The FISA Coaching Development Programme

HANDBOOK – LEVEL III

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Preface

The FISA Coaching Development Programme represents the synthesis of the movement for international cooperation in developing and expanding the scope of the sport of rowing. The programme started in 1985 as part of FISA Competitive Commission's activity, with support from IOC Olympic Solidarity Programme and already in February 1986 a working group of international coaches met in Ratzeburg, Germany to discuss and form a policy for the programme. The members of that group were:

During the 19 years the programme has been in activity more than 4000 coaches worldwide have participated in Level 1 courses, approximately 2000 in Level 2 courses and 60 at the Coaching Academy, representing Level 3. It is the hope that the new version, represented by this booklet, will continue to assist new coaches – to be better coaches!

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In the next years the Coaching Manuals was produced, and many National Federations supported the program and provided source material. The main supporters where: Amateur Rowing Association (GBR), Canadian Amateur Rowing Association (CAN), Deutscher Ruder Verband (RFA), Deutscher Rudersport Verband (RDA) and Federazione Italiana Canottaggio (ITA).

The program was revised in 1991, 2002 and 2004. Not many changes have been made from the original material. Rowing Technique, Methodology, Exercise Physiology etc. have not been through any revolutions, the progress in speed are more likely coming from more time invested in training, better material and more sophisticated talent identification programs. We hope also better coaches.

Thor S. Nilsen
FISA Development Director
October 2004

1 Intermediate Rigging

1.1 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 emphasised 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 individualised rigging, emphasise 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 Programme 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 is beyond the scope of this programme and is available from other sources either within FISA or directly from manufacturers. Though the mechanical principles have, of course, remained 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 Programme 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 members 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.

1.2 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 travelling 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.

1.3 A systematic plan / a rigging chart

The purpose of rigging is achieved by adjusting the boat and equipment to optimise 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 0.5cm and 1.0cm) 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.

1.4 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.

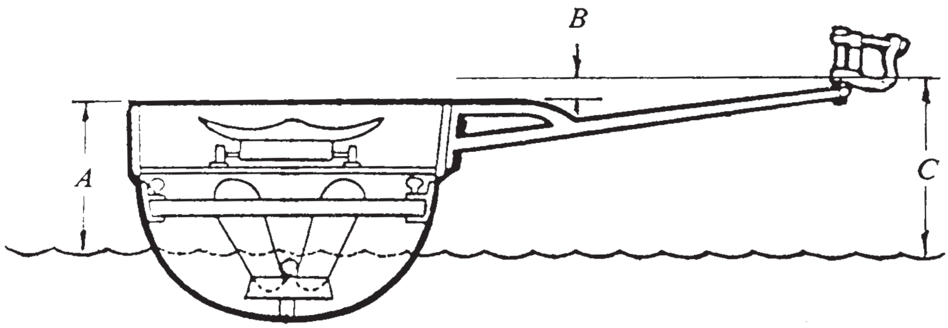
The Boat

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, 1mm for each 10kg 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 24cm in sweep rowing boats and 22cm in sculling boats (see Figure 1).



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

Figure 1: Immersed hull measurements

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).

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.

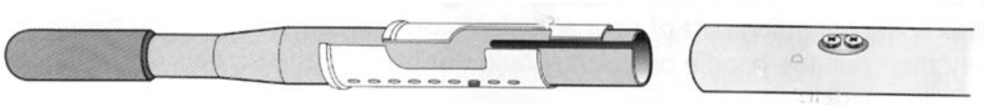


Photo 1: Composite oar with adjustable handle from Concept2

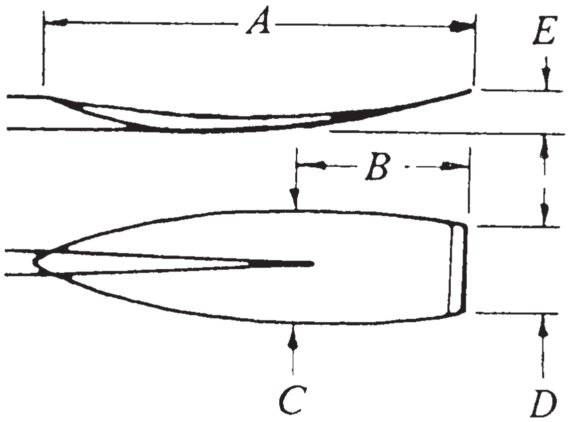
The size and shape of the blade is obviously very important. A wider blade holds the water better but feels "heavier" to the athlete, particularly on the entry. A blade with the greater curvature is more efficient on the entry but a blade with less curvature is better for a clean finish.

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 Rowing 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, particular young or beginner athletes, without serious loss of efficiency.



	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*

Figure 2: The modern blade

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.

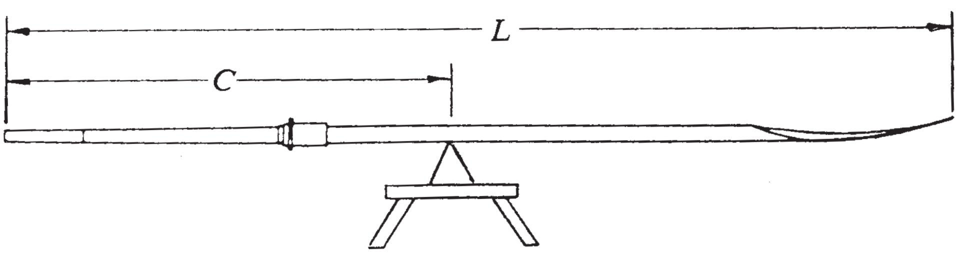
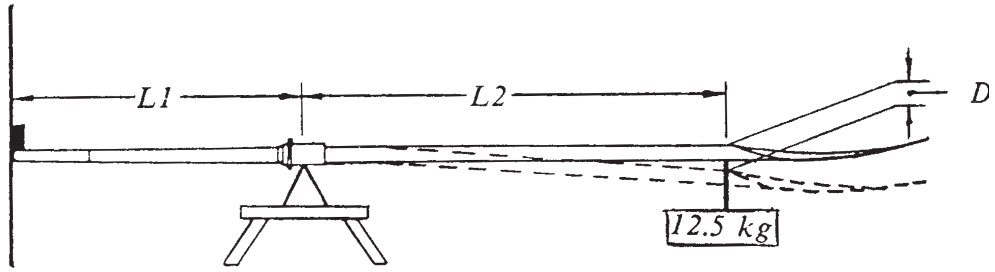


Figure 3: Centre of gravity of the oar C= 46-48% L

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 between 5cm to 6 cm.



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

Figure 4: Flexibility of the oar

1.5 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.

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.

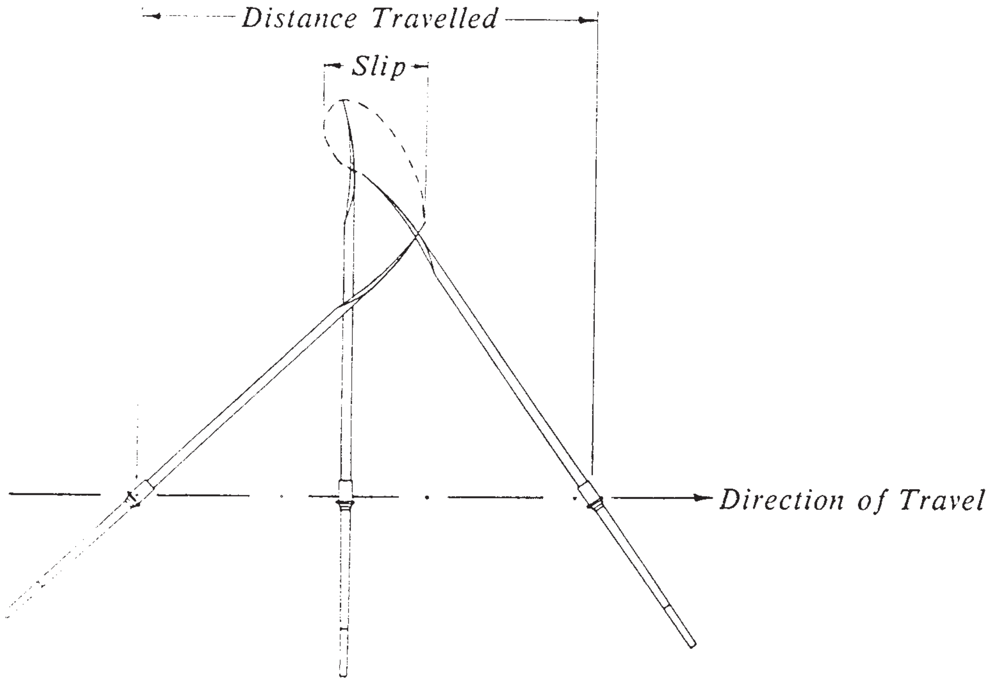


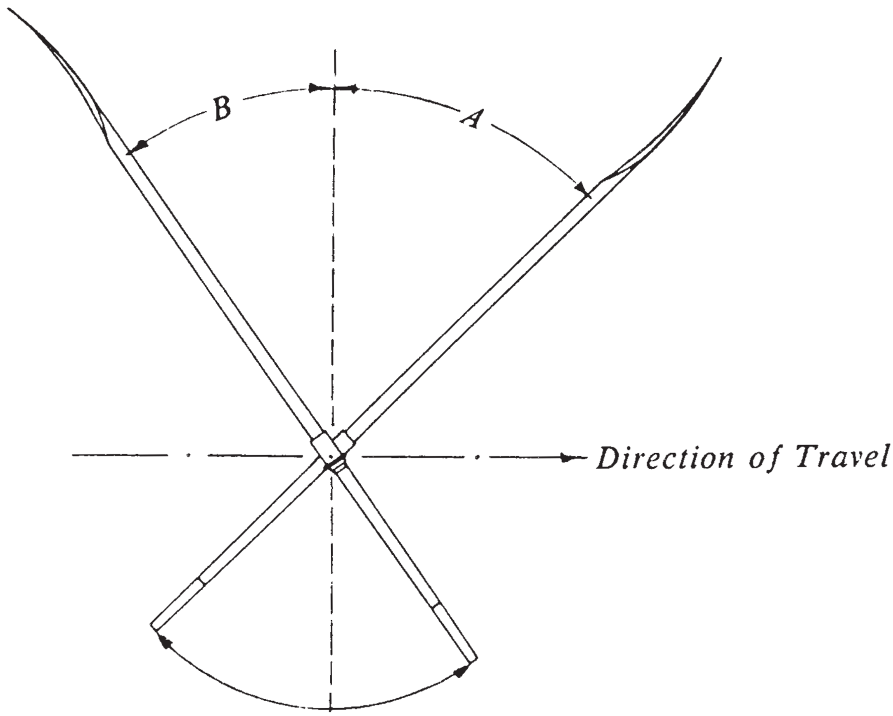
Figure 5: Movement of oar and boat

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 minimised. 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.



