
Bow or arrow manufacturer's catalogs, advertising materials and owner's manuals may also prove useful.

\* 4-H and Youth Development Specialist, Texas Agricultural Extension Service.

## Lesson Narrative

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Although the fundamentals of archery have remained the same, archery equipment has changed a great deal in recent years. Centuries ago archers used self bows, bows made from a single stave of wood. Some bows were reinforced with sinew, horn, bone or other materials; but native woods were the main bow materials. Designs varied in both shape and length. The long, straight or slightly reflexed English long bow was quite different from the short, recurved bows used by the Mongols and the Turks. The function of the bow was reflected in its form.

As composite materials, like fiberglass, were developed, they found use in the bowyer's trade. Laminated limbs, recurve designs and the use of stiffer, stronger materials increased bow cast and speed. The compound bow introduced a major change in bow design. The use of eccentric wheels and cables altered the mechanics of drawing the bow. That eased the drawing process and reduced the force needed to hold the bow at full draw. The mechanical advantage also allowed more of the energy stored during the draw to be transferred to the arrow during the shot. The result was a faster arrow at the same draw weight. Also, the less abrupt, longer acceleration reduced stress on the arrow. This made the use of lighter, "softer" spined arrows possible, adding to the increased speed. Archers, particularly bowhunters, were quick to take advantage of the new technology.

Recent years have seen further advances. Development of better materials, like graphite and boron fiber composites, had added stiffness to limbs with the reduced limb mass. Design changes, like the introduction of turned cams or cam limbs, have increased speed and/or "feel" for archers. As a result, the modern archer has choices that were beyond the dreams of archers on decades ago.

### Basic Compound Bow Design

Compound bows and "stick" bows have the same basic components. Both have limbs, riser, handle, arrow shelf, arrow rest, arrow plate, a sight window and a string. Compound bows also have cables and eccentric wheels of some sort to provide the mechanical advantage. The cables transfer the drawing forces to the limbs, which are usually shorter and stiffer than those of recurve bows. The eccentric wheels or cams alter the shape of the draw force curve. It changes from one that rises uniformly or increases in slope with increasing draw length to a flat-topped curve with two "valleys" - one at the resting state and the other at full draw. That change is the key to the efficiency of the compound bow.

Compound bows have several advantages over recurve bows of similar draw weight. First, they transfer a greater proportion of stored energy to the arrow. More work done in drawing the arrow to the anchor point and bending the limbs becomes kinetic (moving) energy in the arrow. Secondly, the reduced stress on the arrow permits the use of a lighter arrow with less spine. That, too, increases arrow speed. Finally, fatigue-induced errors in shooting form may decrease because of reduced holding weight. Hunting archers find this an advantage when waiting at full draw for their quarry to move into a better position.

Disadvantages of the compound bow are related to their moving parts or the same features that yield advantages. Reducing the holding weight, for example, makes variations in release more critical. Relatively minor errors may produce serious changes in arrow flight. The bow's mechanics require a more complex tuning process and cause more difficulty in noise reduction. In addition, the extra moving parts and the greater stress placed upon the limbs, cables, strings and other bow parts increase the potential for breakage during use. Compound bows tend to be heavier than recurve bows of the same draw weight. The increased weight may make them more stable, but it may add to fatigue as well. Many archers feel that the mechanical appearance of the compound bow makes it ugly, too. Beautiful, it seems, remains in the eye of the beholder.

Wheeled bows, those with round eccentrics, and bows with cam limbs tend to have smoother draw force curves than cam bows. Cams store more energy and shoot faster arrows than wheels, however.

The quest for more arrow speed has produced further technical changes in bow design. Overdraws, devices that shorten the draw length from rest to anchor point, permit the use of a shorter, lighter and softer spined arrow. At full draw the tip of the arrow is actually located inside the handle (and the bow hand) of the bow. The Archery Manufacturer's Organization (AMO) recommends a minimum arrow weight of six grains per pound of draw weight for safety. Increases in speed are offset somewhat by the demand for greater consistency in shooting form. Since the arrow rest is not directly over the pivot point of the bow, small changes in bow-hand position can cause substantial changes in impact location. Bow-hand form is critical when using an overdraw. Arrow speed cannot compensate for poor form.

## **Shooting Compound Bows**

Compound bow shooting uses the same basics of form used in shooting recurve bows. Compound bows are less forgiving of form faults, so consistent form is essential to precise shooting. Poor form results in more noise, erratic grouping of arrows and faster arrows hitting in the wrong places. Extra care with form and equipment is necessary. The rest is practice, practice, practice.

## **Summary Activities**

1. Have each shooter try a variety of compound bow types to compare the performance and "feel."
2. Have each participant practice shooting a compound bow of their choice until they are proficient.
3. Have a participant shoot a compound bow with several different arrow weights to see the impact on arrow speed and accuracy.
4. Have each participant select and set up a compound bow for target or hunting purposes.

## **Exhibit and Sharing Ideas**

1. Display a model or diagram of a compound bow labeling all its functioning parts.
2. Compare trajectories of several bows with equal draw weights but different designs. Present the results as graphs and discuss them in your notebook or put them in poster form. Sample targets may be included.
3. Make a compound bow from a kit and display your finished bow.
4. Exhibit a series of targets illustrating a change in skill level using a compound bow.
5. Complete a trajectory experiment as outlined in the Fact Sheet 5: Trajectory and Trajectory Experiments. Exhibit the results of your experiment in an appropriate form with full documentation in your shooting journal or notebook.
6. Exhibit an item you have made for use with compound bows, for example a bow scale, string jig, compound bowstringer, bow rack or similar item of your choice.

## Making Archery Equipment

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### Objectives

Participating youth and adults will:

Understand the basics of constructing personal archery equipment like strings and arrows.  
 Construct selected pieces of archery equipment.  
 Develop skills related to making archery tackle.  
 Determine other types of archery equipment they may wish to make with the aid of instructors or alone.  
 Have fun while learning.

### Roles for Teen and Junior Leaders

Provide extra hands and tutor participants who need help.  
 Demonstrate procedures for making specific items.  
 Demonstrate use of personally made items.  
 Encourage and assist members with tasks that give them trouble.  
 Conduct workshops to make a particular item of interest.

### Parental Involvement

See Roles for Teen and Junior Leaders above.  
 Provide shop space and equipment for workshops.  
 Arrange for or provide transportation.  
 Assist with other types of equipment they make.  
 Arrange for additional leadership on this topic.  
 Arrange for or provide refreshments.  
 Best

### Best Time to Teach

Any time after personal equipment has been selected and basic shooting form is mastered

### Best Location

Well lighted and well ventilated shop area

### Time Required

1 hour (workshop sessions will add to the teaching time)

### Materials/Equipment

- Material requirements vary with the item being made. Refer to teaching outline or individual fact sheets for detailed lists.

### References

*Hunting with Easton Aluminum Shafts*, Easton Aluminum, Van Nuys, CA.  
*Target Shooting with Easton Aluminum Shafts*, Easton Aluminum, Van Nuys, CA.  
*National Archery Association Instructor's Manual*, third edition. P. Baier, J. Bowen. C. R. Fowkes and S. Schoch. National Archery Association, Colorado Springs, CO. 1982.  
*Bowhunting Deer*. W.H. Wadsworth, ed. National Bowhunter Education Foundation. Murray, KY.  
*A Sand County Almanac*. A. Leopold. Oxford University Press, New York, NY. 1966. (Paperback: Sierra Club Balantine Books.)

\* 4-H and Youth Development Specialist, Texas Agricultural Extension Service.



## Lesson Narrative

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In A Sand County Almanac, Aldo Leopold stated that the best leisure activities involved some element of uncertainty or risk. He went on to say that archery was one of those activities. He hunted with bows he had constructed, arrows he had made and points that had been handcrafted from sheets of steel. Like Leopold, or other famous archers such as the Comptons, Saxon Pope, Art Young or Ishi, today's archer can increase shooting enjoyment by making some of his or her own equipment. Making personal equipment also can promote safety, understanding and even shooting skill.

An archer can make simple equipment or more complex items that require a great deal of time and skill. Many accomplished archers have tried their hand at making bows. The increased popularity of the longbow has resulted largely from a sense of history and interest in making bows. The bowyer's art is complex and will not be covered in this lesson.

We will concentrate on making bowstrings, arrows, a string jig and a couple of types of bowstringers. Along the way we will learn some of the skills needed to maintain archery equipment.

### Making Arrows

Many archers enjoy making their own arrows. It is easier to match the arrows to your size, shooting style and other equipment when you make your own. The arrows may be customized to fit personal desires as well. Those custom touches may be as simple as nock or fletching color. They may include customized fletching, a personal crest and individual identification of shafts. The starting point is selecting shafts with the proper spine and length in the desired material.

