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Intermediate Rigging

Editors: *Ted Daigneault (CAN), Matt Smith (USA), Thor S. Nilsen (NOR)*

1.0 INTRODUCTION

The FISA CDP Level I course in rigging, titled BASIC RIGGING, introduced the terminology of the principle parts of the boat and equipment as well as the basic adjustments and the tools necessary to make those adjustments. The course also emphasized the necessity of regular equipment maintenance and recommended measurements for club level boats.

This course will expand on those topics and, since the construction of modern boats allows the possibility of individualized rigging, emphasize adjustments that will assist the individual athlete. At the end of this booklet, there is a Table of Recommended Measurements for national level boats for reference. By the end of this course, you will be able to make proper adjustments to the equipment for a national level athlete.

Since the mid-1980s when the FISA Coaching Development Program began, composite materials have essentially replaced wood in the construction of oars and sculls as well as boats excepting the structural frame of boats. The detailed care and maintenance of equipment constructed with composite materials is different than when constructed with wood, but this information in beyond the scope of this program and is available from others sources either within FISA or directly from manufacturers. Though the mechanical principles have, of course, remain unchanged, there has been a change in the length of the oar or scull due to a dramatic alteration during the 1990s in the size and shape of the blade. This alteration has increased the holding power of the blade thus necessitating a shorter outboard distance otherwise the rower would not be able to draw the oar or scull through the water due to the increased load.

The FISA Coaching Development Program has been active over the last number of years in collecting wooden material either oars or sculls as well as boats and sending it to new FISA member or developing countries. By reason of this activity, this chapter remains relevant and the charts remain unchanged. Even so, it is to be noted that, in effect, only the outboard distance measurements have been affected (and, of course, the total length of the oar or scull) and the other measurements remain unaffected.

Suggestions for changes in the affected outboard measurements due to the 'big blade' were presented in Level I, but are not repeated here.

2.0 THE PURPOSE OF RIGGING

It was stated in BASIC RIGGING that rowing is a sport that requires concerted motion between the athlete and the boat. Further, it is clear that rowing requires well maintained boats and equipment and learning proper technique requires that the equipment be properly adjusted.

"A properly rigged boat may not necessarily win the race for you, but a poorly rigged boat will impede the performance of your crew and cause technique problems that are difficult to correct": the CARA Coaching Manuals.

The primary purpose of rigging is to provide the athlete with a comfortable work position from which the most effective power application to the boat by the oar can be performed. Although rigging partly determines technique, it should permit the execution of a technique with natural movements. This will enable the athlete to effectively apply power through an oar with a blade fully covered and traveling on a horizontal plane through the drive phase of the stroke cycle.

In the formation of a crew, the primary purpose of rigging becomes the development of a uniform power application which may result in different adjustments and measurements of the foot-stretcher, oar and rigger for individual athletes.

3.0 A SYSTEMATIC PLAN / A RIGGING CHART

The purpose of rigging is achieved by adjusting the boat and equipment to optimize the movement of the athlete and, in the formation of a crew, to accommodate athletes of different size, strength and range of movement. The determination of an optimum rig for an individual or crew is a trial and error process using the experience of the coach and the aid of a stop watch.

The process must be systematic by requiring a written record of the reason for the adjustment and the measurements.

In the event that the adjustment does not achieve the desired result, a further change may be made at the same or another location. It is advisable that only one small adjustment (between 0.5 and 1.0 cm) be made for each attempt to achieve the desired result. This procedure will allow an opportunity for the athlete to adapt to the change and for a proper assessment of the effect of each adjustment.

It should be noted that the initial adjustments to the boat and equipment will have been established within the guidelines presented in either BASIC RIGGING or this booklet (or, of course, some other suitable source). These adjustments and subsequent alterations will have been recorded by you or your athlete in a rigging chart.

The rigging chart will provide a convenient list to set, check and duplicate the measurements, particularly after boat transportation, and will provide a convenient summary of alterations. A sample rigging chart is provided for your assistance in Appendix A.