The recommended arc of angular movement in degrees is:

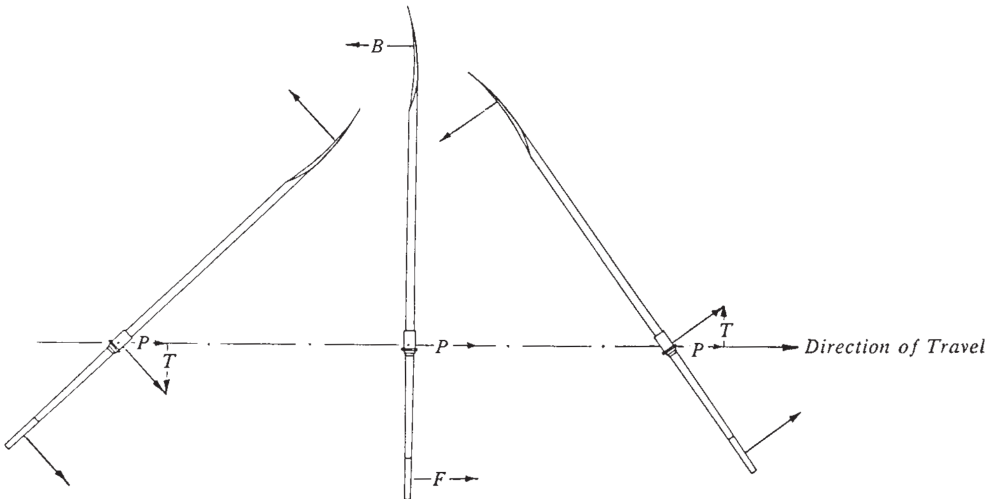
	Club:	*National:*
Sweep rowing	*80-85*	*85-90*
Sculling	*85-100*	*95-110*

Figure 6: Arc of angular movement

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 maximise 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.



B – Pressure of blade against water. F – Force applied by athlete. P – Propulsive force. T – Turning force.

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.

The angle, height and placement of the foot stretcher

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 foot stretcher is adjustable in most new competition boats.

It was suggested in BASIC RIGGING that a good position for the angle of the foot stretcher is between 38 and 42 degrees and, for the height of the foot stretcher, between 15cm to 18cm. The angle or height of the foot stretcher 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 foot stretcher 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.

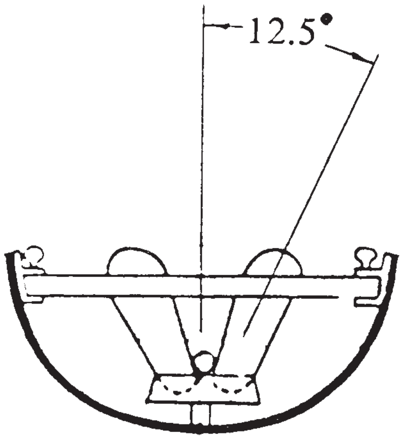


Figure 8: Opening angle of the foot stretcher

Finally, the placement of the foot stretcher 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.

The height of the swivel

The height of the swivel is generally measured within the range of 16cm to 18cm. 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 towards the backstop of about 1cm to 2cm, 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 1cm 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 recognises 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.

The pitch of the blade

It is generally recognised 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 eight degrees for novices and beginners, it may be decreased as the athlete improves in technical proficiency. This could result in a pitch of five to eight degrees in sweep rowing boats and four to seven 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 than 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 2.5cm.

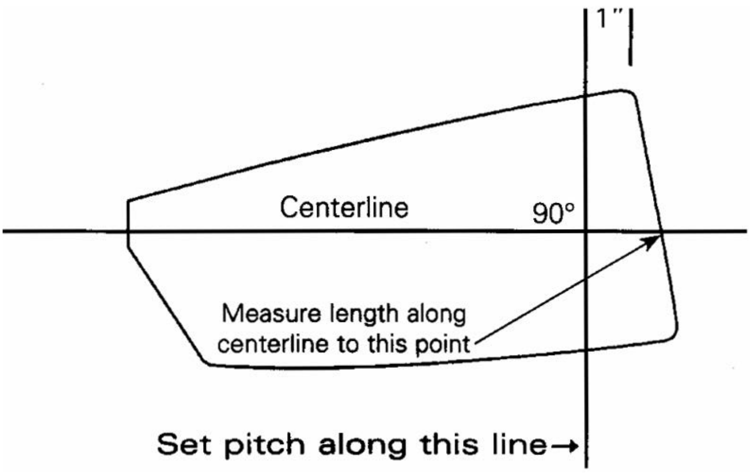


Photo 4: Big blade picture instructions from Concept2.

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 one to two 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 two degrees will cause a seven degree pitch of the blade to change from about eight degrees on the entry to seven degrees in the middle and about six 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 four degrees built in (excepting those that allow this to be altered), it is advisable to purchase oars with zero to two degrees built into the shaft since this would allow some adjustment of the pin to obtain the desired pitch of the blade.

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 foot stretcher 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.

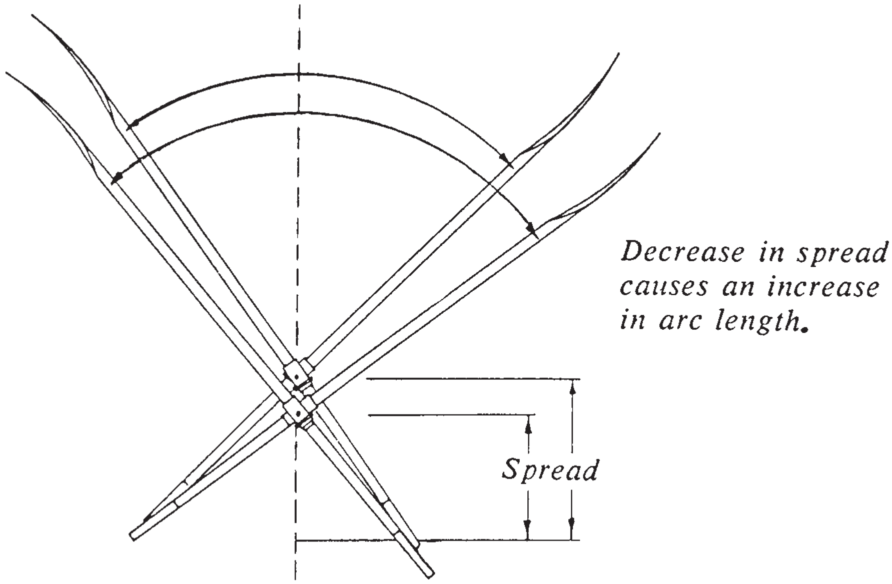


Figure 9: Length of arc

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:

Outboard distance 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 athlete's natural path of movement throughout the stroke cycle. As suggested in BASIC RIGGING, the inboard distance will be about 30 to 32cm and 9 to 11cm 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 a men's four 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 to 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 30cm to 32 cm and 9cm to 11cm 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.

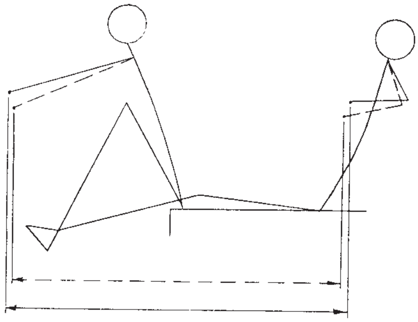


Figure 10: Arm pull

1.6 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 practised by some coaches and experienced athletes.

1.7 Appendices

Appendix A – Table of recommended measurements

Club level – “Big blade” – all measurements in centimetres.

Boat	Spread	Outboard	Inboard	Length	Overlap
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

Appendix B – Rigging chart

Name			
Date			
Boat			
Type			
Design wt.			
Oar:			
• make			
• length			
• pitch			
Blade:			
• width			
• tip			
• length			
Adjustments			
Track length			
Foot stretcher:			
• angle			
• height			
• placement			
• opening			
Swivel:			
• pitch			
• height			
Spread			
Outboard			
Inboard			
Ratio			
Pitch/Blade			
Pin Angle:			
• forward			
• lateral			

2 Intermediate Rowing Physiology

2.1 Introduction

The FISA CDP booklet titled BASIC ROWING PHYSIOLOGY provided information about the energy requirements of a rowing race. The information included a description of aerobic and anaerobic metabolism with an emphasis on the major systems and components of aerobic metabolism.

As this booklet will expand and not extensively review that material, the reader is encouraged to review the FISA CDP Level I booklet.

This booklet will present more information about metabolism, the effects of training on metabolism and some simple tests to measure those effects.

2.2 Energy for rowing

The human body acts as an engine to propel the rowing boat across the water. As explained in Level I, the boat is pried forwards across the surface of the water by an athlete seated in the boat and moving forwards and backwards on a sliding seat while pulling on an oar placed intermittently in the water.

The body, acting as an engine, produces power by the application of force which provides the boat with a forward velocity (see Figure 1).