Shaft selection is discussed in the bow tuning lesson. Use a table of potential shaft sizes from a manufacturer as a guide, but also use your personal experience. Shafts for target or field use may be cut to the actual draw length as determined by using a draw-check arrow. Those for hunting purposes should be cut a few centimeters ( $\frac{3}{4}$  to 1 inch) longer than the distance from the string to the back of the bow. This provides adequate clearance for the broadhead and a margin of safety for the shooter. Dealers will cut the shafts to length for a small fee, or they may be cut with an abrasive cut-off wheel. Pipe cutters, hack saws and similar cutting tools should not be used. The light burring at the cut area should be removed to provide a uniform tube diameter for inserting points or screw-in adapters.

After the shafts have been cut to length and de-burred, the points or adapters can be inserted. On fiberglass arrows, the nock inserts can be installed at the same time. Most archers prefer to use an epoxy for fiberglass and similar types of arrows. Heat set or meltable adhesives are used for installing inserts on aluminum shafts. Wooden shafts need not be cut to length or tapered until they have been completed. If screw-in adapters are used, a few precautions can increase your satisfaction with the installation. Place a small amount of petroleum jelly on the threads of a field point. Screw the point fully into the insert before it is installed. That keeps excess glue from getting into the threads and fouling the insert. Melt a small amount of glue on the insert. Twirl the insert to spread the glue evenly over its surface while pre-heating the end of the shaft. Insert the adapter with a twisting motion to spread the glue evenly. Hold it tightly in place for a few seconds to let the glue set. (Some people twirl the tip of the shaft under cool water to hurry the process.) Once the glue has set, the arrow can be spun on its tip to check for proper insert alignment. If necessary, reheat and adjust the insert so the arrow spins without wobbling. Once the insert is aligned and the glue has set, the field point can be removed. The arrow is ready for next step.

Before the shafts are used to construct arrows, they must be cleaned. Manufacturers make special solvents for preparing arrow shafts, but other solvents or home cleansing techniques can be used effectively. The shafts can be scrubbed with a cleanser, wiped clean with alcohol or cleaned with lacquer thinner or remover. Once they are clean and dry, they should not be touched with oily fingers. The bases of the fletching should also be cleaned with a thinner or alcohol to remove any remnants of the release agent from the molding process.

Once the shafts are cleaned, most arrow makers apply a thin coat of lacquer to the area where the crestring and fletching will be applied. Some adhesive manufacturers recommend their lacquers for providing a good base for the adhesive. The lacquer base tends to promote excellent bonding. Lacquer color is a matter of choice. Drawing a very light line around the shaft where the lacquer should stop is a good practice for consistent results. Lacquer is most easily and consistently applied by using dip tubes. Merely insert the shaft to the line, allow to drain briefly, and hand it up to dry. The lacquers used for archery applications are tough and difficult to remove, so protect your work area. Adequate ventilation is also essential.

After the shafts dry completely, remove the lacquer from the nock area or remove any irregularities in the lacquer from that area. Place a drop of glue on the tapered portion of the shaft, and insert a nock with a slight downward twisting motion. The nick should fit tightly and evenly on the nick taper. Refer to the shaft maker's materials or another chart of nock sizes to select the proper nock for the shafts used. Care in applying the nocks will ensure the nock is properly aligned with the shaft.

The next step is to apply the fletching. Set up your fletching jig according to the manufacturer's instructions. Select the fletching style you prefer. Set a shaft in the jig, being sure the nock engages properly in the nock receiver. Position a feather or vane as you want it on the shaft, and mark the clamp where the end of the fletching crosses it. Apply an even bead of glue along the base of the fletching material and slip the clamp into the jig. Follow the manufacturer's advice on the length of time each vane or feather must remain in the clamp. Usually 3 to 4 minutes is adequate. Remove the clamp. Rotate the nock receiver to bring a new area of the shaft into position. Repeat the process until all the fletching has been applied. Finally, place a small drip of fletching cement on the leading and trailing edges of the base of each feather or vane.



If no crestring is desired, the arrow is complete. All you need to do is screw in a point of your choice and head for the range. If the arrow is to be crested, a few more minutes' work are required. The crest is your signature. Design one that is pleasing to you. Remember that light colors should be applied first. They are easily covered by darker ones. Use an assortment of brush sizes to get the effect you want. Having a junked shaft to use as a practice area is often very helpful, as is keeping your lacquer rather thin.

Congratulations! You have just finished your first set of arrows.

## Making a Bowstring

There are many advantages to making your own bowstrings. You can easily adjust length, string weight and the thickness of the servings, making it easier to fine tune your equipment. Making a bowstring requires a few tools and materials: a string jig, a serving bobbin, nylon serving thread and monofilament for the center serving. The techniques are easily mastered and the process is relatively quick. Let's go through them one step at a time.

The first step is to establish the proper length for the string. If you have a string that has been working well on your bow, use it for a pattern. With Dacron strings, you may want to shorten the string slightly (perhaps as much as ½ inch) to compensate for the initial stretching when the string is put on the bow. Mark the base of the string jig to indicate the ideal string length for your bow. That will make duplicate strings easy to produce later. Remove the old string from the jig and, following the directions on the string material, wrap the required number of strands around the ends of the jig. Leave a little extra material on both ends of the thread for knotting and finishing. Both of these should be on the same end of the string.

Pivot the end of the string jig on the end having the two tied-off strands. Following the directions with your serving bobbin, serve the middle portion of the end loop with nylon thread. Once that middle portion is served (the part that will become the end loop), rotate the end of the jig back into line. Adjust the string position slightly so that the serving thread will conceal the end of the other side of the serving and begin to form the loop. Either wind the loose ends of each cross pattern over the area to be served. Serve the remainder of the end loop area (about 4 to 6 inches) and whip finish the serving thread.

While the string is in this position, mark the loop area on the other end of the string with wax pencil or chalk. (Note: some inks damage some types of string materials.) Once the loop area is marked, rotate that end of the string jig, serve the loop and finish off the other end of the string as before.

At this point, many archers like to "set" the string. Place the string on the bow, wax it completely and rub it vigorously with a small patch of leather. This process conditions the string and settles the strands into place. Many manufacturers recommend that the string be twisted slightly in the same direction that the individual strands are twisted to increase its strength. Note that all servings should be made in that same direction.

Once you have established the proper length for the string, mark the top and bottom of the center serving with chalk. Generally the top of the center serving should be about 2 to 3 inches above the arrow rest. The bottom should be about 5 to 6 inches below it. The main functions of the center serving are to protect the string from abrasion, to provide a smooth area aiding release and to provide a snug fit for the nock. Feel free to build your to fit your shooting style.



On recurve bows the center serving can be applied while the string is on the bow. The cables of compounds complicate the matter a bit. In either case, the string could be removed from the bow and replaced on the jig for serving the center. Although nylon can be used in the center of the string, most archers prefer to use a monofilament center serving. Mono comes in several diameters and colors. Select a combination that is pleasing to the eye and one that fits your nocks snugly. Starting at the top mark on the string, insert the monofilament through the string and leave several inches of the free end protruding through the string. Hold that free end along the string and wind the start of the serving over it. Continue winding in the same direction as the twist in the string (and the same direction in which the string will roll on release) until most of the area to be served is covered. As you near the end of serving, insert a loop of monofilament (loop side toward the unfinished end of the serving) and continue to wind at least 12 to 15 additional turns of serving material. Keeping the serving tight, snip off the monofilament and insert the loose end through the loop. Pull the loop through, drawing the free end under the wrapped monofilament; and pull it up tight. Trim the end and apply a drip of fletching cement.

In order to have the string function properly, it must have a nocking point indicator of some type. Some archers wrap one of dental floss or a similar material. Others use metal/plastic nock sets. Place the string on the bow and position the nocking point as desired. If you have found the best location for your bow's tuning, simply repeat the placement (you should have that noted or marked on your bow square). If not, try various locations until the bow is tuned properly. Hunters and target archers alike should have extra, pre-stretched, conditioned and tested strings with nock sets available in their field gear.

## **Making Tree Climbing Blocks**

While the target archer may not appreciate climbing blocks, the tree-stand hunter will find them very helpful. Ethical hunters avoid damaging trees by using non-invasive ways of climbing trees. The climbing block is an excellent way to do that, and it can be made from scraps of 2 x 4 construction lumber. Each block should be about 5 to 5 ½ inches long and cut square on both ends. Approximately 1 ¾ inches from one end of the block, drill a centered ½ -inch hold through the 2-inch side of the block. Rasp or sand off all eight corners of each block slightly. At this point you may want to paint the blocks with a dark paint or camouflage paint to preserve and conceal them. Using 400 to 600 pound test nylon or Dacron rope that has been dyed a dark color, pass one end through the hold, around the wide side of the block and back through the hold again. Make a small loop close to the edge of the block using a bowline knot. Cut the opposite end of the rope to a length suitable for the trees you are likely to be climbing. I usually make mine about 15 to 20 feet long. About 6 to 10 of these blocks will get the hunting archer into most tree stands.

