

# ***Elements of Form***

## ***The Drawing Arm***

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### **AIM:**

After the session you should:

- Be able to state a suitable objective of best practice for drawing arm use
- Be able to describe the anatomical and mechanical advantages of particular implementations
- Be able to prescribe a performance development programme to achieve best use of the drawing arm.

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### **OUTLINE:**

Introduction	Talk	5 min
Objectives for the drawing arm	Exercise	10 min
Anatomical foundation	Presentation, exercise & discussion	20 min
Mechanical principles	Presentation, exercise & discussion	20 min
Top archers and ideal form	Group exercise/discussion	15 min
Developing best form	Group exercise	15 min
Closing discussion	Discussion	10 min

### **Post session**

Homework

## Elements of form 1: The Drawing Arm Exercises

### ***Exercise 1: Objective***

Write a short statement of the objectives of good Drawing Arm use.

### ***Exercise 2: Safety and injury***

List the main types of injury affecting the drawing arm and hand.

### ***Exercise 3: Anatomical foundations***

i) Sketch the main bones of the drawing shoulder and arm at full draw, as seen from the front.

ii) Once at full draw, what movements of drawing arm scapula, clavicle and upper arm will draw the bowstring further?

iii) Sketch (on a separate diagram if necessary) the main muscles involved in drawing and holding the string.

### **Exercise 4: Forces**

Sketch an archer at full draw, seen from a) the front and b) the top (i.e. show the drawing and bow arms). In each diagram, indicate the main forces acting around the drawing arm and shoulder.

a) Front view

b) Top view

### **Exercise 5: Efficiency**

a) Given the forces and muscles involved, what arrangement (or arrangements) of the drawing arm and shoulder minimise the muscular forces involved at the drawing arm? (Hint: consider where the draw force line passes relative to the main joints)

b) Are the best arrangements for the drawing arm also best for the bow arm?

### **Exercise 6: Analysing technique**

i) Fingers and arms

Place your drawing hand flat on your chest. Note that the back of the hand is vertical. Look along your normal aiming direction (left for a right/hander), and raise the drawing arm so that the hand touches the line of the jaw. Check the orientation of the drawing hand; was the back still vertical? Move the hand further, to a cheekbone reference. How easy is it to maintain a vertical hand position? Comment on the implications for recurve target shooting, field face-walkers, and compound shooting.

ii) Follow through

a) Considering the forces identified in exercise 3, what is the likely drawing arm movement (if any) on loosing? (Hint: Which forces disappear? Which remain?)

b) Discuss what happens to the shoulder blade on release?

iii) Top archers' form

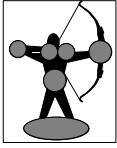
Examine and discuss the available material on top archers.

a) Are there consistent features of drawing arm use, and if so, what are they?

b) In general, do top archers appear to follow the 'best efficiency' arrangements identified in Exercise 4?

***Exercise 7: Developing technique***

Briefly identify the main physical requirements for executing "best" drawing arm technique, in terms of individual muscle condition and flexibility. How could these requirements be developed?



## Elements of form: The Drawing Arm

### Notes

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#### 1 Objective

The drawing arm provides much of the energy for the shot, takes the force of the draw on the fingers and is one of the two key reference points in aiming the bow.

Objectives should include

- Safe use, with particular attention to prevention of chronic injury
- Efficient use of muscles (usually corresponding to minimal use)
- Consistency in reference position
- Consistent release of the string (which is usually interpreted as minimal interference)