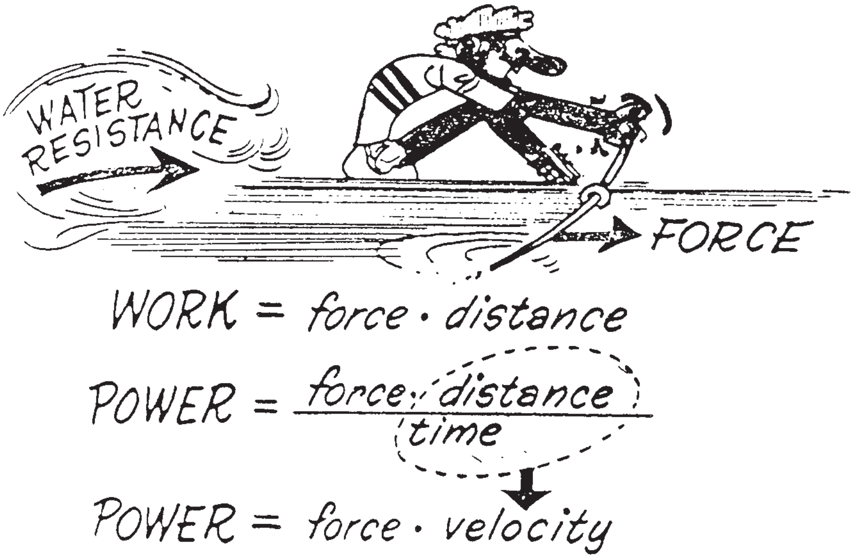


Figure 1: Production of power

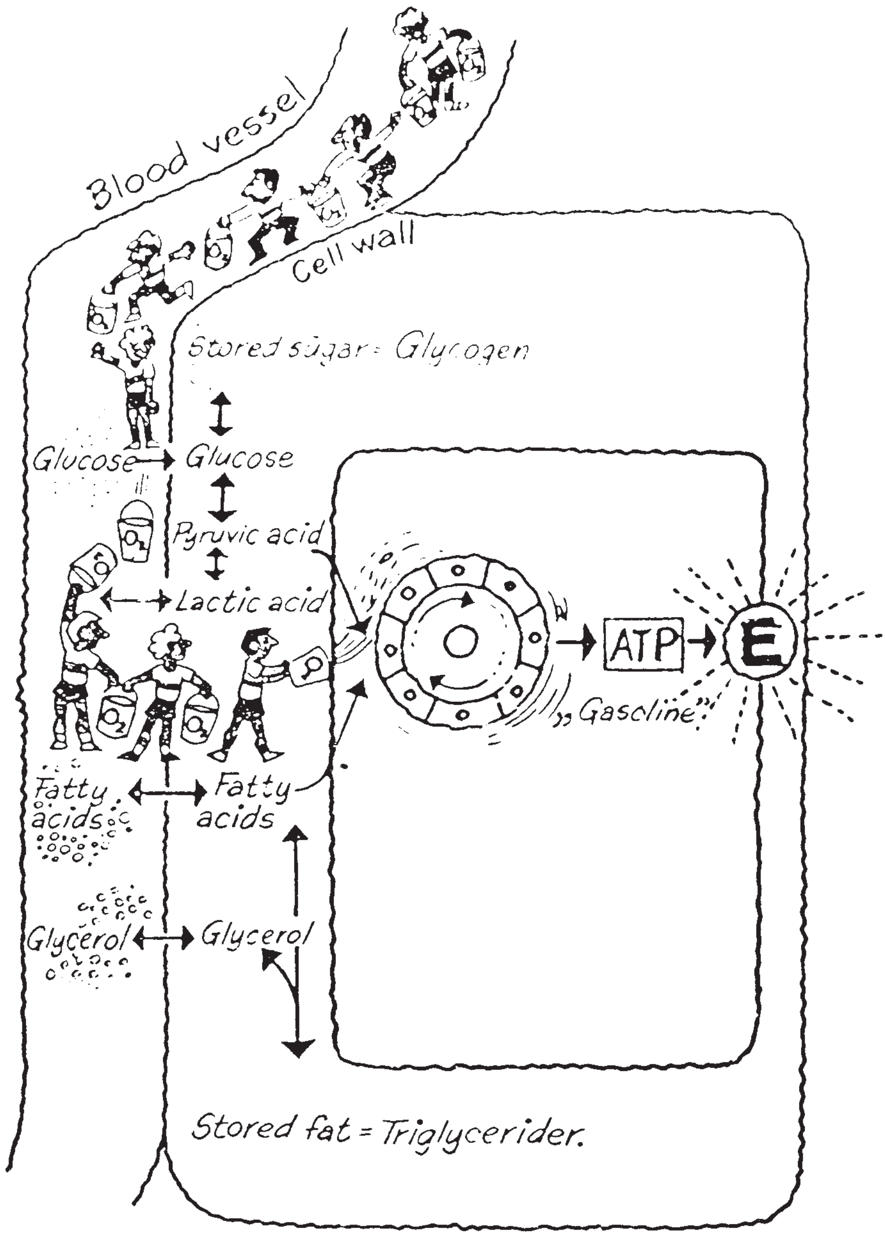


Figure 2: Production of energy

Force is applied by the contraction of muscles which requires energy. The source of the energy for muscle contraction is the breakdown of chemical bonds in the muscle cells. These chemi- cal bonds are provided by chemical substances stored in the muscles:

1 ATP (adenosine triphosphate),
2 CP (creatine phosphate),
3 glucose (stored as glycogen)
4 fats

ATP is the only substance that can directly supply energy for muscle contraction. As the muscle cells only contain enough ATP for a contraction of a few seconds, it is necessary to replace the ATP. The other substances are indirect sources of energy since they supply energy for the resynthesis or replacement of ATP.

The relationship between ATP and the principal sources of energy, glucose and fats, to replace ATP is illustrated in Figure 2.

2.3 The replacement of ATP

The replacement or resynthesis of ATP is generally considered to involve three processes:

1 ATP-CP reaction
2 Anaerobic glycolysis
3 Aerobic metabolism.

The ATP/CP reaction

The stored CP in the muscle cell is a high energy substance similar to ATP. It can provide the energy to resynthesise ATP rapidly but the amount stored is only sufficient for less than twenty seconds. Since this process is conducted in the absence of oxygen and does not produce lactic acid, it may be referred to as alactic anaerobic metabolism.

Although this process will provide energy for the start phase of the race, its contribution is a small percentage of the total energy requirements of the body during the 2,000m rowing race.

Anaerobic glycolysis

The production of energy in the absence of oxygen which does produce lactic acid may be referred to as lactic anaerobic metabolism. This was presented in BASIC ROWING PHYSIOLOGY as an important source of energy during the start and finish phases of the rowing race.

This process results in the production of energy for the resynthesis of ATP through the breakdown of carbohydrates (primarily glycogen stored in the muscle cell, therefore this is termed anaerobic glycolysis). It can provide the energy almost as rapidly as that supplied by the ATP/CP reaction.

A great amount of energy may be supplied by this process but the depletion of glycogen and the accumulation of lactic acid in the muscle cells results in the reduction of the muscle's ability to contract. The accumulation of lactic acid may also cause pain in the muscle of the athlete. Due to these effects, it is not possible to use this process for prolonged periods. Therefore, the process is utilied primarily during the start and finish phases of the race.

Although this system may provide energy for up to two to three minutes of intense activity (for the period of 30 to 90 seconds after the start and during the 60 to 90 seconds of the finish phase), it will only provide about 20-25% of the energy requirements of the rowing race.

Aerobic metabolism

Aerobic metabolism provides about 75% to 80% of the energy requirements of the rowing race. It involves the combustion of a fuel in the muscle cell in the presence of oxygen. The source of the fuel is generally from either glycogen or fats stored in the muscle, or glucose and fats stored elsewhere in the body, and delivered by the circulatory system to the muscle cells (see Figure 2).

As this process depends on many more reactions in the muscle cell, the energy is released more slowly and depends on a suf- ficient supply of oxygen being delivered to the mitochondria; the power plants of the muscle cell (see BASIC ROWING PHYSI-OLOGY). Therefore, the respiratory and cardiovascular systems must be capable of delivering oxygen from the air we breathe to the muscle cell.

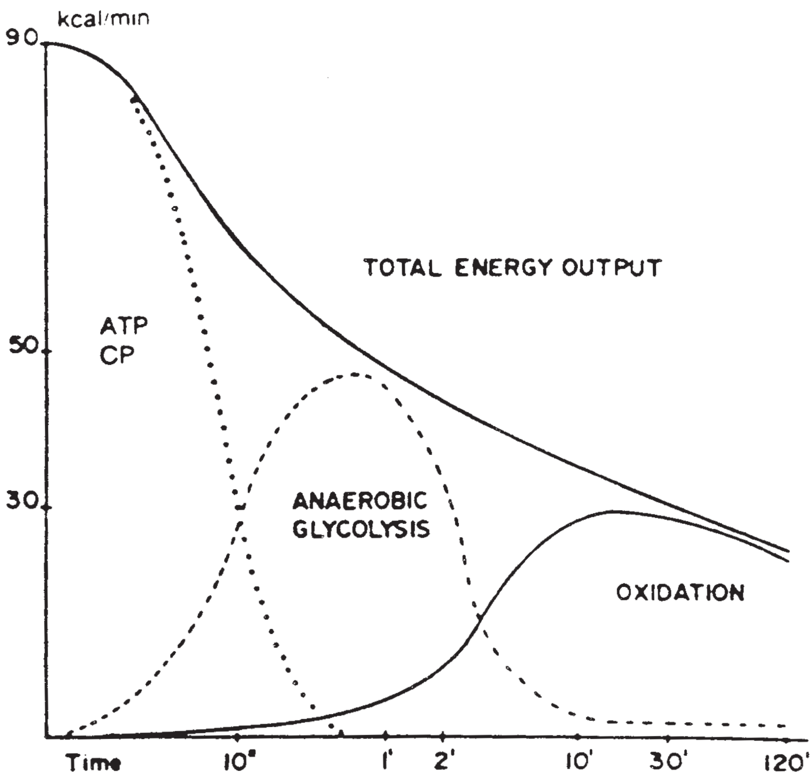


Figure 3. The Importance of aerobic metabolism

It takes about 60-90 seconds to activate these two systems to provide sufficient oxygen to aerobically meet the energy require- ments of the muscle cell during a rowing race. The continual suf- ficient supply of oxygen during the middle or distance phase of the rowing race enables the body to replace the ATP almost exclusively from aerobic metabolism. Unlike anaerobic metabo- lism with its debilitating waste product, lactic acid, the by-prod- ucts of aerobic metabolism, water and carbon dioxide, are either eliminated to the atmosphere or partially retained (water) to assist in body functions.

It should be noted that aerobic metabolism is actually two processes:

1 Lipid metabolism (the breakdown of fats), and
2 Aerobic glycolysis (the breakdown of glycogen).

Since lipid metabolism provides abundant energy, it is an impor- tant source of energy for training; but, due to the fact that the reactions are very slow, it is generally not useful during a 2,000 meter rowing race. For this distance, aerobic glycolysis and its complete breakdown of glycogen is utilised.

The interaction of the ATP/PC reaction, anaerobic glycolysis and aerobic metabolism

The replacement of ATP during a rowing race is dependent on the interaction of the three processes:

1. the ATP-PC reaction (less than 5%)
2. anaerobic glycolysis (20-25%)
3. aerobic metabolism (75-80%)

These three processes do not operate in isolation or independently during exercise but occur simultaneously and are integrated to provide the necessary energy to satisfy the requirements of the rowing race. This is illustrated in Figure 4.

Adapted from “Energy stores and substrates utilisation in muscle during exercise” by Howald, H., et al in The Third International Symposium on Biochemistry of Exercise. F. Landry and W.A.R. Orban (eds.), Miami Symposia Specialists, 1978.

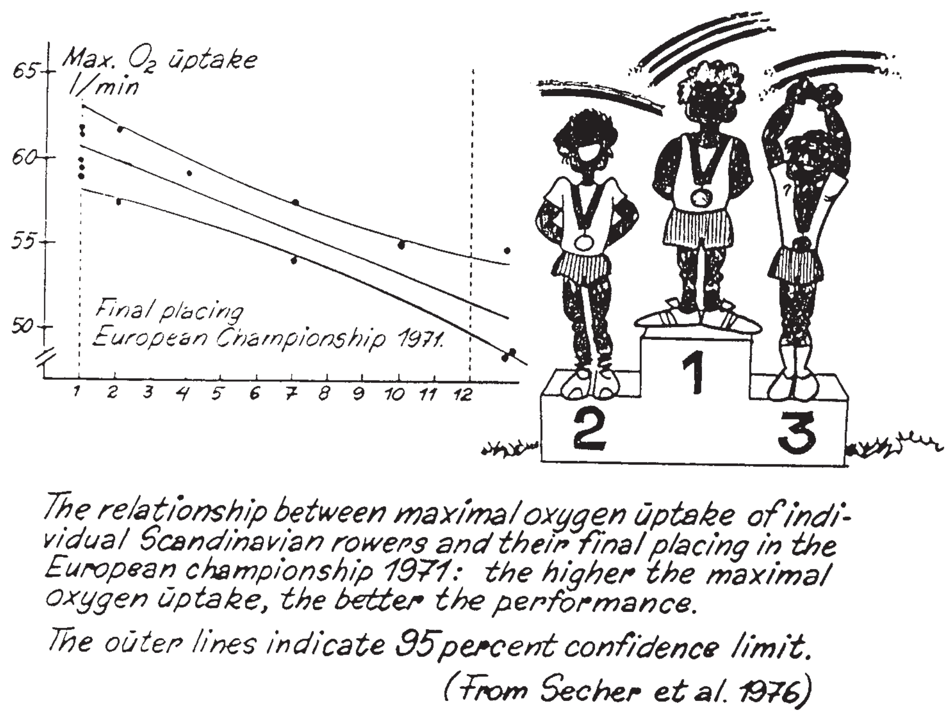


Figure 4: The output of energy

The exact determination of the relative contribution of the three processes is difficult to determine but most physiologists agree that the athlete's maximum oxygen uptake or VO2 max represents the maximal total aerobic metabolic rate.

This is an important measurement because of the relative importance of aerobic metabolism to rowing. This is demonstrated by the research findings illustrated in Figure 3.

Although a generally accepted method to measure an athlete's anaerobic capacity is not available or is impractical to perform, measurements of lactate in blood after exhaustive exercise have been used frequently as a gauge of the athlete's ability to tolerate high concentrations (an ability that may improve with training). A measure of lactate concentration in the blood during exercise at below maximal level is also used to gauge the fitness level of the athlete.