The climbing blocks are used by wrapping the rope around the tree at the desired location, passing the end of the rope through the bowline loop and cinching it down as tightly as possible. The line is then passed back around the tree and cinched under the block (called frapping) with a couple of turns of rope before passing back around in the opposite direction and repeating the process. Once the block has been frapped in place, the remainder of the rope can be tucked under the block to keep it from blowing in the wind. The block will shift when weight is first applied to it, but after that it should remain stable.

## **Making a Hauling Line**

Any archer that hunts from a tree stand should wear a safety belt or safety line every time they enter a tree stand. Safety belts can be purchased at modest cost, but you can also make one from a heavy piece of braided Dacron rope. A length of rope about 4.5 to 7.5 meters (15 to 25 feet) in length is adequate for most areas. The ends should be sealed with a flame. Take care not to start a fire or get burned on the molten polymer.

The safety line attaches the archer to the tree to prevent dangerous falls. Start by tying a bowline snugly around your upper body. Keep the rope fairly high on the chest. Turn to face the tree while standing at about the distance you want as your limit. Attach the line chest height or higher on the tree. Another bowline is adequate, but any string and easily untied knot (a clove hitch for example)

will do. Rotate the knot to the center of your back. Test the arrangement to see if you have enough room to shoot before hauling your equipment into the tree stand. A secure safety line can improve your shooting if it is used as a support when shooting from a tree stand.

## **Other Things You Can Make**

Archers can find plenty of things to make for themselves, and all of them can add to your enjoyment of the sport. Some of them, like the climbing blocks or hauling line can be made quickly and simply. Some, like arrows or bowstrings, take a little more time and planning. Lots of others are complicated projects that may take many hours of work to complete. Examples include items like tree stands, bow presses, string jigs, cresting lathes or bow cases. Let your skills and your imagination be your guide, and try your hand at making your own archery equipment.

## **Summary Activities**

Have each participant complete a selected project from the lesson. Select one that will be useful to nearly all the shooters, like a hauling line or a shooting safety line for bow hunters.

Have each participant make at least one arrow, simultaneously with the entire group.

Have each person participate in making one or more bowstrings. Demonstrate the proper technique first, and then let the participants try their hand at applying the servings.

## **Exhibit and Sharing Ideas**

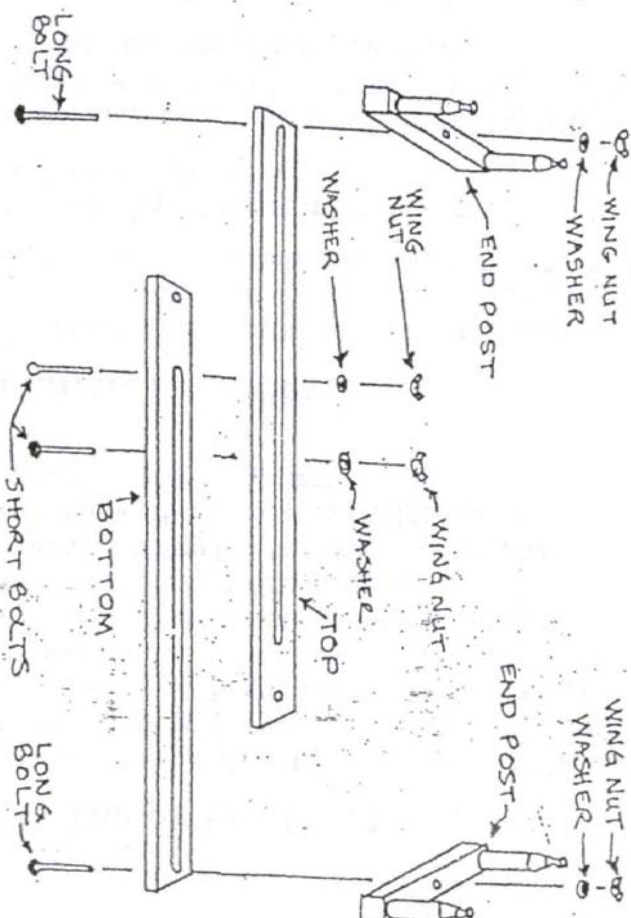
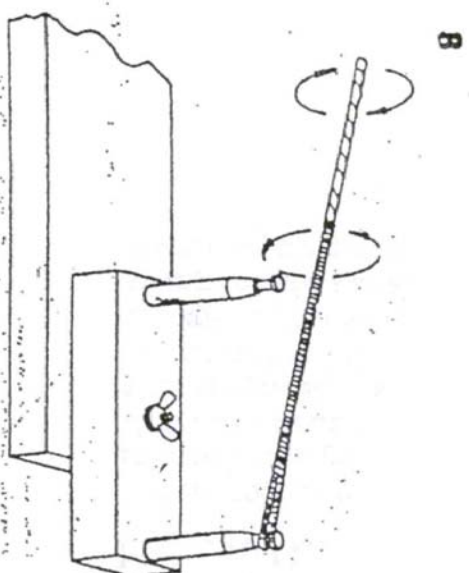
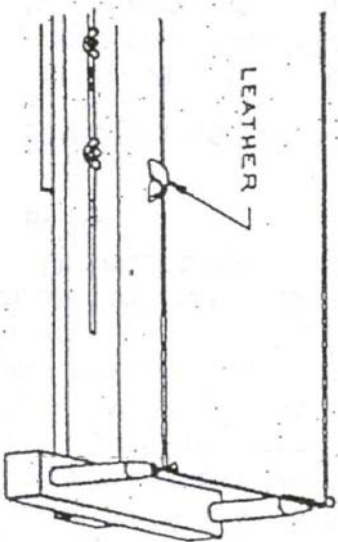
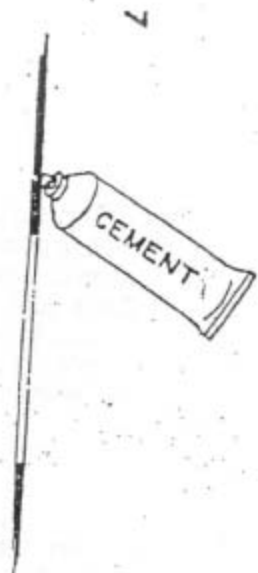
Nearly any item that is personally constructed by the archer could be displayed as an exhibit in shows or fairs. In addition, some of the items would make excellent demonstration topics or be potential activities for a workshop conducted by young people. Some of the more complex items could be used as projects for science fairs. A few of these functional items may even become fund-raising projects. Opportunities for active and continuing demonstrations at sportsmen's field days, shoots, bowhunter education programs, or National Hunting and Fishing Day exhibitions are also abundant. Let your imagination be your guide.

## **Links to Other 4-H Programs**

The relationship to woodworking, wood science or other mechanical sciences and engineering projects is obvious. Wildlife links are also clear and abundant. Heritage projects, outdoor skills, forestry and photography also have direct connections to some of the items being constructed or their use. Many of these items present an opportunity to explore science and technology as well. Let your imagination be your guide and stay alert for areas of interest shown by the young people in your group.

## Martin Bow String Jig

- Pivoting end posts for ease in serving loop sections
- Quick positive adjustment for all length bowstrings
- Designed for the professional or amateur
  - Careful and rugged construction
  - Metal fittings on end posts
  - Will last a lifetime
  - Select Material



### HOW TO MAKE A BOWSTRING

Assemble your STRINGSMITH JIG as shown above. If you wish calibrations in bowstring length, turn the pivoted End Posts in line with Base and set the spread of the jig exactly 60" between the two outside posts. Mark a line on the Bottom Base where the end of the Top Base comes. Remove Top Base and using a ruler, calibrate from 48" to 70" using the 60" mark as a guide.

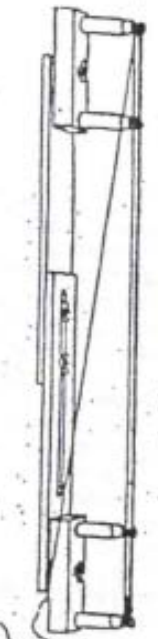
Either screw or "C" clamp jig to bench to keep it steady.