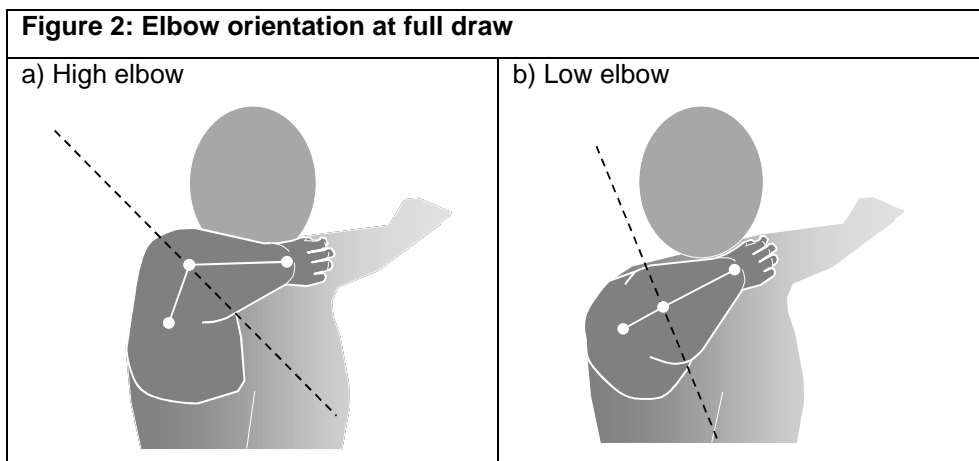
#### 2 Anatomical foundation

##### 2.1 Bone structure

The bone structure of the bow arm and hand are shown in Figure 1 (from reference 1).

Important features are:

- The complex bone structure in the hand and wrist, and the different lengths of the drawing fingers.
- The radius and ulna, attached to the lower end of the humerus. The radius and ulna have some rotational freedom at the elbow, which behaves as a whole as a hinge joint with limited rotational freedom. This limitation is important for archery, since in the 3-fingered Mediterranean grip on string, the hand is almost fully pronated (rotated outward). The back of the hand can only remain vertical (parallel to the string) with the arm approximately horizontal (Figure 2 shows the elbow hinge line in two cases).



- The humerus, a single large bone. The upper end is located in the shoulder joint via a relatively loose ball and socket joint (the glenoid cavity). The range of movement is considerable and includes rotation as well as flexion. Because the head of the humerus does not fit exactly in the glenoid cavity, however, there is some scope for lateral movement in the joint. Upward movement of the arm is limited by contact between the humerus and the top of the scapula (acromial process); the arm cannot be raised much past the horizontal without raising the scapula and clavicle..

- The shoulder blade, or scapula. Attached to the skeleton only by the clavicle, the scapula can slide across the back, rotate and slide up or down within its range of movement. It is held in place primarily by muscle action.
- The collar-bone, or clavicle. The outward tip of the clavicle supports the scapula. The inner end is fixed to the upper part of the sternum. If the scapula moves inward, the clavicle pivots around the sternum, and the shoulder joint moves back. Notice that at full draw, this movement does not move the shoulder joint outwards at all. At full draw, movement of the drawing hand along the direction of the draw can only come from movement of the upper arm.

The angle between drawing arm and draw force line depends in part on the position of the scapula. The further forward or outward the scapula, the further forward the drawing elbow will be for a given hand position.

With the longer finger in between two shorter fingers, it is impossible to take any drawing pressure on the middle finger without muscle action (it cannot just 'hook on' unaided).

### *2.1 a) Implications for good practice:*

(see also mechanical considerations)

- A high elbow or high reference point will tend to twist the drawing hand away from the vertical if the forearm is held horizontal. Combined with the different finger lengths, this will make a full 3-finger grip difficult.
- Alignment of the drawing forearm with the direction of the draw force of the bow is facilitated by inward and downward movement of the scapula
- Movement of the scapula alone does not provide movement of the bow hand *unless* the upper arm is 'locked' to the scapula via the connecting muscles.

## 2.2 Musculature

The most important muscles are those around the shoulder joint and upper back. In particular

- The deltoid, attached to the humerus, scapula and clavicle. Primarily lifts the arm; it also assists in pulling the arm to the rear or to the front when extended.
- Trapezius and rhomboids; upper back muscles, primarily useful in inward movement of the shoulder blade.
- Rotator cuff musculature. A collection of muscles important in rotating the upper arm and in controlling and supporting the humerus in the shoulder joint.

Other important muscles include

- The latissimus dorsi, which pull the humerus downward (abduction) and, to an extent, backward
- The biceps, and brachial, largely responsible for bending the elbow. The triceps are not necessary to draw the bow, and if used generate outward movement of the hand on release..
- Supinator and pronator groups, chiefly deep muscles located near the elbow joint, rotate the wrist.
- Wrist extensor and flexor groups in the forearm extend and flex the hand at the wrist.
- Muscles of the thumb: about eight muscles controlling the thumb, particularly those controlling inward movement. Some of these are 'wired' to act in opposition to the flexors for the ring and little finger, so palm tension may show as inward movement of the thumb. Also, a thumb-and-finger failsafe release aid which relies on relaxing the little finger at the same time as tightening the thumb (or vice versa) actually involves a very unnatural combination of movements.