4.0 BOATS AND EQUIPMENT

The basic terminology used in sculling and sweep rowing has been presented in BASIC RIGGING. Since this section will only provide further information and not review Level I, it is recommended that BASIC RIGGING be reviewed prior to proceeding with this section.

4.1 The Boat

The size and shape of the hull of the boat is generally determined by the manufacturer. Although a deeper and narrower hull creates less resistance to its movement in water than a flat bottomed boat, it is not as stable and, therefore, is more difficult for young and beginning athletes to row.

The depth of immersion of any specific hull is also established by the manufacturer in the design stage and is based upon the crew weight expected to be carried by the boat. The optimum depth of immersion is termed the Designed Water Line. This is the point at which the hull reaches its lowest water resistance. This should also be the point at which the boat supports the individual or crew with the minimum amount of fluctuating movement in the bow and stern.

The actual depth of immersion may vary if the actual crew weight does not correspond to the designed crew weight (generally, 1 mm for each 10 kg difference). Any alteration in the depth of immersion will bring with it an alteration in the height of the freeboard and swivel above the water surface. This may affect the position of the pull on the oar handle and reduce the effectiveness of the drive.

To ensure that the drive is at the proper level, it is recommended that the height of the swivel above the water be 24 cm in sweep rowing boats and 22 cm in sculling boats (see figure 1).

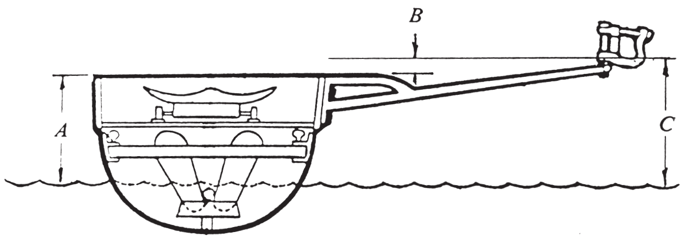


Figure 1. Immersed Hull Measurements

	A	B	C
Sculling boats	*17 cm*	*5cm*	*22 cm*
Sweep rowing boats	*17 cm*	*7 cm*	*24 cm*

It is hoped that the boat used by your athlete will be near to these measurements but, in any event, swivel height adjustment may still be necessary to accommodate individual athletes (see BASIC RIGGING and section 5.0 of this booklet).

*4.2 The Oar *)*

**) In this part oars and sculls with the Macon blade made from wood or, perhaps, composite materials are the focus, since they are still used in many developing countries. For many years composite oars or sculls have dominated the market. These should be delivered with fixed point of gravity and with varying stiffness — stiff, medium or soft — depending on the manufacturer. Some manufacturers also deliver oars and sculls with adjustable handles.*

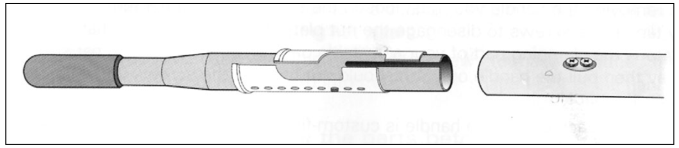


Photo 1. Composite Oar with adjustable handle from Concept2

The size and shape of the blade is obviously very important. A wider blade holds the water better but feels "heavier" to the athlete, particularly on the entry. A blade with the greater curvature is more efficient on the entry but a blade with less curvature is better for a clean finish.

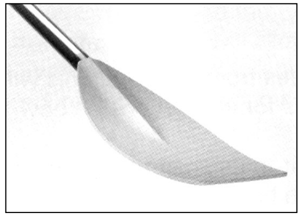


Photo 2. Macon Blade

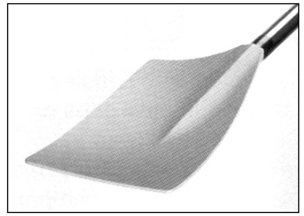


Photo 3. Big Blade

Although oars may be purchased with blades of various size and shape, the most popular have evolved from the "Macon" blade. This blade was designed by the West Germans for the 1959 European Championship in Macon, France. The standard measurements of the modern blade are illustrated in Figure 2.