**RECOMMENDED NUMBER OF STRANDS  
TYPE B, AND B-50 DACRON**

6 to 8 strands—bows up to 35 pounds  
 8 to 10 strands—bows 35 to 40 pounds  
 10 to 12 strands—bows 40 to 45 pounds  
 12 to 14 strands—bows 45 to 50 pounds  
 14 to 16 strands—bows 50 to 55 pounds  
 16 to 18 strands—bows 55 to 60 pounds

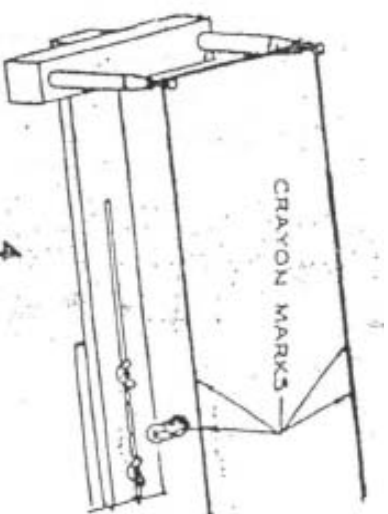
Increase 2 strands per 10 pounds thereafter

**STEP 1:** Turn both End Posts in line Base and set jig for desired bowstring (Normally about 3-1/2" less than bow Slide Dacron Thread under End Post at leaving about 18" hanging over. Wrap number of strands of thread around being sure thread is fitted into metal Wrap snug, but not tight. (1) After of thread are wrapped, tie ends together End Post using a square knot. (2)



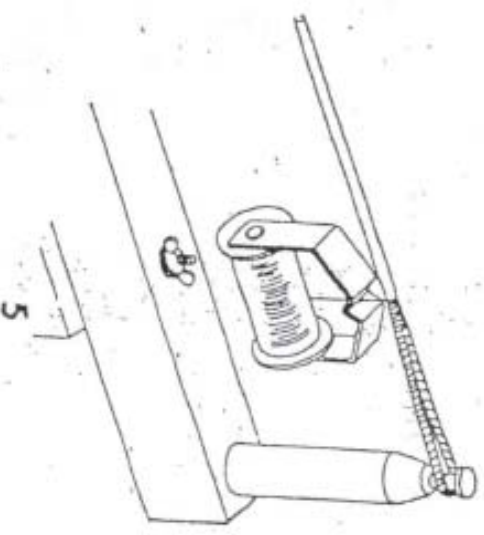
STEP 2: Rotate bowstring around End Post until knot is about 1-1/4" from Post. Mark with crayon on both sides of bowstring at knot. Repeat the marking at other end. This determines loop size and may be varied as you prefer. [J]

STEP 3: Rotate bowstring around End Posts until crayon marks are about in center of jig. Pivot End Posts opening up bowstring. [4] Apply Bowstring Wax between marks. Serve bowstring between marks using your favorite method, too, and material.

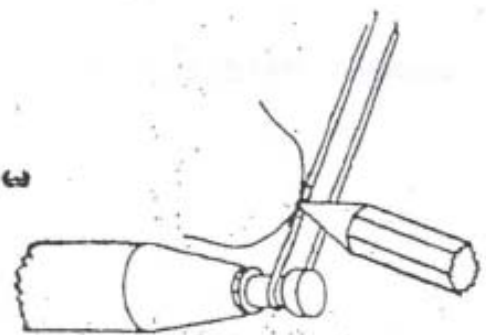


STEP 4: Pivot End Posts in line with Base. Rotate bowstring around End Posts until served loop sections are in position for forming loops. [5] Serve shank of loop about 5" down bowstring, overlapping the original loop serving about 1/8". Complete both loops.

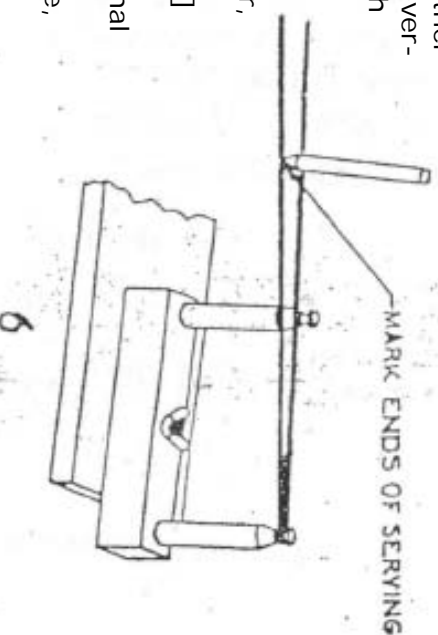
STEP 5: Loosen Jig Adjustment Nuts and remove one loop bowstring. Place loop over End Post on top of other loop. Stretch bowstring and mark location of center serving on both halves of bowstring [6] The center serving should be about 8" Return loop to other End Post, tighten Jig and serve center serving.



STEP 6: Apply a dab of Duco, Everfast, or other flexible cement to end of each serving and overlapped junction of loops. Rub in cement with finger. [7]



STEP 7: Using a folded piece of hard leather, burnish entire length of bowstring to melt in wax and make string round and smooth. [9] Put bowstring on bow and adjust length by twisting. Do not twist more than 12 additional turns, or until string begins to knot. If bowstring does not fit correctly, make a new one, adjusting the jig according to the error.



## Bow Tuning

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### Objectives

Participating youth and adults will:

Understand the principles of bow tuning.  
Set up a bow for their shooting style and purposes.  
Understand relationships among various bow tuning factors.  
Have fun while learning.

### Roles for Teen and Junior Leaders

Assist participants with interpreting bow tuning situations.  
Demonstrate tuning problems and solutions.  
Supervise range use and operation.

### Parental Involvement

See Roles for Teen and Junior Leaders above.  
Arrange for or provide transportation to the range.  
Arrange for or provide refreshments.  
Reinforce tuning solutions at home.

### Best Time to Teach

When participants are ready to switch from a learning bow to a personal bow, and after sound basic shooting form with and without sights has been achieved.

### Best Location

Anywhere with access to a suitable indoor or outdoor range.

### Time Required

20 to 90 minutes

### Materials/Equipment

- Nocking point indicators or dental floss
- Nocking point pliers
- Bow square
- Felt-tip pen
- Strings of various lengths
- Variety of arrows (lengths, diameters, spines, weights) equipped with screw-in adapters
- Points of different weights and styles
- Adjustable side plate, cushion plunger or thing leather
- Barge cement
- Target and butt (foam, pressed sugar cane or excelsior preferred)
- Allen or hex wrenches
- Spray foot powder
- Moleskin
- String silencers
- Bow stringers

### References

*Bowhunting with Easton Aluminum Arrow Shafts.* Easton Aluminum, Inc. Van Nuys, CA.

*Target Archery with Easton Aluminum Arrow Shafts.* Easton Aluminum, Inc. Van Nuys, CA.

*National Archery Association Instructor's Manual, third edition.* P. Baier, J. Bowers, C.R. Fowkes and S. Schoch. National Archery Association, Colorado Springs, CO. 1982.

*Archery: Steps to Success.* K.M. Haywood and C.F. Lewis. Leisure Press, Champaign, IL 1989.

*Teaching Archery: Steps to Success.* K.M. Haywood and C.F. Lewis. Leisure Press, Champaign, IL 1989.

\* 4-H and Youth Development Specialist, Texas Agricultural Extension Service.



## Lesson Narrative

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Archery equipment must be properly tuned if an archer is to enjoy accurate, successful and safe shooting. Tuning involves balancing the bow with the other equipment used. Adjusting the bow for optimum performance and adapting the equipment to the archer's shooting style. The fundamentals of proper shooting form must have been mastered to a reasonable degree, with the archer capable of shooting groups successfully. Tuning involves factors of both the arrow (material, thickness, diameter, weight, length and attachments) and the bow (nocking point location, plate or plunger adjustment and arrow rest performance).

### Arrow Selection

Typically, tuning starts with selection of arrows. Arrows should be matched to the bow carefully, and to each other. High quality arrows are extremely consistent from shaft to shaft and are straight. Spine or stiffness of the arrow is the most vital factor in good performance. Spine is a dynamic and complex feature of arrow behavior. It involves the type of arrow material, shaft length, shaft diameter, wall thickness, structure and mass of the arrow and its attachments. The weight and structure of the arrowhead, the type of insert and the weight and structure of the arrowhead, the type of insert and the style and amount of fletching influence the spine to some degree.

The archer's paradox is that an arrow must flex to fly straight. The amount of flexing is critical to good arrow flight. Longer arrows of the same construction and size are "softer" than shorter ones, so arrow length influences stiffness. Target archers usually cut their shafts to their true draw length. Bow hunters usually cut the shafts 2 or 3 centimeters ( $\frac{3}{4}$  to  $1\frac{1}{4}$  inch) longer than the true draw length to keep the broadhead away from the back of the bow and their hand. Running a simple test or consulting a spine chart will confirm the relationship between length and stiffness.