During the draw and shot, the main active muscles are the finger flexors in the forearm, the biceps, and brachial early in the draw, and latissimus dorsi, posterior deltoid, trapezius and rhomboid (late in the draw and shot). However, nearly all the muscles in and around the shoulder are needed to control the movement and stabilise the joint.

Many of these muscles, particularly back muscles, are little used in daily life, so some conditioning, or at least, bow weight progression, is essential in early archers. Peak strength and endurance under tournament conditions will also normally require specific conditioning.

### *2.2 a) Implications for good practice:*

- Muscles in and around the bow shoulder joint and upper back are critically important and will need specific conditioning for peak performance.
- The posterior deltoid, rhomboids and trapezius are heavily loaded and require most conditioning.
- Rotator cuff development is indicated for injury prevention (below).

Note: Normal training principles apply. General toning is probably adequate for most club archers; for top athletes, more specific training – matching the loading pattern and timing in archery - is suggested. Note that shooting does itself provide a degree of specific conditioning, but overload is required for progression. Also note that most good training practice includes antagonist training, especially where rapid movement is involved.

## 2.3 Safety and injury

Probably the most common drawing arm/hand injury is blistering or other fingertip damage. Though easily remedied, blisters, subsequent callousing, cracking and soreness may stop someone shooting unless prevented where possible and treated properly. Preventive measures include appropriate finger protection, appropriate finger placement and even finger use on the string. Extensive blistering is often associated with undue tension in the drawing fingers, poor finger placement, or rotation of the hand after string placement ('dog-legging' the string).

More serious injuries include tendonitis in drawing hand (especially palm) and elsewhere in the arm, caused by overuse or, possibly, by overtraining. Tendonitis is normally treated by extended rest and cautious return to full load. The most vulnerable joint is the shoulder. The most frequently quoted study (Mann and Littke) identified marked prevalence of rotator cuff injury in a small group of female archers. The risk of rotator cuff injury is reduced by flexibility training and general rotator cuff conditioning. Treatment is essentially long term rest followed by rehabilitation; since chronic rotator cuff injury may take months to subside, it is well worth avoiding.

### *Implications for good practice:*

- Finger placement on the string should provide (as far as possible) even finger use, a relaxed hand at full draw, and minimal rotational pressure.
- Mann (reference 1) recommends including rotator cuff conditioning (toning only) in training programmes to reduce chances of rotator cuff injury.

## **3 Mechanical principles**

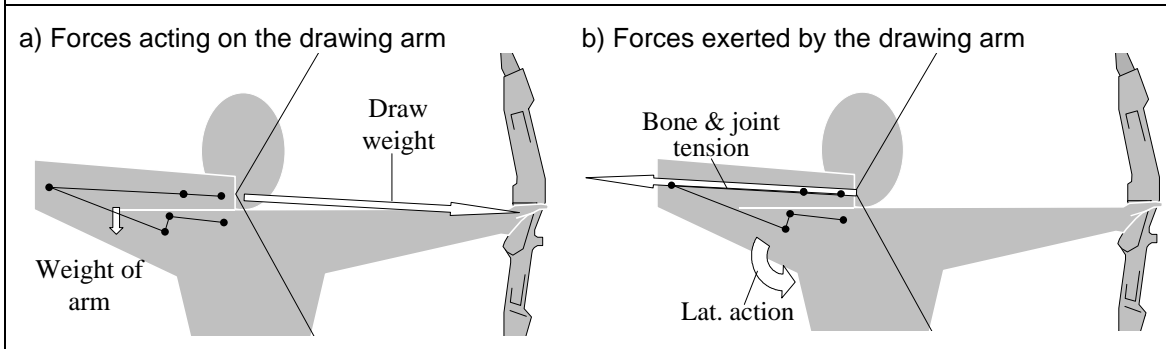
### 3.1 Main Forces

Figures 3 and 4 show the main forces acting at full draw, from the front and top respectively. These are:

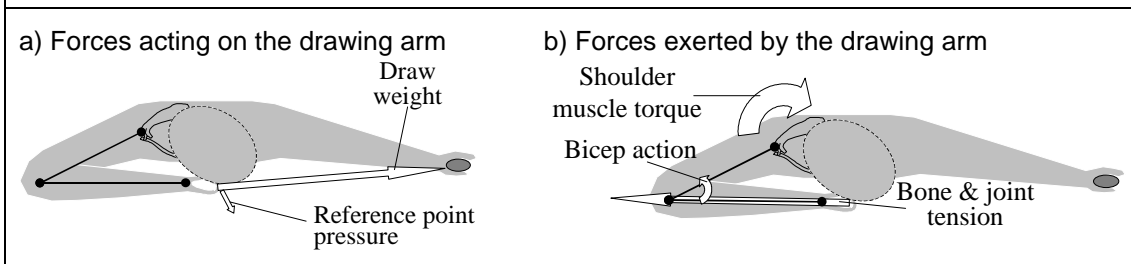
- The draw weight of the bow acting from the drawing fingers toward the bow hand pressure point.
- The weight of the arm
- Any forces resulting from the hand/face contact at the reference (anchor) point.

- The force exerted by the drawing hand on the string and reference point.

**Figure 3: Main forces at full draw: Front view**



**Figure 4: Main forces at full draw: Top view**



## 3.2 Muscles and forces

### 3.2 a) Muscles

It is worth considering which muscles are needed to generate the bow arm forces involved in holding the bow, and how they are transmitted.

- The back muscles (primarily rhomboid and trapezius) pull the shoulder blade towards the spine.
- In turn, the posterior deltoid and other shoulder muscles (possibly) pull the drawing arm humerus back, pivoting around the shoulder joint and holding the elbow back.
- The bicep and brachial generate any force necessary to hold the forearm into the reference point and, if the elbow is far forward, support the draw force of the bow. With extreme extension (substantially past the draw/force line), the triceps may add marginally to the drawing force, but in general their effect in the direction of the draw force line is negligible.
- The finger flexors curl the fingers and contribute somewhat to the force acting on the string.

### 3.2 b) Forces

The exertion needed from each muscle is extremely sensitive to the position of the drawing elbow relative to the draw/force line, and to the position of wrist and fingers. The effects are illustrated in turn.

#### i) Elbow position

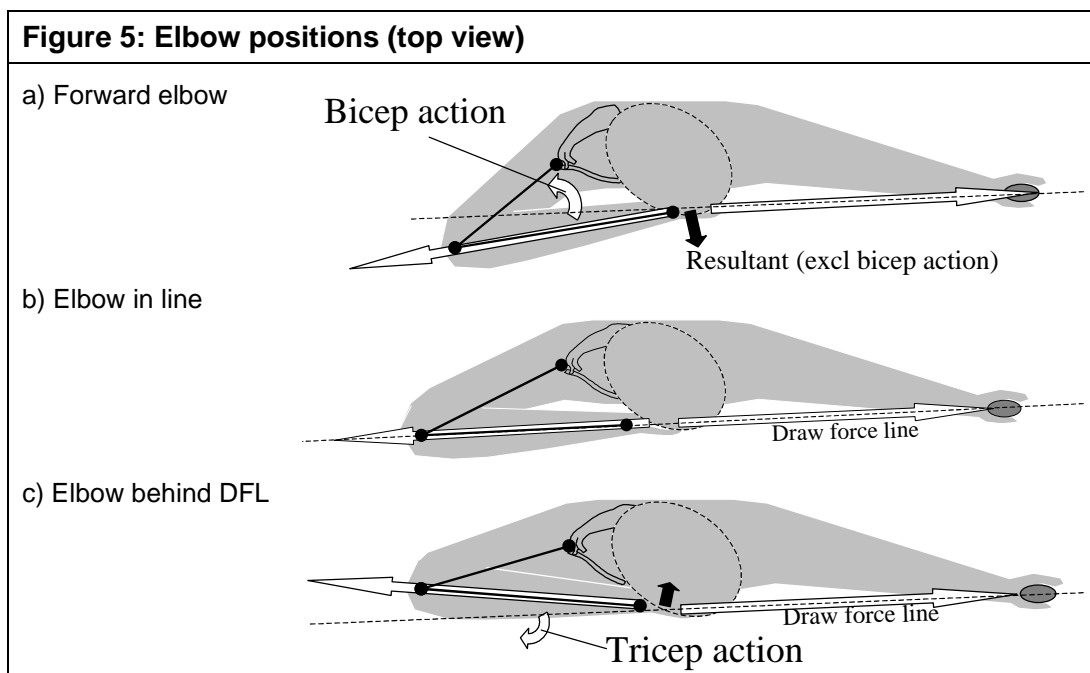
Figure 5 shows three positions for the drawing elbow. In Figure 5a, the elbow is well forward of the draw force line. The forward force from the bowstring and backward force generated by the drawing arm are out of line, with a resultant force (black arrow) outward from the reference point. To counter this force and maintain good face contact, the bicep has to



contract, holding the hand into the reference point. In extreme cases, the bicep is generating a significant portion of the drawing force. A rough calculation suggests that for moderate displacements, the bicep needs to generate a lateral force at the string of about 5% of the draw weight for every inch the elbow is out of line.