Another measurement that may be used to gauge the fitness level of the athlete and is useful in providing training assistance is the determination of the anaerobic threshold.

Essentially, the energy requirements of the body exercising at a training load below this threshold will be met primarily by aerobic metabolism whereas exercising at a training load above this threshold places an increasing demand on the anaerobic glycolytic process. This is illustrated in Figure 5.

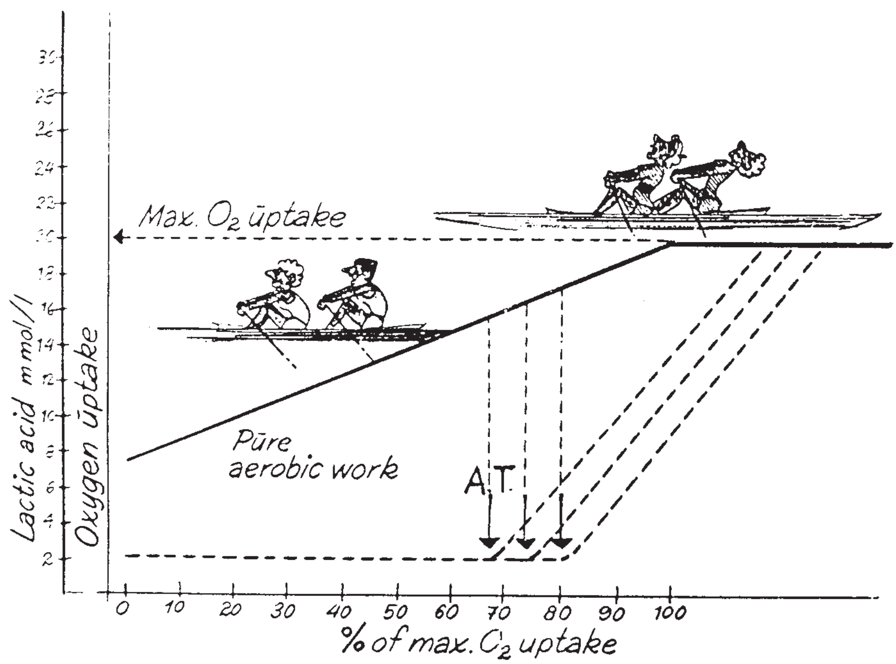
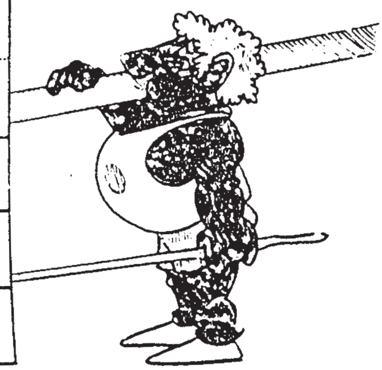


Figure 5: Anaerobic threshold

It is obvious that the purpose in training for rowing would be to enable the athlete to both increase the maximum oxygen uptake and to able to use a greater percentage of this level before obtaining the significant increases in lactate concentrations. In Figures 5 and 6, the result of a successful training programme is illustrated.

Improvement in physiological factors from Dec. to May in a group of American oarsmen.
(Heavyweight)
(From F. C. Hagerman)

	DEC.	FEB.	MAY
O_2-uptake l/min.	5,41	5,65	6,16
ml/kg/min.	59,6	62,0	68,4
A.T. (%)	72	75	83
VO_2 - A.T.	3,92	4,27	5,14
Watts	345	380	393



As a result of strength and endurance training.

Figure 6. Improvements in physiological factors

Some other methods to measure these processes and comments about the effects of training will be presented in the following sections.

2.4 Measurements

The scientific measurement of the energy systems generally requires the use of expensive equipment and experienced researchers but, through the use of some simple techniques, useful information can be provided to assist the athlete and coach.

VO2 max / testing of aerobic metabolism

The most common method used in rowing to measure aerobic metabolism is the determination of maximum oxygen uptake or VO2 max. The direct determination of this measurement does require the use of expensive equipment and the assistance of an experienced researcher.

Although the determination of this measurement is not necessary to produce world class rowers, it does provide information to:

1. assess the suitability of an athlete for the sport,
2. determine the effect of a training programme, and
3. measure the athlete's rate of improvement.

The use of measuring physiological factors in determining the effect and rate of improvement due to a training programme has been illustrated in Figure 6. The determination of maximum oxygen in various categories for international athletes in rowing is illustrated in Figures 7 to 10.

Although the direct method is better, an indirect measurement method may be used to predict VO2 max. The prediction is made from the results of submaximal exercise and is based on the assumption that a relationship exists between VO2 and the other more easily measured variables during submaximal workloads and those extrapolations to maximal workloads can be made to estimate or predict VO2 max. Two predictive tests are the:

1. Step test:
   a test requiring a step up to and step down from a bench (33cm and 40cm high for women and men, respectively) at a rate of 30 steps per minute for five minutes; the pulse taken for one minute following the conclusion of the test is used to read from the Astrand nomogram to predict VO2 max (see Appendix A).

2. Bicycle test:
   a test requiring a ride on a bicycle ergometer for a given submaximal work load that is sufficient to maintain a heart rate in excess of 120 beats per minute for a period of two minutes; the average pulse taken over the two minutes is used to read from the Astrand nomogram to predict VO2 max.

Although these tests do not use rowing specific testing equipment (such as a rowing ergometer), they do provide some information and may be particularly useful for club level programmes. These predictive tests are inexpensive, easy to administer and excellent for group testing but are subject to error, particularly for very low or very high VO2 max categories.

Testing of anaerobic metabolism

It should be remembered that the anaerobic energy system provides energy for short-term intense exercise from the breakdown of glycogen and energy-rich substances. It is possible to perform some simple tests to provide some information about the capacity of this metabolic system. The testing procedures could be:

1. alactic anaerobic capacity: a maximum effort for about 10 to 15 seconds.
2. lactic anaerobic capacity: a maximum effort for about 30 to 90 seconds.

The method used would be to either compute the amount of mechanical work that can be performed in the specified time or record the time required to perform a given amount of anaerobic work by the use of:

1. the lifting of barbells,
2. the performance of exercises/calisthenics, or
3. the rowing or bicycle ergometer.

The computation of the amount of mechanical work is generally the preferred method and is a simple procedure that may also be correlated with a more complicated procedure of the computation of lactic acid produced during the lactic anaerobic capacity test. This latter computation must be determined from a sample of blood taken from the athlete during or immediately after the test. The taking of blood is termed an invasive testing procedure because it involves the taking of a physical sample from the body of the athlete.

An example of a non-invasive testing procedure which does not require the taking of a physical sample would be the recording of the heart rate by either touching the body or using an electronic device attached to the body. This procedure may be used in the predictive measurement of VO2 max or in a determination of the anaerobic threshold.

```
                  Name :
                                                     Datum :   20-04-88
             ID-Nummer :   2                         Alter :   26
           Grße   (cm) :  193                 Gewicht (kg) :  90
          Druck (mmHg) :   726                     Temp (C) :  22.3
      Geschlecht(M/F):   M                                  30 5.7
             FIO2 (%) :   20.81
```

Time Min	Work Watt	HR	BF	RQ	EQ-CO2	VE l/min	Vo2 l/min	Vo2/mL kg*min	MET	VO2/kg /HR	VCo2 l/min	FCo2 %	EQ-O2
0:30	450	158	37	1.13	41	82.2	1.75	19.5	5.6	0.12	1.99	3.07	47
1:00	420	171	59	0.85	40	161.3	4.79	53.3	15.2	0.31	4.07	3.20	34
1:30	420	178	63	0.92	38	214.6	6.10	67.8	19.4	0.38	5.61	3.32	35
2:00	390	174	67	1.00	38	227.3	6.00	66.7	19.1	0.38	6.03	3.37	38
2:30	400	175	64	1.03	37	227.7	5.95	66.1	18.9	0.38	6.11	3.41	38
3:00	380	178	65	1.03	37	236.1	6.11	67.9	19.4	0.38	6.31	3.39	39
3:30	390	180	67	1.03	37	234.7	6.09	67.7	19.3	0.38	6.30	3.41	39
4:00	370	181	62	1.02	37	229.2	6.03	67.1	19.2	0.37	6.16	3.42	38
4:30	390	179	65	1.01	38	233.8	6.13	68.1	19.5	0.38	6.18	3.36	38
5:00	380	178	64	1.01	37	232.6	6.16	68.4	19.6	0.38	6.21	3.39	38
5:30	380	181	68	1.00	38	235.5	6.18	68.6	19.6	0.38	6.19	3.34	38
6:00	434	180	67	1.01	38	229.6	5.98	66.4	19.0	0.37	6.02	3.33	38
6:30												3.34	
7:00												3.32	
Max	450	181	68	1.13	41	236.1	6.18	68.6	19.6	0.38	6.31	3.42	47
Pred		193				199.5	3.37	45.7					
%Pre		92%				118	183	150					

Figure 7: Testing results / senior men

Name :			
ID-Nummer :	07	Datum :	20-04-88
Grße (cm) :	181	Alter :	21
Druck (mmHg) :	727	Gewicht (kg) :	68
Geschlecht(M/F):	M	Temp (C) :	23.9
FIO2 (%) :	20.81		30 4.5

Time Min	Work Watt	HR	BF	RQ	EQ-CO2	VE l/min	Vo2 l/min	Vo2/mL kg*min	MET	VO2/kg /HR	VCo2 l/min	FCo2 %	EQ-O2
0:30	350	168	39	0.90	38	109.1	3.18	46.8	13.4	0.28	2.88	3.35	34
1:00	360	174	45	0.87	36	124.2	3.96	58.3	16.7	0.34	3.45	3.53	31
1:30	360	179	61	0.91	34	149.9	4.80	70.5	20.2	0.39	4.37	3.70	31
2:00	360	178	62	0.99	34	170.7	5.09	74.9	21.4	0.42	5.04	3.76	34
2:30	360	180	65	1.05	34	180.9	5.07	74.6	21.3	0.41	5.32	3.73	36
3:00	350	180	69	1.09	34	187.2	5.02	73.8	21.1	0.41	5.45	3.70	37
3:30	350	179	84	1.09	35	194.9	5.14	75.6	21.6	0.42	5.61	3.65	38
4:00	340	182	94	1.09	36	197.7	5.09	74.9	21.4	0.41	5.58	3.58	39
4:30	360	180	98	1.09	37	206.7	5.20	76.4	21.8	0.42	5.66	3.48	40
5:00	340	180	101	1.09	38	210.5	5.12	75.3	21.5	0.42	5.61	3.38	41
5:30	350	183	105	1.09	39	225.3	5.24	77.1	22.0	0.42	5.73	3.23	43
6:00	403	183	105	1.11	42	233.7	5.02	73.8	21.1	0.40	5.59	3.04	47
6:30												3.01	
Max	403	183	105	1.11	42	233.7	5.24	77.1	22.0	0.42	5.73	3.76	47
Pred		196				157.5	3.53	48.5					
%Pre		93%				148	148	159					

Figure 8: Testing results / lightweight men

Name :		Date :	31-03-88
ID-Number :	06	Age :	25
Height (cm) :	185	Weight (kg) :	78
B. P. (mmHg) :	723	Temp (C) :	21.4
Sex (M/F) :	F		30 4.1
FIO2 (%) :	20.88		