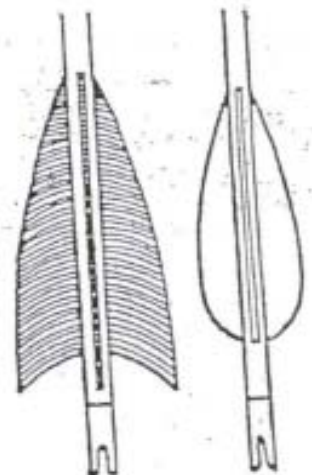
Arrow weight, and therefore speed and momentum, are influenced by shaft length, too. The longer arrow has greater mass and inertia. Although it may have somewhat greater momentum, it is more difficult to propel at the same speed or velocity as a lighter shaft. Overdraws permit use of shorter, lighter, thinner shafts, achieving higher velocity while maintaining adequate spine for good performance in heavy bows. Shooting style, arrowhead mass and other factors can also be important. The archer must determine the best combination for his or her shooting style and equipment.

Shooting form, bow tuning (set-up) and arrow spine deviations can cause impact changes. Arrows that consistently hit on the bow-hand side may be too stiff if the other factors have been checked. Those that strike to the string-hand side are likely to be too soft, or the head is too heavy for the arrow spine. Bow hunters should be particularly cautious, since performance with heavy broadheads may be quite different from that seen with field points used in practice.

### Fletching

Fletching helps control the arrow in flight. The drag and spin provide stability to the shaft, although a properly tuned bow should shoot bare shafts equally well at short ranges. The two primary fletching materials used today are feathers (primarily domestic turkey feathers) and plastic vanes. The former are cut to length and burned to shape. The latter come in hard and soft materials, a variety of styles and thicknesses and a pre-cut or cast shape. In general, feathers offer more control. Archers speak of them as being "more forgiving" of minor form faults. At the same time, feathers are much more affected by weather and susceptible to wear. Vanes are more "slippery" in the air. They may increase arrow speed slightly, but at the cost of being less forgiving of shooting form faults. They are also much more resistant to weather changes.

The amount of fletching required depends on use of the arrow. Normally flight arrows have the smallest amount of fletching. Target arrows are next. Hunting arrows usually have very large areas of fletching to guide the heavy



arrows under uncertain conditions. Target archers may be satisfied with three 2- to 3-inch vanes; or they may opt for more flight stability with "spin wings," a thin, curled type of vane. Hunting archer or field archers usually use four 4-inch vanes or three 5-inch ones to adequately control the heavy arrows in heavy bows.

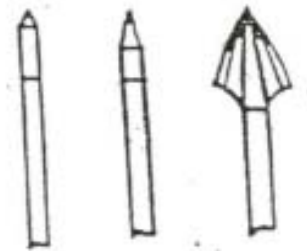
Fletching may be applied in line with the shaft (straight fletch), slightly offset or in a spiral (helical fletch). These styles are listed in decreasing order of speed and increasing order of control or stability. Selection of a fletching style involves trade-offs between speed and control. Usually the choice in style reflects personal experience and preference.

Some archers use strips of brightly dyed rabbit fur at the back of their fletching to increase their ability to follow the arrow. Others use either spirally wound feathers or six full-length feathers to control the cast of the arrow. These flu-flu arrows are used in shooting at flying targets or small game and game birds.

## Point Selection

Arrowheads come in a wide array of types and styles. Target points are no longer limited to the traditional short, sharply pointed cone. Bullet-shaped points are now preferred by many archers because they tend to be deflected less when they strike another arrow in a tight group. Each archer should try these styles of points to see which one they prefer personally. Traditional field points now have shorter or longer tips, and may even resemble an elongated bullet point. As with the target points, the archer should examine and experiment to find the ones that perform optimally for them. Broadheads come in so many styles and types that they can be confusing.

NO hunting broadhead should be barbed. Broadheads should meet these four criteria: razor sharp, tough enough to withstand impact with bone or the ground, large enough to be legal and make an adequate wound channel, and true and consistent in flight.



Archers will find uses for other types of heads as well. Judo heads or those of similar design are outstanding for roving. Blunts are used for small game. Snaro heads may be used for flying game. Look at an archery catalog and see which types you might want to try. Remember, size and mass of the head will affect arrow performance and tuning considerations. While the target archer may want to tune specifically for target shooting, the bow hunter may want to tune for the broadhead of choice, selecting practice points that mimic their broadhead's performance.

## Tuning Your Bow

Three major factors need to be considered when tuning bows for optimal performance. These factors are vertical stability (porpoising or planing), horizontal stability (fishtailing) and clearance. In general, it is wise to tune the bow in the order stated.

Porpoising may be caused by shooting faults as well as by improper location of a nocking point. An arrow that oscillates up and down in flight shows porpoising. Bow hunters may refer to the same situation as "planing." Moving the nocking point up or down slightly will usually correct the situation. As a starting point, locate the nocking point about 9 millimeters (3/8 inch) above true perpendicular. Using a target at relatively close range (about 15 meters or 15 yards), shoot three bare shafts and three fletched ones using the same aiming point. If all six arrows are in the same group, the nocking point is correctly situated. If the two groups are not together, move the nocking point slightly in the direction of the bare shafts and repeat the test. Once you have located the nocking point indicator properly, note it in your journal and mark your bow square as a reference for later use.

Fishtailing is a lateral (side to side) oscillation in arrow flight. It may be caused by shooting form faults, as well as improper tuning. Tuning to eliminate fishtailing involves adjusting either the tension on a cushion plunger or the amount of "center shot" on the bow. Initially, the string and arrow should bisect the limbs on a recurve bow and be approximately 3 to 4 millimeters (1/8 to 3/16 inch) into the sight window on a compound bow. Using the same bare-shaft technique outlined above and following

the instructions with your cushion plunger (if one is installed) or our bow manufacturer, adjust the arrows for straight flight. If the bare shafts are to the bow-hand side of the fletched ones, decrease the tension on the cushion plunger or move the side plate closer to the bow. If the bare shafts are to the string-hand side of the fletched ones, increase the tension or move the side plate out from the bow. If major adjustments are necessary, it may indicate that the arrows are improperly spined for the bow. Arrows that are too stiff will impact to the bow-hand side. Those that are too soft will impact to the string-hand side. In general, if you can adjust the two groups to within approximately 10 centimeters (4 inches) of each other at 12.5 meters (15 yards), the spine is within acceptable limits for good arrow flight.

Clearance adjustment is designed to eliminate contact between the arrow and the bow during a shot. Powder applied to the fletched end of the arrow and the area on either side of the arrow rest can leave tracks of any impact. If moving the pressure point in or out slightly does not correct the problem, a change in spine may be needed. If the nock end hits the riser beyond the arrow rest, increase the spine or the length of the pressure point. If the shaft is hitting the riser on the inside of the arrow rest, it may be too stiff for the bow set up. Anytime a clearance adjustment is made, adjustment for horizontal stability or fishtailing should be rechecked.

## **Conclusion**

Basic bow tuning is a complex process, but one that can be mastered using a step-by-step procedure. First, you need to determine your draw length and the appropriate shaft size at that length. Next, select a fletching style and amount that fits your needs. Third, the bow should be tuned for vertical stability by adjusting the nocking point. Next, tune for horizontal stability. Then, check the set up for clearance. After these factors have been set, a final check of all equipment should be made. The rest is up to you.

## **Summary Activities**

1. Have each shooter tune his or her bow in a clinic setting.
2. Have assistants or shooters fire groups and let the participants analyze what tuning considerations should be made. If possible, include some form or dominant eye faults to challenge them.

## **Exhibit or Sharing Ideas**

1. Illustrate tuning problems and correction with a series of targets or illustrations.
2. Give a demonstration on tuning a bow for performance.
3. Examine the physics of arrow performance and discuss the importance of tuning to achieve optimum performance.

## Target Archery Games

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### Objectives

Participating youth and adults will:  
 Understand some of the shooting games available in the archery discipline.  
 Select a type of shooting that interests them.  
 Experience some of the shooting opportunities available in the local area.  
 Have fun while learning.

### Roles for Teen and Junior Leaders

Demonstrate various shooting games.  
 Act as line captains, scorers and judges.  
 Lead groups of shooters through courses of fire.  
 Present descriptive discussions of shooting games.

### Parental Involvement

See Roles for Teen and Junior Leaders above.  
 Arrange for or provide transportation to field events.  
 Arrange for or provide refreshments.  
 Arrange for and/or manage specific shooting events.  
 Conduct shoots during field trips or workshops.

### Best Time to Teach

Anytime after basic shooting form has been mastered

### Best Location

Classroom or other quiet location and appropriate ranges

### Time Required

1 hour (actual shooting experiences could cover several hours each)

### Materials/Equipment

- Assorted target types (NAA/FITA, NFAA, IBO, etc.)
- Bow-bird targets
- Stake and flag
- Clout rope
- Balloons
- Flu-flu arrows

### References

- Target Archery with Easton Aluminum Arrow Shafts.* Easton Aluminum, Inc. Van Nuys, CA.
- National Archery Association Instructor's Manual, third edition.* P. Baier, J. Bowers, C.R. Fowkes and S. Schoch. National Archery Association, Colorado Springs, CO. 1982.
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\* 4-H and Youth Development Specialist, Texas Agricultural Extension Service.