It should be noted that the width of the blade at its maximum and at its tip may be reduced by 0.5 to 1.5 cm for some athletes, particularly young or beginning athletes, without serious loss of efficiency.

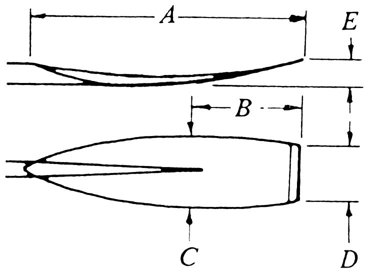


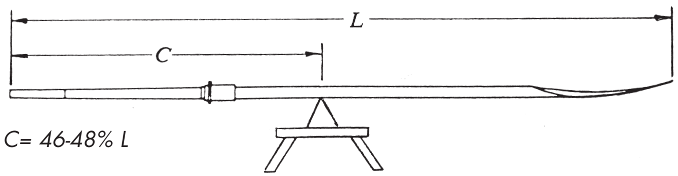
Figure 2. The Modern Blade

	A*	B	C	D	E
Sculling	*54*	*20*	*17-19*	*14*	*7*
Sweep rowing	*60*	*25*	*20-21*	*18*	*8,5*

**all measurements in cm*

There are two other characteristics of the oar that should be discussed: its centre of gravity and its flexibility.

Since there are usually small differences in the weight of oars, it is necessary to determine the weight and centre of gravity of each oar. This is to ensure that a sculler receives sculls with the same centre of gravity and that the oars are evenly distributed to each side of a crew boat to reduce disturbances to the boat's balance.



C= 46-48% L

Figure 3. Centre of Gravity of The Oar

The centre of gravity can be easily determined by balancing the oar on a narrow support structure (see figure 3). Any change in the structure of the oar (e.g. shaving the handle) or repair of damaged areas will probably affect the weight and centre of gravity. Differences may be rectified by putting lead inserts into the end of the handle. It should be noted that, in matching oars, a 2-3 cm difference in the location of the centre of gravity between oars is probably acceptable.

It is also important that the oar possesses the proper degree of flexibility to ensure that an effective technique is not adversely affected by an improper oar characteristic. A simple method to determine the degree of flexibility is illustrated in figure 4. A recommended deflection is 5-6 cm.'

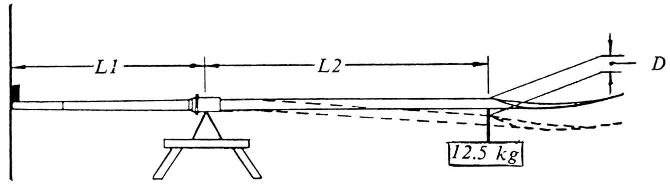


Figure 4. Flexibility of the Oar

	A	B	C
Sculling	*85 cm*	*150 cm*	*5-6 cm*
Sweep rowing	*110 cm*	*200 cm*	*5-6 cm*

5.0 ADJUSTMENTS OF BOATS AND EQUIPMENT

The booklet BASIC RIGGING presented the necessary information to prepare a rowing boat by using a set of standard measurements. This section will provide information for a better understanding of using that set of measurements and the table of measurements, provided in Appendix B, which is more suitable for national team athletes.

This section will also introduce some basic mechanical principles of rowing. Although no scientific or mathematical formulae will be used, this information will provide a good understanding of these principles.

5.1 The Basic Mechanical Principles of Rowing

It is written in BASIC ROWING TECHNIQUE that the goal in rowing is to have the athlete, the moving power, propel the boat through the water. The moving power or propulsive force is supplied intermittently because the oar is both in the water with force being applied and out of the water with no force being applied.