In Figure 5b, the elbow joint is essentially in line with the forward force of the bowstring. The drawing arm force acting between elbow and hand is neatly in line with, and opposite to, the force of the bowstring. There is little or no lateral force required; the only muscle use necessary is the finger flexors.

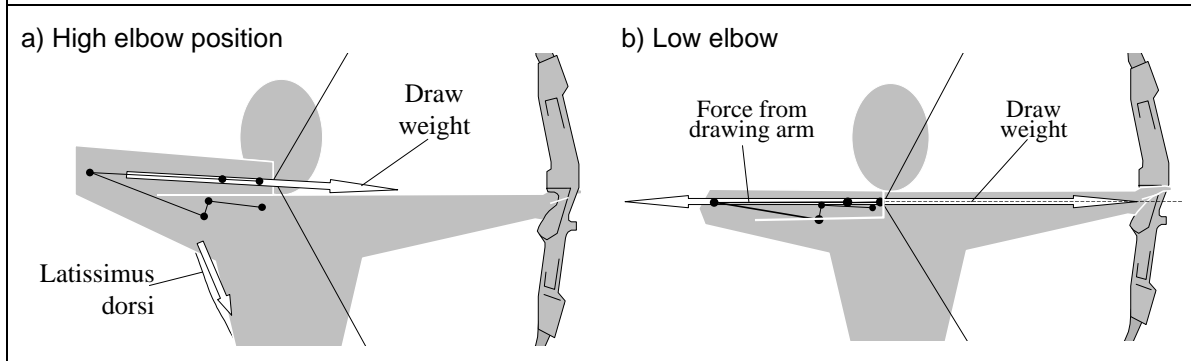
In Figure 5c the elbow is behind the draw-force line. The resultant force (again shown in black) is inwards against the reference point. That force is countered either by additional pressure from the head against the drawing hand, or by contraction of the triceps (shown).



Notice that in all positions in Figure 5a-c, the draw-force line passes at the same distance from the drawing shoulder. The force acting at the shoulder is therefore the same in all these figures. However, changes in the relationship between drawing shoulder and draw-force line do affect the forces acting at the shoulder. Briefly, the smaller the distance between drawing shoulder and draw-force line, the smaller the shoulder muscle use needs to be to hold the arm back in the full draw position.

This is perhaps more important in the vertical plane. Figure 6 shows two elbow positions from the front. In 6a (elbow high) the draw-force line passes well above the shoulder. The bowstring tension then tends to rotate the drawing arm around the shoulder. To counter this, the latissimus dorsi are very likely to be in use, pulling the upper arm downward as shown (the drawing arm force is not shown). With the latissimus dorsi in use, the drawing elbow will normally move downward on release as the bowstring tension disappears. In 6b, with the elbow level with the shoulder joint, essentially no vertical forces are needed; on release, the arm would move horizontally. Even in 6b, however, the upper arm (humerus) is inclined slightly upward from the shoulder joint, simply to maintain some semblance of face contact. In practice, it is very difficult to maintain a low elbow and keep a sound face reference.

**Figure 6: Elbow positions (Front view)**



### ii) Hand and finger position

Three general wrist positions are possible:

- *Wrist cocked outward.* Both the wrist extensor muscles and the finger flexors are needed to hold the string.
- *Wrist and fingers aligned with the draw force.* Minimal wrist and finger flexion are needed; the hand is, as nearly as possible, relaxed.
- *Wrist curled inward.* Inward flexion of the wrist is maintained by additional finger flexion and wrist flexor use.

In general, the more closely aligned the hand and fingers, the less superfluous muscle use is necessary.

It is also sensible to ask where the string should be placed on the fingers. Mechanically, close to a joint is most likely to minimise muscle use. Clearly, use of the second joint (closer to the hand) risks considerable interference with string and arrow, so a position close to the outermost joint is preferred. In practice, placing the string just inside the first joint at the beginning of the draw keeps the string as close as practically possible to the joint during the draw. If the string is initially placed beyond the joint, the tendency is for it to migrate toward the fingertips, increasing the load on the flexors and making a clean loose harder.