Time Min	Work Watt	HR	BF	RQ	EQ-CO2	VE l/min	Vo2 l/min	Vo2/mL kg*min	MET	VO2/kg /HR	VCo2 l/min	FCo2 %	EQ-O2
0:30	300	154	63	1.04	43	75.3	1.70	21.8	6.2	0.14	1.76	2.98	44
1:00	308	171	63	0.81	42	113.6	3.36	43.1	12.3	0.25	2.73	3.07	34
1:30	308	165	63	0.88	38	132.9	3.94	50.5	14.4	0.31	3.47	3.33	34
2:00	308	168	62	0.96	37	140.2	3.94	50.6	14.4	0.30	3.78	3.44	36
2:30	291	172	63	0.99	37	147.3	4.06	52.1	14.9	0.30	4.00	3.47	36
3:00	300	168	61	1.00	36	143.5	3.96	50.8	14.5	0.30	3.98	3.54	36
3:30	291	172	59	1.00	36	144.3	4.07	52.2	14.9	0.30	4.07	3.60	36
4:00	291	177	65	1.01	36	153.4	4.17	53.5	15.3	0.30	4.23	3.52	37
4:30	291	177	65	1.02	36	151.5	4.13	52.9	15.1	0.30	4.20	3.54	37
5:00	300	179	66	1.03	36	159.0	4.26	54.6	15.6	0.31	4.37	3.51	37
5:30	291	179	67	1.02	37	159.2	4.21	53.9	15.4	0.30	4.30	3.45	38
6:00	291	178	67	1.03	37	158.4	4.17	53.4	15.3	0.30	4.29	3.46	38
6:30												3.42	
Max	308	179	67	1.04	43	159.2	4.26	54.6	15.6	0.31	4.37	3.60	44
Pred		194				143.5	2.25	38.8					
%Pre		92				111	189	141					

Figure 9: Testing results / senior women

Name :		Datum :	13-05-88
ID-Nummer :	05	Alter :	17
Grße (cm) :	168	Gewicht (kg) :	60
Druck (mmHg) :	725	Temp (C) :	23.9
Geschlecht(M/F):	F		30 3.2
FIO2 (%) :	20.75		

Time Min	Work Watt	HR	BF	RQ	EQ-CO2	VE l/min	Vo2 l/min	Vo2/mL kg*min	MET	VO2/kg /HR	VCo2 l/min	FCo2 %	EQ-O2
0:30	258	171	40	1.05	38	97.2	2.45	40.8	11.7	0.24	2.57	3.36	40
1:00	267	174	57	1.00	38	128.9	3.36	56.0	16.0	0.32	3.36	3.32	38
1:30	258	177	55	1.09	36	139.1	3.54	59.0	16.9	0.33	3.86	3.53	39
2:00	241	179	50	1.14	35	143.6	3.59	59.9	17.1	0.33	4.11	3.64	40
2:30	241	180	54	1.17	36	145.1	3.49	58.2	16.6	0.32	4.08	3.58	42
3:00	233	181	52	1.15	36	151.2	3.71	61.8	17.7	0.34	4.27	3.59	41
3:30	225	180	52	1.12	36	144.1	3.62	60.4	17.3	0.34	4.05	3.58	40
4:00	225	182	65	1.11	38	164.7	3.91	65.1	18.6	0.36	4.35	3.36	42
4:30	241	183	65	1.16	39	158.6	3.52	58.7	16.8	0.32	4.09	3.28	45
5:00	293	185	47	1.11	35	130.5	3.35	55.8	16.0	0.30	3.71	3.62	39
5:30												3.76	
Max	293	185	65	1.17	39	164.7	3.91	65.1	18.6	0.36	4.35	3.76	45
Pred		199				112.0	2.36	41.7					
%Pre		93				147	166	156					

Figure 10: Testing results / lightweight women

Testing of anaerobic threshold

Anaerobic threshold, as explained in section 3.4, is a metabolic response to an increasing workload when aerobic energy production is augmented by anaerobic energy production to satisfy the energy requirements of the exercising muscles. At this point, there is a corresponding onset of blood lactate accumulation. Although anaerobic threshold is a controversial scientific measurement, its determination may have some practical applications in the sport of rowing.

The anaerobic threshold is observed by determining the change in lactate accumulation in the blood or the change in ventilatory response during periods of increasing workloads. (The volume of air going into and out of the lungs is called ventilation.)

Although not as exact, another method is recording heart rate during increasing workloads. This non-invasive technique is based on the principle that, during continuous and progressive efforts, the linear correlation between heart rate and increasing workloads will change (or deflect) at the anaerobic threshold point. After this change, increasing workloads will be accompanied by smaller increases in heart rate.

The increasing workload may be either an increase in work performed on an ergometer (rowing or cycle) or an increase in velocity in rowing, skiing or running. Again, this procedure is not preferred but it does provide some information which is of practical assistance, particularly during training. This assistance will be explained in the next section.

2.5 Training methods

The FISA CDP has emphasised the importance of training the aerobic metabolic system as this system provides about 75% to 80% of the energy needs of the body during a rowing race. In BASIC ROWING PHYSIOLOGY, the following training advice was presented:

1. To improve oxygen utilisation: long-distance training (at a heart rate of 130 to 160 beats per minute and below anaerobic threshold).
2. To improve oxygen transport: interval training (at a heart rate of 180 to 190 beats per minute and above anaerobic threshold).

The results of training the aerobic metabolic system is illustrated in Figure 11.

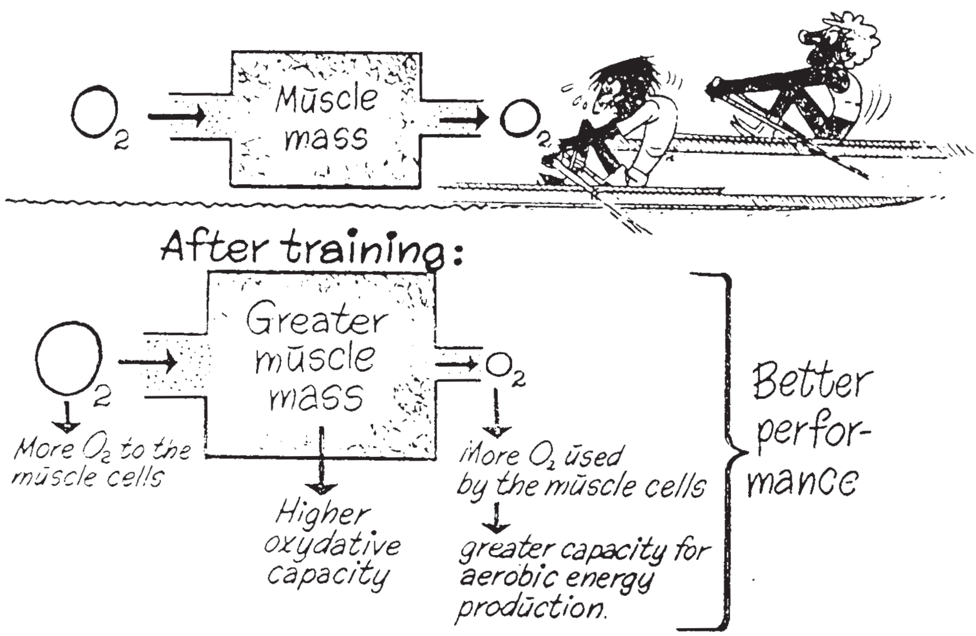


Figure 11: The results of aerobic training

Although the lactic anaerobic metabolic system accounts for only 20 to 25% of the energy requirements during a rowing race, it plays a crucial role during the start and finish phases of the race. Further, as stated in Section 3.4, a purpose of training is to be able to use a greater percentage of the maximum oxygen uptake before obtaining significant increases in lactate concentrations. The training methods that most effectively influence these factors appear to be:

1. Training at or near the anaerobic threshold point improves the body's ability to utilise a greater percentage of the VO2 max before the onset of lactate accumulation.
2. Interval training at high training loads with sufficient rest periods to remove all or most of the accumulated lactate improves the body's ability to tolerate lactate accumulation.

Since the alactic anaerobic metabolic system accounts for limited contribution to the energy requirements of the rowing race, the training of this system is generally restricted to late in the season and may be accomplished by multiple intermittent work periods of 10 to 15 seconds with recovery periods of 30 to 60 seconds between each work period.

Further information about training methods for these systems is presented in the booklet titled SPECIFIC FITNESS TRAINING of the FISA CDP Level II Programme.

2.6 Summary

You should now have expanded your understanding of the physiological requirements of the sport of rowing. With this information, you will be able to provide better assistance to your athletes in the design and implementation of training programmes.

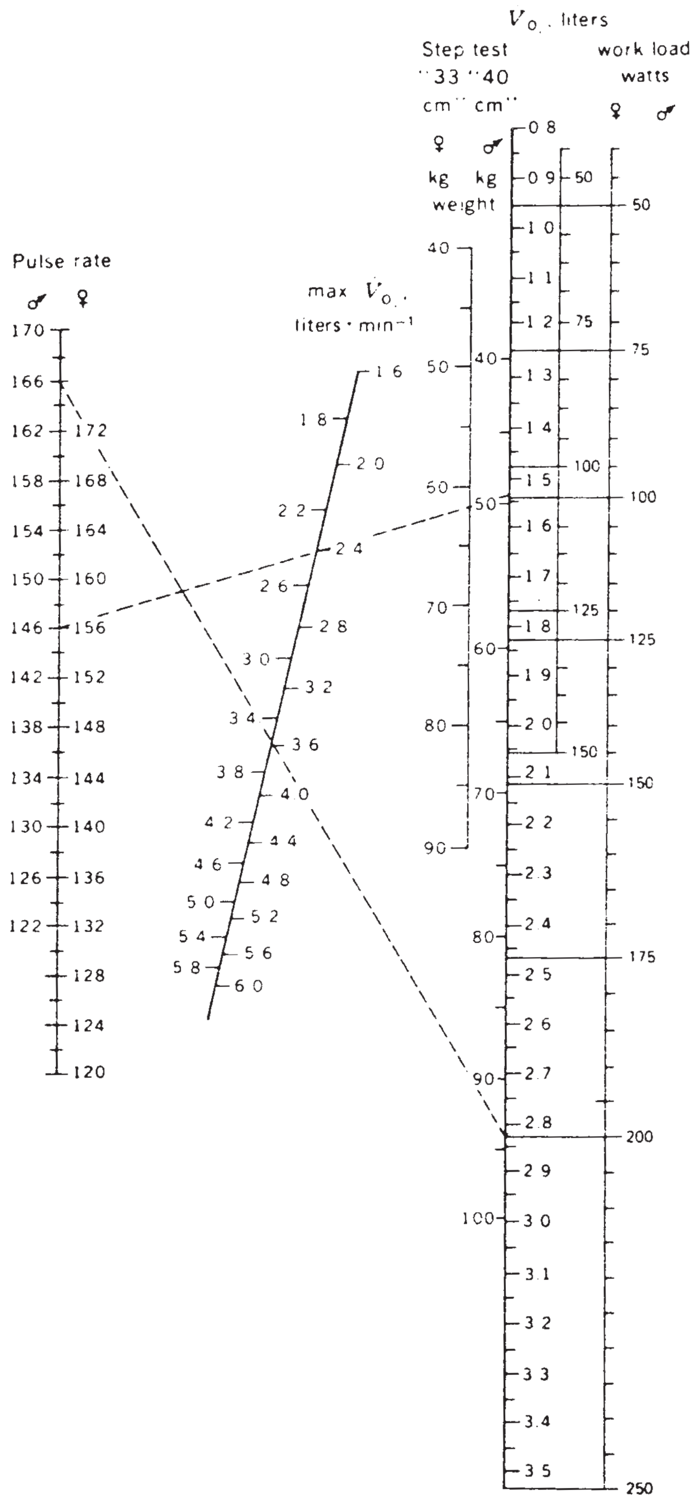
2.7 Appendices

Appendix A. Astrand nomogram

Adapted from Textbook of Work Physiology, 2nd ed., by Per-Olof Astrand and Kaare Rodahl from McGraw-Hill Book Company. 1977.