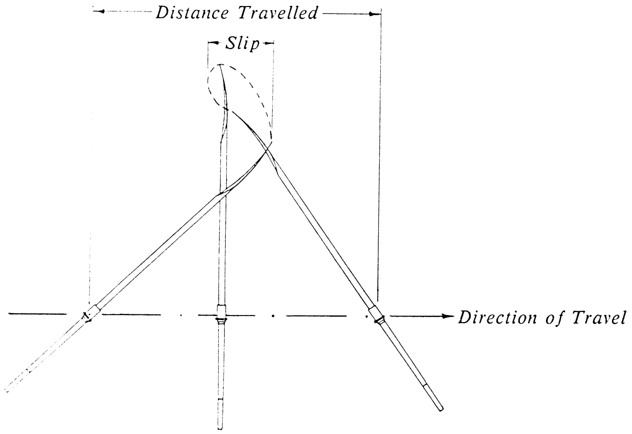


Figure 5. Movement of Oar and Boat

The athlete applies force by pulling on the oar handle as the blade enters and holds the water at the entry. This force causes the flat face of the oar to maintain contact with the working face of the swivel and the blade surface to maintain pressure against a wall of water. The continual application of force with the oar in contact with the swivel and the water causes the oar to act as a lever to pry the boat past the submerged blade. This movement is illustrated in Figure 5.

The distance traveled by the boat during each intermittent application of force will depend on the amount of force applied and the technical efficiency of the athlete.

Since the blade describes an arc as it "slips" through the water (see figure 5), there is a turning point in or close to the blade. The turning oar meets resistance caused by the back surface of the oar against the water and, as this resistance is not applied to the propulsion of the boat, it should be minimized. Hence, the shorter "Macon" blade was developed.

It should be noted that, as the blade describes an arc, there is a corresponding arc of the angular movement of the handle and shaft of the oar. This arc is illustrated in Figure 6.

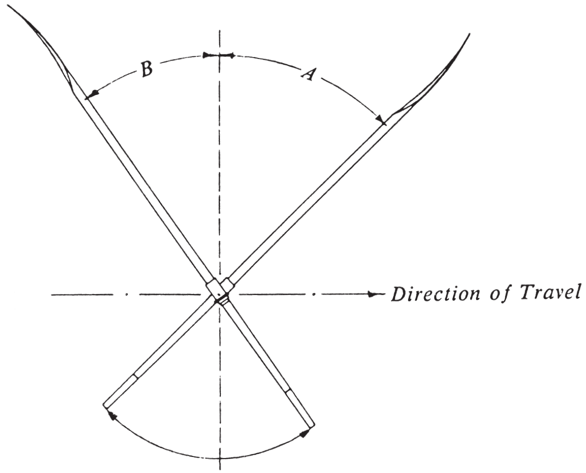


Figure 6. Arc of Angular Movement

The recommended arc of angular movement in degrees is:

	Club:	*National:*
Sweep rowing	*80-85*	*85-90*
Sculling	*85-100*	*95-110*

The continual application of force by pulling on the oar handle will maintain the pressure of the blade surface against a wall of water throughout the oar's arc of angular movement. Since the centre of pressure on the blade surface travels in an arc as illustrated in figures 5 and 6, there is a changing directional force being applied against the working face of the swivel and thereby through the pin to the boat.

The force being applied against the swivel has two components: a propulsive component and a turning component. The propulsive component provides force in the direction of travel and reaches its maximum before the oar is 90 degrees to the direction of travel. The turning component affects the direction of travel by providing a force acting perpendicular to the direction of travel. These components of force are illustrated in figure 7.

The effect of the propulsive and turning forces dictates the limit of the arc of the angular movement that the athlete may use effectively. To exceed these limits will only increase the turning force and not maximize the propulsive force. Thus, the oar is most effective in propelling the boat when it approaches and shortly after it passes the perpendicular position; it becomes progressively less effective as it nears the limit of the arc.