## Lesson Narrative

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Archery includes many different games, both formal and informal. International competitive shooting, including the Olympic Games, is governed by FITA, the Federation Internationale de Tir A l'Arc. The governing body for FITA-style shooting in the United States is the National Archery Association. These organizations govern archery shooting based on large, round, multi-colored targets shot at known distances over level ground.

Most other forms of target shooting with archery equipment take place under the governance of the National Field Archery Association. NFAA shooting varies more than NAA shooting, and includes activities for bow hunters. Several other organizations also sponsor specific formal competitive events for archers.

International shooting and American competitions in that style are relatively long-range games. These events are the equivalent of high-power rifle competitions, using open ranges and relatively large, multi-colored targets. Different courses of fire are used by men, women and young people of different ages. Cadets, kids under 12 years old, shoot at targets from 15 to 45 meters, while men over the age of 18 shoot at ranges from 30 to 90 meters. Targets for these events are either 80 centimeters (shorter ranges) or 122 centimeters (longer ranges) in diameter. The inner, gold-scoring area is worth 10 points and the outermost white scoring area is worth 1 point. International shooters must use conventional tackle (compound bows are not permitted), but most American shoots allow them. Sights, stabilizers and similar equipment are used by nearly all shooters, but release aids and a number of other devices commonly seen in other types of competitions may not be used.

Field archery is more complex. Both indoor and outdoor shoots are governed by NFAA, which uses smaller targets with a different scoring system at shorter ranges. Field courses are usually set up with a variety of terrain, target sizes, shooting angles and target types. Shooters may cover a course of 14 to 28 targets in a given round of shooting. Animal targets are used in some types of shoots. Usually round targets are black and white or blue and white with three scoring rings (scored 5, 4, 3 from the center out). Sometimes silhouettes or even steel targets with cutout "kill zones" are used. Shooters are usually classed by both age and the type of shooting equipment used, from bare bow to unlimited. Compound bows dominate the field, even though all types of equipment can be seen.

In addition to these formalized types of shooting, archers may enter other types of formal or informal shooting games. They can play golf, often using different types of arrows for different types of shots. They can shoot at huge, 48-foot horizontal targets at long range in the game of clout shooting. They can try their hand at wing shooting using hand-thrown bow birds or even mechanically launched disc targets. Some archers rove the woods and fields shooting at safe targets, like clumps of grass, leaves or small rotten stumps. Others may play "poker" by shooting at cards on a target face of tic-tac-toe by shooting at the spaces on a target or balloons on a target butt. Any of these are appropriate shooting games for the archer.

While the formal games have documented rules, the informal games you invent can have any set of rules you decide. You are only limited by your imagination. The main things to remember in games are:

1. Safety must be carefully and completely considered at all times.
2. Perfect practice makes perfect shooting (good shooting form is essential to all shooting).
3. Keep it fun by balancing skill and challenge.

Have a good time trying some archery games, competitive ones with other shooters or skill-building ones you can play alone. It is almost impossible not to enjoy yourself while shooting arrows down range.

## **Summary Activities**

1. Shoot at least one type of formal target archery game. If possible try several different types of target shooting during a series of field trips where the sites and the opportunities present themselves.
2. Have participants' research different archery games and present a summary of the rules and courses of fire to the group.
3. Attend and archery shoot and observe the processes used in conducting it. Assist or co-sponsor a shoot if the young people are prepared to do so.
4. Organize and conduct an invitational archery shoot of your choice for the youth in your area or in neighboring counties.

## **Exhibit and Sharing Ideas**

1. Construct a model of an archery shooting field or range and explain the course of fire used.
2. Photograph a tournament or match and tell the story with photographs and appropriate captions.
3. Research an archery game. Write rules, course of fire and history. Exhibit in your shooting sports notebook or journal.
4. Exhibit your notebook or journal with scores, comments and notes on a series of events in which you have participated.
5. Demonstrate an established game for your club or other groups.
6. Arrange a shoot for other members of your club or another group, featuring a game of your preference.

## Trajectory and Trajectory Experiments

Many people think that bullets, shot or arrow travel in straight lines just like light. It does not take much shooting experience to realize that projectiles and light behave quite differently. The physics of projectiles (ballistics) is discussed at the end of this fact sheet for those interested. The main purpose of this material is to help you understand how trajectory enters into shooting.

Under normal conditions, light travels in straight lines. Changes in the density of substances it passes through may deflect it, but within substances of fairly uniform density (like air) light travels in straight lines. Electromagnetic forces, like magnets can bend light, but it has not mass (weight).

Projectiles like bullets or arrows have mass. As a result, they respond to gravity under normal conditions. As soon as an arrow leaves the string or a bullet leaves the muzzle, it begins to fall, accelerating toward the earth under the influence of gravity. In fact, if an arrow or bullet was fired parallel to the surface of the earth on level ground, it would hit the earth at the same time as one dropped from the same height at the same time – much farther away, but at the same time.

In addition to their mass, projectiles are solid objects. Pushing them through a dense medium, like air, causes friction and turbulence. Both forces affect the projectile immediately. The projectile begins to slow down as soon as it leaves the string or the

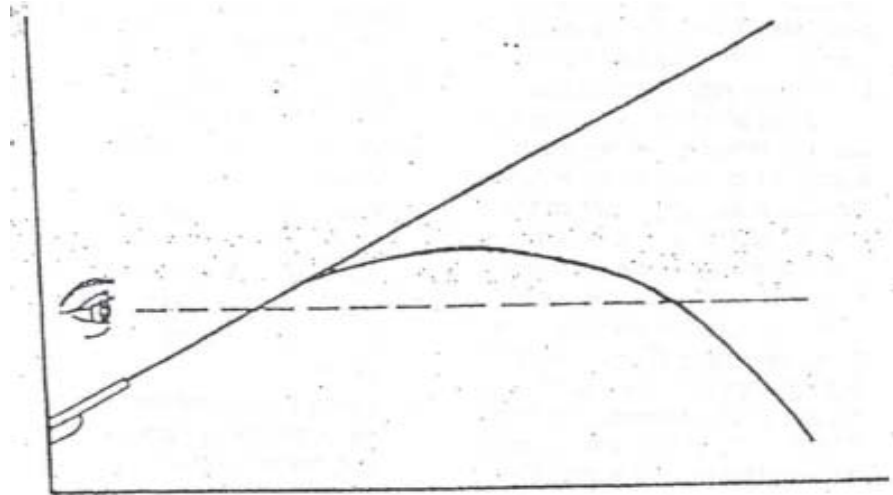
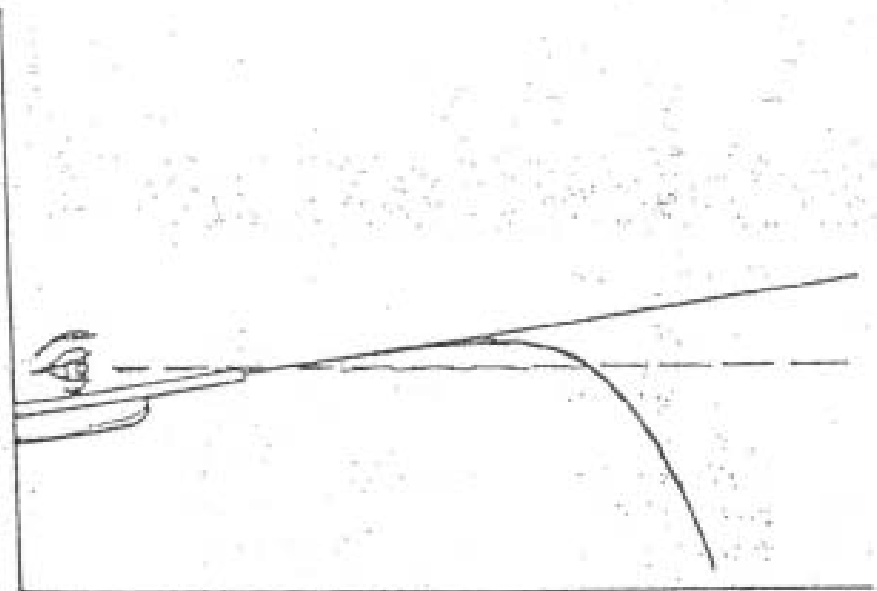


Figure 1 Relationships among line of sight, line of bore, flight paths and drop

muzzle. The slowing influence is cumulative until the projectile finally comes to rest.