### Implications for best practice

- Minimising the angle between forearm and draw-force line minimises lateral forces.
- Minimising the distance between drawing shoulder and draw-force line minimises the effort necessary at the shoulder joint
- A high draw-force line requires muscle action to maintain a level draw force.
- Keeping the draw hand straight minimises finger and wrist flexor use.
- Placing the string just behind the first joint is currently the preferred initial position.

In practice, several compromises are necessary. There are mechanical advantages for the bow arm in a slightly high draw-force line, which minimises bow shoulder deltoid use. Similarly, keeping the bow shoulder close to the draw force line is likely to promote better fine control at the bow shoulder. It follows that it is practically impossible to minimise muscle effort for one arm without increasing effort in the other. Broadly, the most efficient position with maximum bow arm control follows the guidelines below;

- minimise the distance between bow shoulder and draw-force line while keeping safe string clearance.
- having found an efficient bow shoulder position, minimise the distance between drawing shoulder and draw-force line
- place the elbow close to the resulting draw-force line.

## **4 Developing best practice**

### **4.1 Strength and flexibility requirements**

The drawing arm and shoulder are heavily used in archery. Recommended conditioning is 'toning' (moderate to high repetitions with moderate load), coupled with flexibility maintenance (stretches). Strength development may be necessary for major muscle groups, particularly the trapezius, rhomboids and posterior deltoid.

It is important to condition ALL the shoulder muscles; many are invoked post-shot by stretch reflexes or other rapid movements; all are important in stabilisation and fine control. Normal conditioning practice (within sessions) is to warm up, exercise larger muscles first and progress to smaller muscles later.

In general, for developing club archers, shooting alone provides basic conditioning provided that bow weight is increased progressively. However, if flexibility or strength prevent achievement of good alignment and appropriate shoulder positioning, flexibility and/or strength training may be needed to progress. Note, too, that most better archers either use high shooting volume, additional training, or both, to improve condition.

### **4.2 Skill development**

The most important elements of skill development for the drawing arm (as for the bow arm) are 'best' alignment and efficient muscle use. Skill development is accordingly likely to;

- Educate the archer on relevant mechanical principles (depending on the archer/coach relationship)
- Adopt a finger position consistent with the archer's elbow placement.
- Develop a good relaxed drawing hand. Use of a lightweight bow, with correct finger placement, helps. Conscious practice off the field (e.g. adopting a 'shooting grip' on shopping bags etc!) is often useful.
- Train for a good 'feel' for drawing elbow position and effective back use. Training aids such as elbow cups or the "FormMaster" pattern are useful. Video or photographic analysis will also help the archer see what alignment is being achieved.
- Move towards a pre-drawn T-draw for simplicity and consistency
- Develop consistent drawing technique through practice.

## **5 Bibliography**

1. Ray Axford, *Archery Anatomy*, Souvenir Press, London (1995). ISBN 0-285-63265-5
2. D L Mann, *Injuries in archery* in *Clinical practice of Sports Injury Prevention and Care*, P. A. F. H. Renström (Ed), Blackwell Scientific, London.
3. R McKinney, *The Simple Art of Winning*

## **Elements of form: The Drawing Arm**

### **Post-session Assignment**

#### ***1 Anatomy and function***

i) Sketch the main bones and muscles involved in use of the drawing shoulder and arm. Briefly state the function of each of the muscles at full draw.

ii) Briefly discuss the physiological and mechanical advantages or disadvantages of a low elbow position as opposed to a high elbow

iii) What do the rhomboid muscles do in drawing and shooting the bow?

#### ***2 Developing technique***

i) Explain how you would train for (i.e. exercise!) and develop good bow arm technique in a developing archer.

## Session feedback

Session: \_\_\_\_\_

Name (optional) \_\_\_\_\_

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

Do you think the session (including homework) met its objectives?

Fully  
 About right  
 Partly  
 Miles off

Difficulty rating;

Far too basic  
 Basic  
 About right  
 Difficult  
 Oh help!

Timing

Too long  
 About right  
 Too rushed

## General Comments

How do you think the session could be improved?

It would be particularly useful to have some indication of specific things that were not well explained, over-discussed, things that you think should have been discussed and were not.