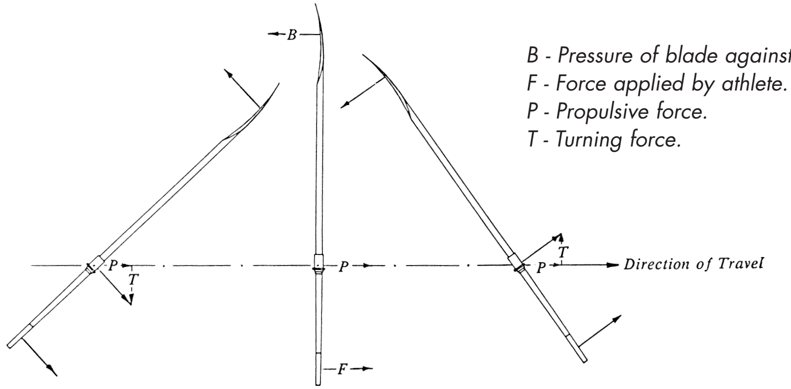


Figure 7. Propulsive and Turning Forces

This sub-section has provided a brief explanation of some of the mechanical principles of rowing. The FISA CDP Level III will provide more detailed information but the interested reader should consult other sources for more information.

The next sub-sections will provide further practical information about adjusting the boat and its equipment.

5.2 The Angle, Height and Placement of the Footstretcher

It is important to obtain a good position for the athlete which would allow a free and comfortable movement because, in part, the quality of the stroke is determined by the correct execution of the leg drive. Therefore, the angle and height of the footstretcher is adjustable in most new competition boats.

It was suggested in BASIC RIGGING that a good position for the angle of the footstretcher is between 38-42 degrees and, for the height of the footstretcher, between 15 to 18 cm. The angle or height of the footstretcher may be determined by the technique but should, again, permit a free and comfortable movement. Adjustments will often be necessary to accommodate athletes who have limitations, for example, due to stiff ankle joints or lower back. For these athletes, it may be necessary to use a

smaller or flatter angle and lower the heel, both preferably within the suggested range.

It should be noted that many boats now use shoes instead of the traditional clogs. This permits the heels to rise at the entry position allowing a better commencement of the drive phase of the stroke cycle. The use of shoes may also allow a deeper flexion of the legs and reduce the problem of stiff ankle joints.

It should also be noted that the footstretcher has a normal opening angle of the two feet of about 25 degrees, see figure 8. A greater angle may cause the knees to separate further in the full forward position causing a severe forward lean; a lesser angle may cause the foot pressure on the stretcher to shift to the outer edge of the foot.

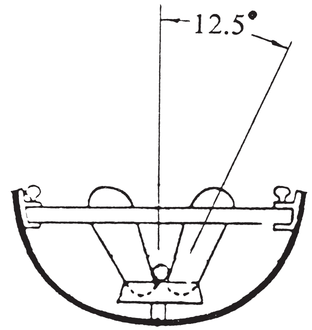


Figure 8. Opening Angle of the Footstretcher

Finally, the placement of the footstretcher along the longitudinal length of the boat, while not affecting the size of the arc of angular movement of the oar, will determine the relative position of the oar at the entry and release positions, see BASIC RIGGING.

5.3 The Height of the Swivel

The height of the swivel is generally measured within the range of 16 to 18 cm. This is a more convenient and practical measurement than using the Designed Water Line. This latter measurement will assist in determining the general suitability of the boat for the expected weight of the crew.

The correct height adjustment of the swivel is to ensure that the athlete is able to achieve a solid and direct pull on the oar handle and to maintain a properly submerged blade. This is important to ensure good control, effective power application and a well balanced boat.

The proper height adjustment of the swivel will also facilitate a clean blade extraction and a good recovery with the blade not touching the water and hands clear of the thighs and gunwale. Since there is generally a rise in the track toward the backstop of about 1 to 2 cm, this also helps to keep the blade covered at the finish of the stroke. These factors provide a better angle of the oar to the water for the release.