The adjusted nomogram for calculation of maximal oxygen uptake from submaximal pulse rate and O2 uptake values (cycling, running or walking and step test). In tests without direct O2uptake measurement, it can be estimated by reading horizontally from the ”body weight” scale (step test) or ”workload” scale (cycle test) to the “O2-uptake” scale. The point on the O2 uptake scale (VO2 liters) shall be connected with the corresponding point on the pulse rate scale, and the predicted maximal O2-uptake read on the middle scale. A female subject (61 kg) reaches a heart rate of 156 at step test: predicted max VO2 = 2.4 liters min. A male subject reaches a heart rate of

166 at cycling test on a workload of 200 watts; predicted max VO2 = 3.6 liters min (exemplified by dotted lines).

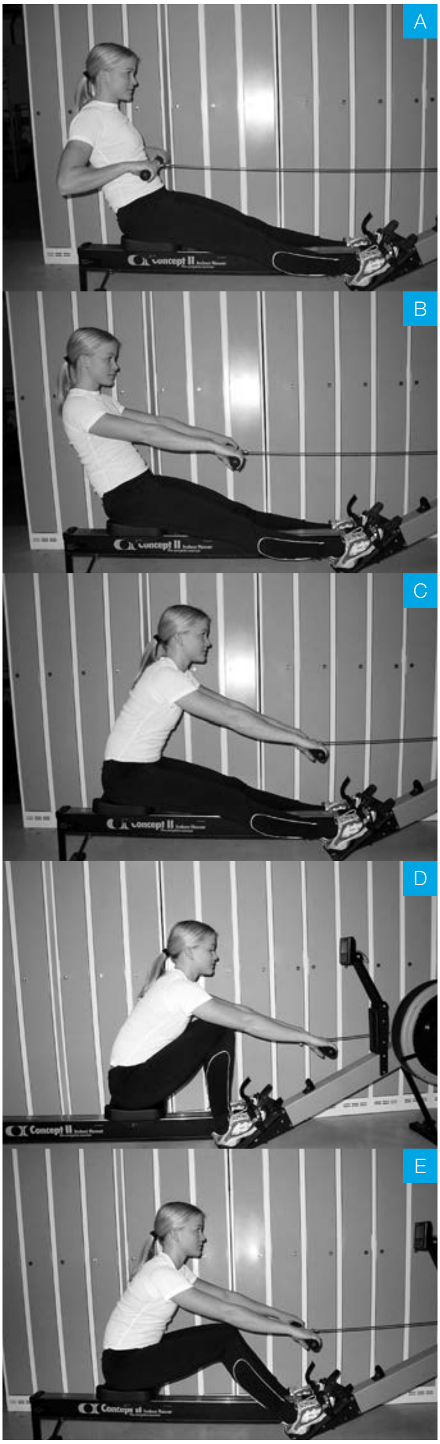


(From I. Åstrand, 1960)

3 Intermediate Rowing Technique

3.1 Introduction

The FISA CDP Level 1 booklet titled BASIC ROWING TECHNIQUE provided a description of the rowing stroke cycle. In this booklet, a brief review of that material will be presented as well as a guideline for the periodisation technique including a description of some useful drills. Finally, a chart will be provided to assist in technique error identification and correction.



A – Finish position
B – Arm starts the recovery
C – followed by the body
D – and the gliding starts (arm-body-legs)
E – During the drive the order is legs-body-arms.

At the full forward position, hands and arms are raised to generate good blade depth in conjunction with the body weight being completely transmitted to the foot stretcher. The active utilisation of the body's muscles, particularly through the initiated leg drive and body swing, causes an effective transmission of force to the sculls.

3.2 The stroke cycle

The six phases of the stroke cycle were presented and described in BASIC ROWING TECHNIQUE. The reader is directed to refer to the description and diagrams presented in that booklet and in Appendix A of this booklet while reading the following review.

The preparation

The athlete utilises the total body height in a natural position with arms approaching full extension and wrist flat. The shins are essentially vertical. The blades are squared and ready for the entry.

The entry and first half of the drive

Rowing ergometers are used in many training programmes in the preparation period, not only for physical training, but also for instruction and technical training. In this series the body movements are parted up as follows:

The finish of the drive

Although the first half of the drive relies primarily on the legs, the upper body has also been initiated but lags behind the leg thrust. During the drive, the back muscles accelerate to catch up to the leg drive with the shoulders and arms finishing. It is important that the body weight is utilised at all times and that the work is transmitted to the oars.

The finish and release

The maintenance of the body weight behind the oars with active and supporting back and legs allows the shoulders and arms to provide the maximum effort at finishing the drive.

It is important to maintain a good blade depth throughout the drive and execute a smooth, quick release with the blades feathered and clear of the water.

The first half of the recovery

The hands execute a quick and fluid movement of pushing the oars away from the body which will be followed by the forward swing of the upper body.

The second half of the recovery

The upper body swings forward with the advancing hands and, as the body nears the correct position of the entry, the athlete commences the forward movement of the seat to initiate the new stroke.

Adaptation to sweep rowing

The FISA CDP advocates that the technique of sculling and sweep rowing is essentially identical although the asymmetrical movement of sweep rowing does require an adaptation of the body to the movement of one oar.

This adaptation requires the upper body to rotate in the direction of the oar movement, particularly as the oar is extended forward for the entry. In effect, the athlete will continue to face the oar, by allowing the body to rotate at the hips, and swing away from the centre line of the boat.

It is important during the forward reach that the athlete maintains a good position to transmit the body weight to the foot stretcher and to avoid over-extending the upper body.

Summary

The long-term objective of the coach and athlete is the mastering of good technique. This will be achieved when the stroke cycle demonstrates:

a consistentpattern and length
b good blade depth
c firm, direct and consistent action of the blade
d relaxed, but controlled, body movements during the recovery
e powerful, but fluid, body movements during the drive and with an overall impression of coordination, rhythm and economy of motion.

3.3 Periodisation of technique acquisition

The FISA CDP has emphasised the necessity of the coach being organised and systematic in planning for athlete development. This is facilitated by the utilisation of a plan to direct development. The planning process with its consequential division of the training year has been termed periodisation.

The concept of periodisation was introduced in Level I and is expanded in INTERMEDIATE TRAINING METHODOLOGY. Planning the improvement of the physical component of training is presented in SPECIFIC FITNESS TRAINING. In this booklet, the periodisation of learning technique is presented, including a description of some helpful technique drills.

The acquisition of technical skills is a complex and continuous process but three progressive phases of motor development have been identified.

These phases are:

1 Rough coordination: the basic elements of the stroke are leaned.
2 Smooth coordination: the learned elements of the stroke are refined.
3 Stabilisation: the refined elements of the stroke are stabilised with adaptation to changing conditions.

During the rough coordination phase, the athlete will concentrate on the major body segments (arms, upper body and legs), body posture and stroke length. It is also an opportunity to work on the dynamic balance of the body, boat and oar throughout the stroke cycle.

The smooth coordination phase emphasises the repetitious practice of the elements introduced in the rough coordination phase. This practice consciously refines these activities into a more efficient and economic movement.

It is also an opportunity to evaluate technique modifications during increased training loads and to emphasise reactive coordination while working on the rhythm of the stroke cycle.

The stabilisation phase is the period of acquiring smoother and more fluid movements that are quick, confident, and economic and proved under varying conditions, including competitions. These movements become automatic and will demonstrate consistent and rhythmical applications of power.

The information presented in Diagram 1 outlines this process as it may be applied during one training season. Although it is not exhaustive, this information is intended to provide a guideline to assist in the planned development of technical skills.

Period	Phase	Emphasis	Drill
General Preparation	Rough	Body Posture	• getting into and out of the boat • attention to hand grip and body position; body upright, firm yet relaxed
		Leg Drive	• 1–3–5 strokes stopping hands on full extension during recovery • 1/2 slide rowing
		Upper Body And Arms	• rowing in pairs and fours, concentrating on hip swing during drive and recovery • rowing in pairs and fours, concentrating on steady arm pull • 1 stroke placement from release to entry • 1 stroke placement from entry to release with full arm and body extension
		Stroke Length	• attention to stroke length; note, optimum stroke length only achieved when athlete increases technical proficiency and fitness.
		Balance	• stopping on command • rowing in pairs and fours with eyes closed

Specific Preparation	Smooth		Repetitious practice of emphasis from rough coordination phase. Review body posture, leg drive, upper body swing (from the hips) and hand action.
		Seat/Blade Timing	• rowing in pairs and fours • squared blade rowing for entry
		Entry And Blade Depth	• 1/2 slide rowing at front • one stroke pulls concentrating on blade depth
		Blade Work	• short work intervals at high rating • pick drill (arms only rowing)
		Grip	• 1/4 slide rowing at front with emphasis on hand control • emphasis on control and quickness during release Continue attention to general dynamics of stroke cycle, stroke rate, overall control and consistency, and economy of motion by: (1) rowing at changing rhythms; (2) short sprints; (3) emphasis of power on drive followed by relaxed recovery; and, (4) rowing under various conditions
Competition		Stabilisation	Although attention may be given to the general dynamics of the stroke cycle, etc., the emphasis is on the movements becoming more refined, automatic, and competition-proof having been tested under various conditions, including competitions.
Transition			All rowing should be performed in small boats with an emphasis on an overall relaxed stroke cycle. An opportunity should be taken to evaluate the technical skills as demonstrated at the end of the prior period.

Diagram 1: Periodisation of technique acquisition. Adapted from an article titled Coaching Notes by Jim Joy (CAN)

3.4 Technique correction

It must be remembered that the various elements of the stroke cycle will be learned, refined and stabilised at different rates during the season and stages of learning; therefore, the learning process is continuous and requires many years.

During this process, the coach and athlete are often able to identify specific elements of the stroke cycle which require modification. Keeping in mind the development process presented in the above section, Appendix B has been provided to assist in identifying and correcting these elements.