These two factors combined cause projectiles to follow a curved flight path. If two straight lines are used to show the line of the bore or the resting position on the string and the line of sight, the line of flight (path of the projectile) would relate to those lines as shown below (Figure 1).

The curved flight path requires that the bore must be pointed above the line of sight to hit a distant object on the line of sight. If the sights are above the bore or the arrow, it must cross the line of sight twice, once while rising and a second time while falling toward the earth. The exact shape of the trajectory curve can be determined by complicated mathematics or by testing. Actual testing yields better results for a given shooter and



his or her equipment and is more easily understood.

The projectile accelerates toward the earth at a rate of about 9.8 meters/second<sup>2</sup>). If the projectile was fired parallel to the ground, it would drop 4.9 centimeters (0.16 feet) in the first 0.1 second, 19.6 centimeters (0.64 feet) in 0.2 second, 122.5 centimeters (4 feet) in 0.5 second, and 490 centimeters (16 feet) in 1 second (Table 1). In 3 seconds it would have dropped 44.1 meters (144 feet). If a projectile were able to travel at a constant velocity of 60.96 meters/second (200 feet/second), the trajectory would look like the graph in Figure 2. The actual flight path would curve more sharply downward, since the projectile would be slowing its horizontal motion as gravity pulls it to earth.

You can calculate the trajectory of your personal equipment as you have it set up using the worksheet attached. Shoot the same arrows throughout the experiment if possible. If not, shoot matched arrows with matched fletching. Leave the sight setting the same for all shots and use the same aiming point for each shot and all distances. Measure from the aiming point to the center of the group of arrows and carefully record the distance above (+) or below (-) the point of aim for each distance. Stop shooting if the arrows are falling short (or nearly falling short) of the target. Plot the flight path of the arrows relative to the line of sight. The elevation angle can be calculated if desired by following these steps.

1. Measure the true draw length of the arrow at full draw (the distance

from the anchor point to the arrow rest).

2. Measure the height of the sight pin above the arrow rest.
3. Measure the height of the center of the eye above the bottom of the arrow shaft at the anchor point.
4. Subtract the sight pin height from the eye height.
5. Divide that length by the true draw length.
6. The dividend is the natural sine of the angle of elevation from the horizontal.
7. Use the sine table to locate the angle with that sine value.
8. Plot a horizontal line through the eye and sight to the center of the target.
9. Plot a line starting with the distance from the eye to the anchor point below the line of sight at the calculated angle of elevation above horizontal. This is the line of the shaft or the line of the bore.
10. Plot the true line of flight at the distances selected.

This same procedure can be used with rifle bullets, but a longer range is needed and the differences in impact points should be recorded in centimeters or inches rather than meters or feet.

### **For Those Who Want to Know More**

Ballistics is the science of projectiles. It focuses on the dynamics of projectile flight and the energy stored and released by the projectile. One of the components of ballistics is the study of trajectory, the flight path of projectiles. In shooting,

trajectory relates the straight line of sight to a target with the curved flight line of the projectile. The ballistics of bullet or arrow trajectory involve

complex concepts in physics and engineering.

Newton's first law, the law of inertia, states that objects tend to remain at rest or to travel in a straight line at a constant speed unless they are acted upon by an outside force. For projectiles, the forces include the energy that accelerates them initially, the acceleration of gravity, friction of the air and drag. Projectile mass, shape and even construction can influence those forces. Complex formulas have been developed to calculate the projectile's ability to retain its energy and velocity (speed in a direction). Sectional density and ballistic coefficient are two measures of the "slipperiness" of a projectile.

A projectile starting at rest is accelerated by the stored energy of the limbs, air charge or expanding gasses of the fired round. The internal ballistics (those inside the firearm bore or while the arrow is on the rest) limit the motion to horizontal and vertical vectors (components of the total velocity of the projectile). Under most conditions, the horizontal velocity is greatest.

External ballistics are more complex, and they begin as soon as the projectile leaves the bore or the bow. The horizontal vector of velocity is measured by its horizontal speed toward the target. The vertical vector is measured by its speed upward, perpendicular to the surface of the earth. Both the horizontal and the vertical vectors of velocity begin to decrease immediately. Friction and turbulence in the air reduce the horizontal



velocity. The pull of gravity reduces the vertical velocity. Note that a negative acceleration or velocity in the vertical component means the projectile is moving toward the earth rather than away from it. Wind currents or the rotation of the projectile may cause a lateral movement.

High initial and retained velocities result in a "flatter" trajectory. That is, the arc of the projectile from the shooter to the target is less peaked. The less time the projectile is in flight, the less outside forces influence it. The obvious conclusion is that "faster is better." However, obtaining optimum ballistic performance involves balancing competing factors rather than simple maximization of any one factor. Limits are imposed by the chemical structure of the powder, strength of the materials used, mass of the firearm and the strength or recoil resistance of the shooter. Other factors, like barrel life, consistency in energy release, economics, projectile construction and many more reduce the upper limit toward some optimum value.

Changing a single factor of the internal ballistics can result in major changes in external ballistics. Altering the mass of a projectile results in changing its shape. Both sectional density (a measure of the mass divided by the diameter or basal area) and ballistic coefficient (a measure of the bullet's ability to

overcome resistance of the air which involves sectional density in its calculation)

Are related to the shape of the bullet. Optimizing mass and initial velocity with performance and terminal velocity involves many factors.

The results of changing bullet mass may be surprising. An empirical test could be done using bullets of similar shaped and diameter but different weights. Thirty caliber bullets are available in flat-based spitzer shapes in weights from about 110 grains to 200 grains. Interested shooters could fire a test series with each bullet weight and compare trajectory curves to determine the optimum bullet weight for that shape in their rifle.

Both momentum and energy are related to the velocity and mass of the projectile. Momentum is the product of the mass and the velocity. Kinetic energy (the energy of moving objects) is the product of the mass and the square of the velocity divided by two. Projectile use is a major determining factor in balancing momentum and energy. When a projectile comes to rest, the remaining energy and momentum are translated into penetration and shock. On target ranges bullets and arrows need only enough momentum and striking force to penetrate the target. The shot must have enough remaining energy and momentum to break clay targets. In hunting situations,

small game arrows, shot and bullets kill by hydrostatic shock. The energy of the striking bullet displaces water in the tissue, causing immediate disruption of vital functions. Momentum is not Critical, but kinetic energy is. Big game arrows kill by penetration and hemorrhage. Very little hydrostatic shock is produced, so momentum is much more important than kinetic energy. Big game bullets must combine shock with adequate penetration to reach vital areas. Considering the use of the projectile adds complexity to making ballistic decisions. This may explain the large array of arms and ammunition available today. Many ballistic experiments can be tried by shooting sports participants. Most would be worthy of entry in science fair competitions under the categories of physics and engineering. Altering one factor at a time, such as sectional density or velocity, may offer easier explanations of the events taking place. For the shooter more interested in performance on targets or game, the arms and ammunition companies have tables that can assist in selecting the appropriate combinations of factors to do the job at hand. Wise shooters will test the listed values for themselves using their own firearms, particularly where the shape of a trajectory curve is concerned. Their observed data is much more valuable than the theoretical data from the tables.

Table 1. Theoretical values for drop from the acceleration of gravity and distance traveled for idealized projectiles fired parallel to the surface of the earth at a constant velocity of 60.96 meters/second (200 feet/second) and 914 meters/second (3000 feet/second) is given below. The lower velocity corresponds to a very fast arrow. The higher velocity approximates a high velocity center-fire rifle cartridge.