Height adjustments may also be made by changing either or both the depth of the heels and the height of the seat to achieve a comfortable and effective position. Since these alterations in the boat will probably change the centre of gravity of the individual or crew, a careful analysis should be made before this procedure is used.

Generally the height of the swivels in a crew boat should be within a range of 1 cm between all seats otherwise there may be problems with the balance of the boat due to the varied levels of pull.

Although the FISA CDP advocates that one hand leads the other in sculling, it recognizes that many scullers are accustomed to adjusting the right or starboard rigger slightly higher than the left or port rigger. This difference is generally from 0.5 to 1.5 cm with the difference increasing from the single to double to quadruple.

5.4 The Pitch of the Blade

It is generally recognized that a properly pitched blade will hold the water better during and release more easily at the end of the drive phase of the stroke cycle.

Although it was recommended in BASIC RIGGING that the pitch of the blade be 8 degrees for novices and beginners, it may be decreased as the athlete improves in technical proficiency. This could result in a pitch of 5-8 degrees in sweep rowing boats and 4-7 degrees in sculling boats.

Although the optimum pitch has been shown by experience to be an individual matter, it can be stated that generally a more experienced athlete prefers less pitch and boats in the slower events require less pitch that boats in the faster events.

The measurement of pitch on the Macon blade was introduced in Level I and was to be taken near the end of the blade. The following photo demonstrates the taking of the pitch on a Big blade. Please note that the indicated measurement of 1" is equivalent to about 2.5 cm.

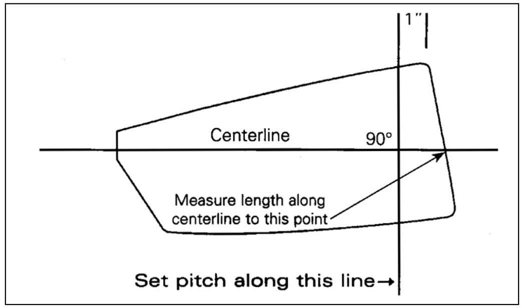


Photo 3. Big Blade picture instructions from Concept2.

Remember, the pitch of the blade is determined by the sum of the angle of the working face of the swivel and the angle of the flat back of the shaft or working face of the oar. With a vertical pin (the lateral and stern angles being zero), the pitch of the blade will not change from the entry position through to the release position. Thus, it is necessary to change either or both the pitch on the swivel or oar while maintaining the pin in the vertical position to reduce the pitch of the blade and maintain it through the drive phase. Changing either or both the lateral or stern angle of the pin will result in the pitch on the blade changing through the drive phase.

By keeping the lateral angle at zero and making the stern angle positive, the pitch of the blade at both ends of the drive phase of the stroke cycle will be lower than in the perpendicular or middle position. This change may allow a good blade depth in the second half of the drive phase but will probably result in the blade being too deep in the first half of the drive phase.

In contrast, making the stern angle negative causes the pitch of the blade at both ends of the drive phase of the stroke cycle to be higher than in the perpendicular or middle position. This change would allow a better entry and first half of the drive phase but the blade would be more difficult to control during the second half and will probably result in a poor release.

Although it was recommended in BASIC RIGGING that the lateral angle of the pin be zero, it is common practice to provide an outward inclination of the pin (a positive angle). By keeping the stern angle of the pin at zero and making the lateral angle positive, the pitch of the blade is always greater at the entry and less at the release than in the perpendicular or middle position. Thus, the pitch progressively decreases through the drive phase of the stroke cycle. This change allows the blade to enter the water easily, to hold better and to release cleanly.

The usual lateral pin angle is 1 to 2 degrees. This will provide an increase and decrease of the pitch of the blade from the middle position of about 0.5 to 1.0 degrees, respectively. Thus, a lateral pin angle of 2 degrees will cause 7 degree pitch of the blade to change from about 8 degrees on the entry to 7 degrees in the middle and about 6 degrees on the release.