Technique correction

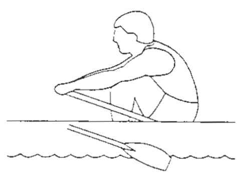
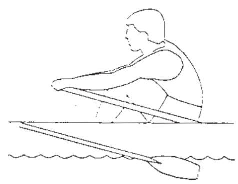
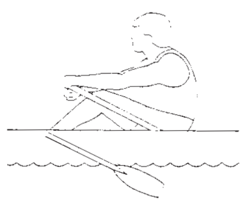
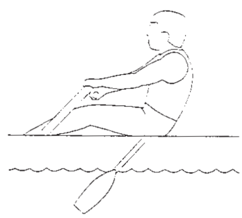
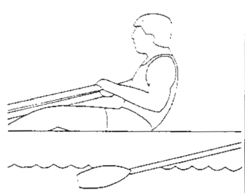
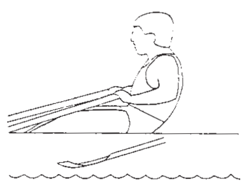
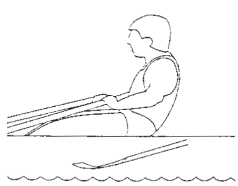
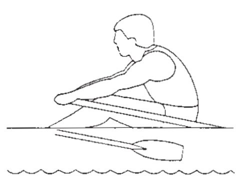
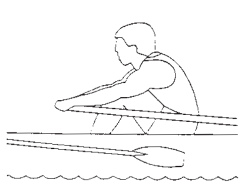
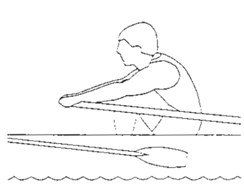
General considerations:

a It is more beneficial to teach proper technique in the beginning than to correct technique later.
b It is important to ensure that the boat is properly rigged.
c It is necessary to first observe and analyse the action of the blade and boat for a demonstration of the effect of improper technique.
d Next, it is necessary to examine the relative body movements of the athlete to determine the possible causes.
e Determine whether the relative body movement causing the problem is at the point of the demonstrated error or in the preceding phase of the stroke cycle.
f Determine the method to correct the error.
g Explain clearly to the athlete the effect, cause and correction of the error.
h Demonstrate the correct body movement.
i Since beginners may have difficulties to correlate the errors with the actual movements of the body, it is better to only show them the correct execution of the movements rather than showing them the incorrect movement.
j Concentrate on one corrected body movement at a time. This is particularly important for beginners.
k Short and frequent training sessions for technique improvement are better than using long and infrequent sessions.
l Since increasing the effective force applied through the oar must be accompanied by an improvement in technique, it is necessary to work continuously on technique correction particularly during periods of increasing training loads.
m Select and use exercises for technique improvement carefully to ensure the maximum benefits.
n Remember, it is important to acquire a good sense of balance and rhythm during the period of learning technique to ensure that the athletes develop the correct perception of the proper rowing technique.

3.5 Summary

This booklet has presented information about the description, learning and modification of the rowing stroke. It is hoped that this information will provide the coach and athlete with some practical guidelines to assist in the proper development of rowing technique.

6.1 Appendix A - Rowing Technique by Thor S. Nilsen ( ) and Kris Korzeniowski (USA)

1. ENTRY *Raise only the hands. *Do not "open". *Enter the water before beginning the leg drive.			2. DRIVE No.1 *Almost no change in the body position. *The body is "hanging" on the oar and footstrecher. *Work is done exclusively by the legs.
3. DRIVE No.2 *Upper body slowly takes over the leg drive. *The body starts to "uncoil" in a natural way.			4. DRIVE No.3 *Legs almost finish their work. *The upper body still continues its swing. *The arms begin their work.
5. DRIVE No.4 *End of the "layback". *The arms move quickly and strongly to the body.			6. FINISH *Forearms and hands move oar handles down and around in a fluid and continuous manner.
7. RECOVERY No.1 *Hands move away from the body at a constant speed.			8. RECOVERY No.2 *At the beginning of the slide, arms are past the knees. *There is early forward body angle preparation.
9. RECOVERY No.3 *The slide is half-way through. *The arms and upper body have finished reaching out.			10. BEFORE ENTRY *Last part of the slide. *All movements are finished except continuation of slide with concentration on a direct entry.

Appendix A – Rowing technique

4 Intermediate Rowing Methodology

4.1 Introduction

The FISA CDP Level I course provided information on the basic principles of training, the concept of periodisation and the development of a training programme. With this information, you, the coach, would have been able to assist your athletes in the achievement of their training objectives.

This course will provide more information on these topics while emphasising the establishment of a well-organised, systematic and multi-year plan. This plan is necessary to ensure the proper development of both existing and future top athletes. Since this course will not review the material presented in Level I, the reader is encouraged to review that material.

4.2 Training stages

The establishment of a multi-year plan should acknowledge that, although long-term training is a continuous process, the athletes would have various training stages during their athletic careers. These stages may be termed:

1. basic training stage
2. advanced training stage
3. high-performance training stage

This division of a multi-year plan assists in the proper systemisation of long-term training (see Diagram 1) and the better development of plans for each training year.

Training Stage	Basic	Advanced	High- Performance
Purpose	All-round development.	Improvement of preparatory base and introduction of specific peformance factors.	Development and maintenance of specific performance factors.
Training	All-round physical development with emphasis on mobility exercises, aerobic endurance and general strength to promote health and development of various systems and organs.	Improvement of the physical qualities by individualisation and specialisation in training. Development of sport-specific motor abilities.	Highly individualised, specific and competition-oriented. There is a maintenance of general motor abilities while specific motor abilities are enhanced.
	Introduction of the basic techniques of the sport as well as elementary tactics and information on rules and regulations.	Improvement of the technical and tactical skills under various conditions including competitions.	Technical and tactical skills are mastered under various conditions.

Method	A variety of exercises during four to five sessions per week and not regimented by a periodised plan.	Exercises are more specialised during the six to eight training sessions per week. The use of a more controlled periodised plan particularly for important competitions.	Training loads are increased during the eight to twelve or more training sessions per week in a periodised plan designed for a competition, either single or multiple events.

Diagram 1: Training stages. Adapted from an article titled Long-Term Training Process by Hardayal Singh.

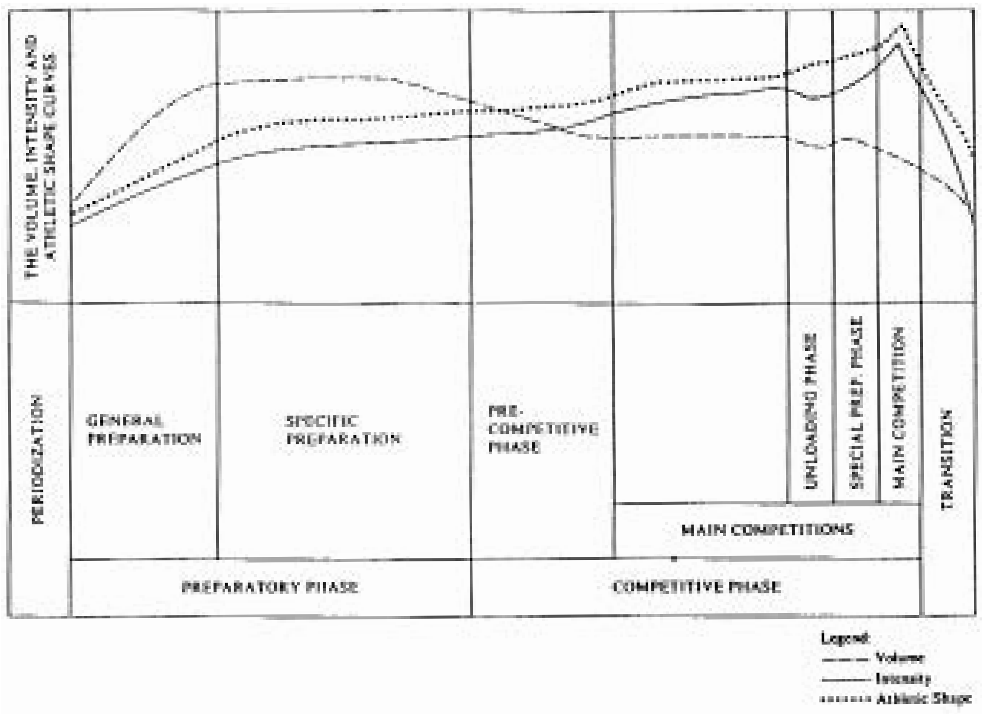


Diagram 2: A mono-cycle annual plan adapted from "Theory and Methodology of Training" by Tudor Bompa.

4.3 Training years

The plan for each training year is designed to optimise performance at a designated event that is usually a major competition during the advanced and high performance training stages of athletic development.

An annual training plan is an important tool for the coach to direct and guide athletic training during the training year. It is based on the concept of periodisation and the principles of training. Annual plans are classified according to the number of competition periods (which culminate in a major competition) included in the plan. Annual plans may include multiple competition periods, but the most common is a mono-cycle plan. This plan is designed to accommodate a major competition, either a local, regional, national or international event (see Diagram 2).

From year to year, the performance at the designated event is evaluated to determine if the training objective has been obtained. During each subsequent year, the training will follow the same basic plan but subject to alterations made as a result of the year-end review. These alterations may also include variations in the basic plan, including the training periods, cycles or sessions, based on either other information about the athlete or advancements in the knowledge of the scientific principles of training.

A systematic annual plan is developed by working backwards chronologically from the date of the main training objective and dividing the training season into the appropriate number of training periods (see BASIC TRAINING METHODOLOGY).

4.4 Training periods

This procedure of dividing the training season is called periodisation. The periodisation of the training season may be represented as follows:

1. preparation period / general and specific
2. competition period
3. transition period

While the preparation period usually includes general and specific preparation, the competition period may be subdivided to accommodate a number of competitive events, including perhaps a major selection event or trial, designed to assist in achieving top performance at the designated training objective. A brief description of these periods including an emphasis on the training components (physical, technical and psychological) is provided in Diagram 3.

In order to manage each period, the period is often divided into training cycles.

4.5 Training cycles

Each training period is generally divided into one or more training cycles of four to eight weeks in length. The plan for each cycle gives the athlete an outline of the particular activities on land and in the boat. It takes into consideration the different degrees of training loads and rest intervals while complying with the wave principle of training.

The best results in improvement of performance can be achieved if the training load (the quantity and quality of the work) is gradually increased during three successive training sessions up to the athlete's maximum load capability and then followed by a very light training session or a complete rest (see BASIC TRAINING METHODOLOGY).

This model is also applicable to training cycles by following a procedure of three weeks of progressively increasing training loads followed by one week of recovery that often culminates in a high performance test.

It should be noted that the same basic weekly plan may be followed for the three to four week cycle to allow optimum development but then the exercises should be varied to achieve additional gains in the next cycle. This is particularly important to top athletes.

The management of training periods through training cycles is usually conducted by providing a six to seven day weekly training plan. This plan outlines the kinds of exercise, the quantity and quality of the work and a detailed programme for each training session.

Training Components	Physical Activities	Technical Skills	Physiological Factors And Tactical Skills
Preparation Period: General Preparation	Longest period of the year with a high quantity of work and a gradual increase in the quality of work. Emphasis on general aerobic endurance and improvements in mobility and strength. Specific exercises are introduced.	Improvement of the fundamental rowing skills with a conscious effort by the athlete to become aware of the movement pattern to be maintained and improved.	Establishment of communication between the athlete and coach for a clear understanding of specific training objectives.
Specific Preparation	General preparation maintained and rowing-specific training, particularly in the boat, is increased. A period of a high quantity and quality of work.	Continual development of a good rowing stroke during increased training loads and at times, near racing velocity.	It is important for the athlete to maintain concentration as the training load increases. Confidence will increase due to improvements in the physical and technical components.

Competition	General preparation decreases while rowing-specific training increases. The development and stabilisation of competitive performance usually through preliminary competitions and perhaps, trials or qualifying events. At the end, there is an active unloading period and final preparation for the main competition event.	The smoother and more fluid rowing stroke demonstrates a consistent pattern after being subjected to various conditions including competitions.	Development of strategies for competition through simulation and actual competitions. The development of confidence is continued due to the growing awareness of a strong base of fitness and technical skills.
Transition Period	A period of active rest through leisure activities to provide physical and mental relaxation from the prior season and to prepare for the next season.	An opportunity to evaluate the rowing stroke, as demonstrated at the conclusion of the prior season, and to review equipment needs and adjustments required.	An opportunity for the athlete to enjoy the feeling of being fit, to evaluate achievements and to establish specific training objectives for the next season.