Time (sec.)	Distance Dropped		Distance Traveled @ 200 ft/sec		Distance Traveled @ 3000 ft/sec	
	(cm)	(ft)	(m)	(ft)	(m)	(ft)
0.1	4.9	0.16	6.1	20	91.4	300
0.2	19.6	0.64	12.2	40	182.8	600
0.3	44.1	1.44	18.3	60	274.2	900
0.4	78.4	2.56	24.4	80	365.6	1200
0.5	122.5	4.00	30.5	100	457.0	1500
0.6	176.4	5.76	36.6	120	548.4	1800
0.7	240.1	7.84	42.7	140	639.0	2100
0.8	313.6	10.24	48.8	160	721.0	2400
0.9	369.9	12.96	54.9	180	822.6	2700
1.0	490	16.00	61.0	200	914.0	3000
1.25	765.6	25.00	76.2	250	1142.5	3750
1.5	1102.5	36.00	91.4	300	1371.0	4500
1.75	1500.6	49.00	106.7	350	1599.5	5250
2.0	1960	64.00	121.9	400	1828.0	6000



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<b>QUALIFICATION ROUNDS FOR INDOOR RECURVE DIVISION</b>				
JOAD Qualified	30 arrows	9 meters	Score 30	60 cm Target Face
Yeoman	30 arrows	18 meters	Score 30	60 cm Target Face
Jr. Bowman	30 arrows	18 meters	Score 50	60 cm Target Face
Bowman	30 arrows	18 meters	Score 100	60 cm Target Face
Jr. Archer	30 arrows	18 meters	Score 150	60 cm Target Face
Archer	30 arrows	18 meters	Score 200	60 cm Target Face
Master Archer	30 arrows	18 meters	Score 250	60 cm Target Face
Expert Archer	30 arrows	18 meters	Score 270	60 cm Target Face
Olympian	30 arrows	18 meters	Score 290	60 cm Target Face

<b>QUALIFICATION ROUNDS FOR INDOOR COMPOUND DIVISION</b>				
JOAD Qualified	30 arrows	9 meters	Score 30	40 cm Target Face
Yeoman	30 arrows	18 meters	Score 30	40 cm Target Face
Jr. Bowman	30 arrows	18 meters	Score 50	40 cm Target Face
Bowman	30 arrows	18 meters	Score 100	40 cm Target Face
Jr. Archer	30 arrows	18 meters	Score 150	40 cm Target Face
Archer	30 arrows	18 meters	Score 200	40 cm Target Face
Master Archer	30 arrows	18 meters	Score 250	40 cm Target Face
Expert Archer	30 arrows	18 meters	Score 270	40 cm Target Face
Olympian	30 arrows	18 meters	Score 290	40 cm Target Face





**Tournament Name**

**Location**

Effective  
April 1, 2006

Archer's Name _____
Division _____ Rank _____
Starting Target No. _____

1/32 <sup>nd</sup> ELIMINATION							
1	2	3	4	5	6	End	Running Score
10s		Xs		1	2	3	Shoot-off

Archer's Signature \_\_\_\_\_

Opponent's Printed Name \_\_\_\_\_

Opponent's Signature \_\_\_\_\_

Opponent's Score \_\_\_\_\_

1/16 <sup>th</sup> ELIMINATION							
1	2	3	4	5	6	End	Running Score
10s		Xs		1	2	3	Shoot-off

Archer's Signature \_\_\_\_\_

Opponent's Printed Name \_\_\_\_\_

Opponent's Signature \_\_\_\_\_

Opponent's Score \_\_\_\_\_

1/8 <sup>th</sup> ELIMINATION							
1	2	3	4	5	6	End	Running Score
10s		Xs		1	2	3	Shoot-off

Archer's Signature \_\_\_\_\_

Opponent's Printed Name \_\_\_\_\_

Opponent's Signature \_\_\_\_\_

Opponent's Score \_\_\_\_\_

1/4 Final				
1	2	3	End	Running Score
10s	Xs			
		1	2	3
				Shoot-off

Semi Final				
1	2	3	End	Running Score
10s	Xs			
		1	2	3
				Shoot-off

Gold / Bronze				
1	2	3	End	Running Score
10s	Xs			
		1	2	3
				Shoot-off

Archer's Signature \_\_\_\_\_

Opponent's Printed Name \_\_\_\_\_

Opponent's Signature \_\_\_\_\_

Opponent's Score \_\_\_\_\_

Archer's Signature \_\_\_\_\_

Opponent's Printed Name \_\_\_\_\_

Opponent's Signature \_\_\_\_\_

Opponent's Score \_\_\_\_\_

Archer's Signature \_\_\_\_\_

Opponent's Printed Name \_\_\_\_\_

Opponent's Signature \_\_\_\_\_

Opponent's Score \_\_\_\_\_

## Name of Indoor Tournament

Location

Date



Archer Name: _____
Category: _____
Target No. _____

SIGNATURES

Archer: \_\_\_\_\_

Scorer: \_\_\_\_\_

Scorer: \_\_\_\_\_

Official: \_\_\_\_\_

End	1	2	3	End Total	Running Total
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Total 60 Arrows					

Summary	10s	9s	Score
Totals			



Archer Name: \_\_\_\_\_

Category: \_\_\_\_\_

Target No. \_\_\_\_\_

End	1	2	3	End Total	Running Total	Name of Tournament Date Location
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

				Total	
Summary	10s	9s	Score		

SIGNATURES  
 Archer: \_\_\_\_\_  
 Scorekeeper: \_\_\_\_\_  
 Scorekeeper: \_\_\_\_\_









**JOAD CLUB:** \_\_\_\_\_

Date: \_\_\_\_\_

Location: \_\_\_\_\_

36 ARROWS								End Total	Running Score
	1	2	3	4	5	6			
1									
2									
3									
4									
5									
6									
Total									

Signatures	
scorer:	_____
scorer:	_____
archer:	_____
official, if necessary:	_____

Summary			
Circle Distance Shot	10s	Xs	Score
90m / 70m / 60m / 50m / 40m / 30m / 25m / 20m			

Print Name: \_\_\_\_\_

Division (Bow): \_\_\_\_\_

Class (Age): \_\_\_\_\_

Achievement: \_\_\_\_\_



**JOAD CLUB:** \_\_\_\_\_

Date: \_\_\_\_\_

Location: \_\_\_\_\_

36 ARROWS								End Total	Running Score
	1	2	3	4	5	6			
1									
2									
3									
4									
5									
6									
Total									

Signatures	
scorer:	_____
scorer:	_____
archer:	_____
official, if necessary:	_____

Summary			
Circle Distance Shot	10s	Xs	Score
90m / 70m / 60m / 50m / 40m / 30m / 25m / 20m			

Print Name: \_\_\_\_\_

Division (Bow): \_\_\_\_\_

Class (Age): \_\_\_\_\_

Achievement: \_\_\_\_\_

\_\_\_\_\_  
**JOAD CLUB**  
\_\_\_\_\_  
DATE:  
\_\_\_\_\_  
LOCATION:



36 ARROWS					Running Score
	1	2	3	End Total	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
Total					

Signatures	
scorer:	_____
scorer:	_____
archer:	_____
official, if necessary:	_____

Summary			
Circle Distance Shot			
90m / 70m / 60m / 50m / 40m / 30m / 25m / 20m			
10s		Xs	Score

Print Name: \_\_\_\_\_  
Division (Bow): \_\_\_\_\_  
Class (Age): \_\_\_\_\_  
Achievement: \_\_\_\_\_

\_\_\_\_\_  
**JOAD CLUB**  
\_\_\_\_\_  
DATE:  
\_\_\_\_\_  
LOCATION:



36 ARROWS					Running Score
	1	2	3	End Total	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
Total					

Signatures	
scorer:	_____
scorer:	_____
archer:	_____
official, if necessary:	_____

Summary			
Circle Distance Shot			
90m / 70m / 60m / 50m / 40m / 30m / 25m / 20m			
10s		Xs	Score

Print Name: \_\_\_\_\_  
Division (Bow): \_\_\_\_\_  
Class (Age): \_\_\_\_\_  
Achievement: \_\_\_\_\_



**JOAD CLUB:** \_\_\_\_\_

Date: \_\_\_\_\_

Location: \_\_\_\_\_

36 ARROWS						End Total	Running Score
1	2	3	4	5	6		
1							
2							
3							
4							
5							
6							
Total							

Print Name: \_\_\_\_\_

Division (Bow): \_\_\_\_\_

Class (Age): \_\_\_\_\_

Circle Distance: 90m / 70m / 60m / 50m / 40m/ 30m / 25m / 20m

Scorer Signature: \_\_\_\_\_ Scorer Signature: \_\_\_\_\_

Archer Signature: \_\_\_\_\_

Official's Signature: \_\_\_\_\_



**JOAD CLUB:** \_\_\_\_\_

Date: \_\_\_\_\_

Location: \_\_\_\_\_

36 ARROWS						End Total	Running Score
1	2	3	4	5	6		
1							
2							
3							
4							
5							
6							
Total							

Print Name: \_\_\_\_\_

Division (Bow): \_\_\_\_\_

Class (Age): \_\_\_\_\_

Circle Distance: 90m / 70m / 60m / 50m / 40m/ 30m / 25m / 20m

Scorer Signature: \_\_\_\_\_ Scorer Signature: \_\_\_\_\_

Archer Signature: \_\_\_\_\_

Official's Signature: \_\_\_\_\_

**Name of Indoor Tournament**

Location: \_\_\_\_\_

Date: \_\_\_\_\_

Archer Name: \_\_\_\_\_

Category: \_\_\_\_\_

Target No. \_\_\_\_\_

End	1	2	3	End Total	Running Total
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Total 60 Arrows					

End	1	2	3	End Total	Running Total
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Total 60 Arrows					



SIGNATURES

Archer: \_\_\_\_\_

Scorer: \_\_\_\_\_

Scorer: \_\_\_\_\_

Official: \_\_\_\_\_

Summary	10s	9s	Score
1st 600			
2nd 600			
Totals			