In reference to the effect of both lateral and stern angles, the following guideline may be presented:

1. when the lateral pin angle is positive and greater than the stern pin angle, the pitch is always greater on the entry, smaller in the middle and smallest on the release;

2. when the lateral pin angle is positive and less than the stern pin angle, the pitch increases from the entry to the middle followed by a decrease to the release (to a degree lower than at the entry); and

3. when the lateral pin angle and stern pin angle are equal but not zero, the entry and middle positions are identical and the release is less.

Although numbers 1 and 3 are acceptable, number 1 is preferred. It should be noted that the change in the pitch of the blade may be determined by measuring the pitch at the entry, middle and release positions by the method illustrated in BASIC RIGGING.

In summary, it may be stated that, as the swivel is now manufactured with 4 degrees built in (excepting those that allow this to be altered), it is advisable to purchase oars with 0 to 2 degrees built into the shaft since this would allow some adjustment of the pin to obtain the desired pitch of the blade.

5.5 The Spread in Sculling and Sweep Rowing

The basic concepts of the oar acting as a lever, the rowing arc and force application have been discussed in section 5.1. As well, it was stated in section 5.2 that the placement of the footstretcher will determine the relative position of the oar at the entry and release positions. It is now necessary to discuss the length of the rowing arc and the effectiveness of the oar acting as a lever.

The length of the rowing arc is measured in degrees and is determined by adjusting the spread in both sculling and sweep rowing. Decreasing (increasing) the spread will cause an increase (decrease) in the length of the arc. This is illustrated in figure 9.

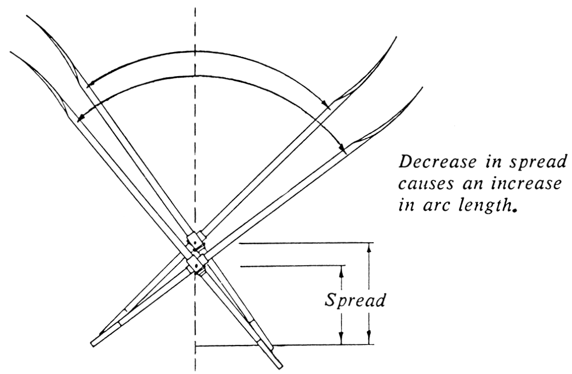


Figure 9. Length of Arc

The actual length of arc chosen (see guidelines in section 5.1) for an individual will depend on the fitness, range of movement or technical proficiency of the individual. An improvement in these factors will allow the use of a longer arc (within the limits suggested under the discussion about propulsive and turning forces).

The effectiveness of the oar acting as a lever or, in other words, the load applied by the athlete during the drive phase of the stroke cycle depends on:

1. the spread, and
2. the outboard distance of the oar.

The important measure of the load is the effect of the centre of the pull on the handle against the pin and the centre of pressure on the blade. The distance from the centre of the pull to the pin is essentially the spread. The distance from the pin to the centre of pressure may be measured to this pressure point or to the end of the blade. The latter measurement to the end of the blade is the outboard distance and is perhaps not technically as accurate as measuring to the pressure point but is more convenient and practical.

Therefore, the effectiveness of the oar may be expressed by using these variables in the ratio:

$$\frac{\textit{Outboard distance}}{\textit{Spread}}$$

Thus, using the figures provided in Appendix B:

	SPREAD*	OUTBOARD	INBOARD	LENGTH	RATIO
Pair with:	90	265	120	385	2,94
Eight:	80	275	110	385	3,44

**all measurements in cm*

we could have the range of 2.94 to 3.44. The greater the ratio, the greater the effective load applied by the athlete.

For a given spread, increasing the outboard distance and thereby increasing the ratio will impose a greater load on the athlete. This load increase is due to the increase in the speed of movement of the blade that would be necessary to work through the increased length of arc and maintain the stroke rate.

Ideally, it is necessary that the oars in a crew boat remain parallel through the stroke cycle and the ratio is constant for all seats. This may necessitate adjusting the spread for an individual to achieve the desired length of arc and providing an oar of a length that maintains the same ratio within the crew. Thus, in crew boats, individuals may row with different spread and length of oars.

The inboard distance must be appropriate to permit the athletes natural path of movement throughout the stroke cycle. As suggested in BASIC RIGGING, the inboard distance will be about 30-32 cm and 9-11 cm greater than the spread at each rigger for sweep rowing and sculling oars, respectively.

This situation of an individual adjustment is obviously only applicable to national crews as it necessitates the availability of various lengths of oars.

In the more common situation of using a set of oars of equal length, an attempt is made to achieve the uniformity of arc length and load ratio by:

1. Rigging the boat using an acceptable spread (or narrow range of spread among the individuals of the crew) based on the length of the oar and desired loading.

2. Adjusting the position of the oar button to provide the appropriate outboard distance based on the desired loading and the natural movement path (overlap).

An example may be provided by considering men's 4- that has one man who rows with a longer arc of angular movement. An attempt could be made to decrease this individual's arc by increasing the spread while maintaining about the same load and still providing a natural path of movement (with overlap of 30-32). Thus,

	SPREAD*	OUTBOARD	INBOARD	LENGTH	RATIO	OVERLAP
Pair with:	85,0	267,0	115,0	382	3,14	32
Eight:	85,5	267,5	114,5	382	3,13	31

**all measurements in cm*

Since the inboard distance allows a range of 30-32 cm and 9-11 cm for a sweep rowing and sculling oar, respectively, exact accommodation can be made for the crew or an individual by adjusting the button on the oar depending on fitness, range of movement or weather conditions. This accommodation will, of course, change the outboard distance and thereby the load carried by the athlete.

Finally, a comment should be made about another factor that affects the length of arc and the effectiveness of the oar. This factor is the height of the arm pull during the drive phase. Essentially, a higher arm pull will result in an increase in both the length of arc and the effectiveness of the oar. This is illustrated in figure 10.

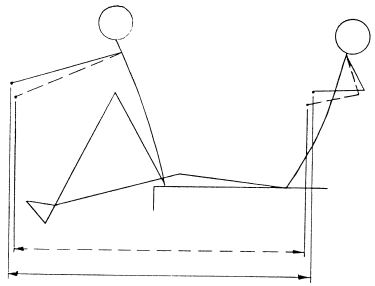


Figure 10. Arm Pull

6.0 SUMMARY

This booklet has attempted to provide more exact information in regard to the making of the correct adjustments to the equipment for a national level athlete.

It should be noted that, before correcting technique, it is advisable to first check the adjustment of the equipment. It is also advisable to exercise caution in the range of measurements used by following the guidelines presented either in this booklet or BASIC RIGGING and not be confused by the variations and extremes practiced by some coaches and experienced athletes.

7.0 APPENDICES

7.1 Appendix A - Table of Recommended Measurements

Club level - "Big Blade" - all measurements in cm.

MEN:					
2-	87	257	117	374	30
2+	88	256	118	374	30
4-	85	259	115	374	30
4+	86	258	116	374	30
8+	84	260	114	374	30

WOMEN:					
2-	86	256	116	372	30
4-	85	257	115	372	30
8+	84	258	114	372	30

7.2 Appendix B - Rigging Chart

NAME:			
DATE:			
BOAT:			
Type			
Design wt.			
OAR:			
- make			
- length			
- pitch			
BLADE			
- width			
- tip			
- length			
ADJUSTMENTS:			
Track length			
Footstretcher			
- angle			
- height			
- placement			
- opening			
Swivel			
- pitch			
- height			
Spread			
Outboard			
Inboard			
Ratio			
Pitch/Balde			
Pin Angle			
- forward			
- lateral			