Diagram 3: Training periods adapted from an article titled “Coaching Notes” by Jimmy Joy

4.6 Training session

The number of weekly training sessions will vary from four to five for beginners to six to eight for experienced athletes to ten to twelve or more for the top athletes. Each session will have various objectives and training loads that will follow the wave principle of training including a provision for sufficient rest between sessions or a complete rest from training.

As the training loads will vary from day to day, they often form a double wave pattern when charted during a weekly training cycle (see BASIC TRAINING METHODOLOGY, Appendix A). Thus, the training load increases during the first three days and then decreases on the fourth day. This fourth day may be a day of active rest of light activity or, possibly, another sport. The training load then increases for another two days followed by a day of active rest or a complete day of rest.

It should be noted that in the development from young athletes to top-level athletes the number and variations of training objectives during each training session and weekly training cycles is reduced as training becomes more and more specialised. Although each session should be well planned, the coach should consider daily the state of the athlete, technique status, or the results from recent competitions or testing to alter the objectives or training loads of the session.

Therefore, each training session must be well planned taking into consideration the training cycle, the training period and stage of the athlete's development. The plan is ultimately individually prescribed and adjusted according to each athlete's physical preparation and level of training. Further, the plan is constantly evaluated and updated to achieve the maximum development of the athlete.

4.7 Training load

The concept of training load was described in The FISA CDP Level I course as the quantity and quality of work. The distance of work, time of work, or number of repetitions represents the quantity of work. The quality of work is the effort exerted in the training session and is represented by the speed of running, amount of weight lifted, heart rate maintained or, in the boat, a combination of pressure applied on the blade and the stroke rating.

The variations in the training load may be obtained by changing either or both the quantity and quality of work to achieve the wave principle of training. The athlete's internal response to these changes will vary according to the athlete's training stage and fitness level.

The athlete's adaptation to the training load is a result of a correct alteration of training load and recovery. A training load causes the athlete to become fatigued which decreases the body's physical capabilities while the rest period allows the body to recover and restore the body's physical capabilities.

In fact, research has demonstrated that the body will recover to a level beyond the initial recovery level with the result that it will commence the next pattern of loading at a higher level. This is termed over-compensation.

4.8 Training control

It is important to develop an organised, systematic and consistent evaluation procedure to control training. This procedure would enable the coach and athlete to evaluate training objectives, including competitions, and review the training programme, particularly at the end of training cycles, training periods, and training years.

This evaluation procedure becomes more important as the athlete progresses to the advanced and high-performance stages of development.

Daily

A common method of controlling training sessions, particularly aerobic endurance training, is the taking of the heart rate. This may be accomplished either manually or using a commercially available heart rate monitor. Although this procedure may be utilised at high training loads, the taking of blood samples for lactic acid determination is preferred but probably impractical for most programmes.

Either or both of these procedures should be used in conjunction with the athlete's and coach's observations, such as body weight, sleep patterns, infections, cold sores, irritability, perceived fatigue, morning heart rate, etc. to control daily training sessions.

Weekly

A video recording session should be conducted in order to allow the athlete and coach an opportunity to view and analyze technique. This analysis could form the basis of a regular and formal technical evaluation by the coach. Further, the editing and storage of the recording on to a master tape would enable the establishment of a video library for the purpose of a long-term assessment of the athlete's technical development.

Monthly

A training chart, a summary of daily records, should be completed by the athlete to ensure adherence to training objectives. Tests may also be administered in order to compare with either group standards or prior results achieved by the athlete. These tests may be, either or both, in the boat or on land, for example a rowing race, determination of running speed or amount of weight lifted during barbell exercises. They may be performed in conjunction with normal training or through more formal sessions designed for this purpose.

Quarterly

The training season should allow an opportunity to evaluate the physiological status of the athlete. This is necessary to ensure that the athlete has acquired the targeted objectives through the periodisation of the training season.

The most common evaluation test in our sport is the maximum rowing ergometer test. It is preferred but not necessary that this test be performed in conjunction with oxygen consumption analaysis. Another useful test is a sub-maximal test to determine anaerobic threshold. A simple non-invasive test for this determination is described in the booklet titled INTERMEDIATE ROWING PHYSIOLOGY.

These determinations will assist the athlete in controlling the adherence to the prescribed training load.

Half-yearly or yearly

An opportunity should be taken to develop a medical profile of the athlete to assist in the maintenance of the athlete's well-being. Further, a complete evaluation procedure should be formalised in order to be in a position to properly advise the athlete in regard to present status and methods of improvement.

This profile and evaluation would form a record of the athlete's development during his career.

4.9 Summary

It is very important that the coach possesses the ability to properly plan the long-term development of the athlete. The coach must use all the knowledge acquired from experience, learning and research to successfully complete this task. This material should assist the coach to achieve this objective.

5 Rowing Medicine

5.1 Introduction

This booklet will introduce some topics related to the medical aspects of rowing. The interested reader is encouraged to con- sult a specialist or other available literature for more information on any of these topics.

5.2 Nutrition

The athlete's diet is similar to a non-athlete since it should promote general health and well-being and contribute to the establishment of proper lifetime nutritional practices. Although it is probably more critical that an athlete receives a well-balanced diet to ensure top performance, the principal difference between an athlete's diet and that of a non-athlete is that an athlete's diet is higher in carbohydrates (see Appendix A).

Carbohydrate replenishment

An exercising athlete will use energy obtained primarily from carbohydrates stored in the muscle as glycogen. Although fats are also stored and used as a source of energy, particularly during long training sessions, it is the carbohydrate level in the muscle that must be replenished for the next training session to reduce the effect of fatigue after hard physical training.

Research studies have clearly established that a failure to replenish this level, particularly after a number of hard training sessions, will result in an impairment of performance. This condition of reduced carbohydrate level may result in substantial impairment of performance during a 2000m rowing race due to the greater dependence on carbohydrates as the fuel for the energy requirement than on stored fats.

It has been suggested that a heavyweight man requires about 500g of carbohydrate daily to ensure proper replenishment in the muscle. An athlete, male or female, rowing in a lightweight category may require about 300-400g of carbohydrate daily. If this individual is undertaking a weight reduction programme, the athlete should maintain the carbohydrate intake while reducing fats (for example butter, oils, lard, fat on meat, etc). If the athlete already eats relatively little fat, it will be necessary to reduce the total quantity of food consumed which will result in weight loss from lean body mass and consequent loss of strength.

Strength development

Success in rowing, as in many sports, depends on the power that the athlete is able to develop (see INTERMEDIATE ROW- ING PHYSIOLOGY) or, in other words, the force that the athlete is able to produce from the contracting muscles. The size and strength of the muscle depends on heredity, exercise and diet.

An athlete is generally restricted in the type of fibres in the muscle by genetic inheritance. Although different types are predominant in successful athletes in sports ranging from sprinters to rowers to marathon runners, an athlete can increase the size and strength of the muscle fibres inherited. (The FISA CDP Level III will provide more information about the various types of muscle fibre.)

This increase in the size and strength is obtained by exercising. It is necessary in the training programme to exercise the specific muscles to be developed by using a progressive training load that exceeds or overloads the capabilities of the muscles.

During this period, the muscles require a nutritionally adequate diet to support muscular development. It is generally not necessary to consume diets enriched with certain foods (for example proteins, minerals and vitamins) to enhance development unless the diet is lacking in some of these nutrients. But, it is recognised that women have demonstrated a requirement for additional iron to prevent anaemia or iron deficiency. This may be accomplished by ensuring that their diet includes iron-rich foods. Iron supplementation should only be directed by a physician.

It is also advisable to consult a physician or the national health services of your country for more information about the sources and availability of food from the four food groups described in

Appendix A. This is particularly important in regions or countries where the quality and quantity of food may not be readily available.

Weight control

A regime of exercise and proper diet will result in an increase in the size and strength of the muscles. This may not necessarily increase the total body weight if the exercise level is such that the calorie expenditure (the amount of total energy consumed by the body) exceeds calorie intake (the amount of total energy taken in by the consumption of food) in which case the total body weight may remain the same or even decrease.

In the event that the athlete's intake of calories exceeds the expenditure of calories or the athlete maintains the same percentage of lean body weight, the increase in the size and strength of the muscles will result in a net gain in weight.

It is possible to control the lean body weight of the athlete throughout the training season by determining the athlete's percentage of body fat. This determination is performed by either taking skinfold measurements or underwater weighing. The taking of skinfold measurements is probably more common because it involves the use of a simple mechanical device, called a skinfold calliper. These measurements are taken at a number of sites on the body, generally from four to eight sites and are relatively quick and easy to perform.

These measurements are used either directly by the sum or through a computation formula to determine the percentage of body fat or the percentage of lean body weight. A system utilizing measurements over six sites was demonstrated by Dr Fernando A Rodrigues in a study conducted during the 1985 World Championship in Hazewinkel, Belgium. A summary of this method is presented in Appendix B.

It should be noted that the rowing athlete would generally have a percentage of body fat in the range of 8-12 and 16-20, for men and women respectively. The increase in popularity of maximum weight categories has resulted in many studies of weight control, particularly in regard to a minimum level of body fat and rapid weight loss. The study performed by Rodrigues suggests that athletes should not be permitted to perform with less than 5 per cent and 9 per cent body fat, for men and women respectively. An athlete approaching this limit and still desiring to lose body weight must do so by the loss of lean body mass (with the accompaniment of strength loss).

The easiest and best method to lose weight is with a combination of diet and exercise. If you eat 500 calories less and lose 500 calories more each day, you will have a 1000 daily Calorie reduction. At that rate, you will lose about 1kg of body weight per week. Obviously, if an athlete is training properly, this decrease in calories will occur with a change in diet (in particular, a decrease in consumption of fat). This guideline is the responsible method to lose weight over an extended period to ensure a top (and healthy) performance on the day of the competition.

It must be remembered that a rapid decrease in weight will only occur with a decrease in the level of carbohydrates and water and not the loss of body fat. This results in an impairment of performance.

Hydration

It is important to realise that water is an important nutrient since it makes up 60 per cent of the total body weight and 40 per cent of the muscles. Without enough water, the athlete will not be able to achieve top level performance and may cause harm to his or her body.

The most important fact about water is that it cools the body. An exercising body will increase in temperature creating sweat which will evaporate from the skin to provide a cooling effect.

If sweating is prolonged or pronounced, the body will become progressively dehydrated. During this period, the loss of water will be accompanied by the loss of electrolytes. (These are substances that are vital for conducting signals along the communication system of nerves.) This fact is not necessarily a problem unless water loss becomes severe and is not replenished, then pronounced impairment to muscle contraction will occur. (In severe cases, dehydration will cause heat illness ranging from cramps to heat exhaustion to heat stroke which is life threatening.) This event will occur more quickly in an athlete who has undergone rapid weight loss because, at the beginning, the body will have a reduced water level.

The loss of water or dehydration can be controlled by recording morning heart rate and body weight, observing urine (clear to pale yellow if hydrated and dark yellow to brownish and strong- smelling if dehydrated), and recording body weight before and after training or racing. It should be noted that to hydrate sufficiently it is usually necessary to drink fluids frequently during the day and the training session. Further, the consumption of fluids should exceed the desire to drink as the body's thirst mechanism may not provide sufficient stimulation to hydrate completely.

In summary, hydration is important to ensure top athletic performance and for good health. This applies to all athletes, particularly to athletes undergoing weight loss or operating in very hot or dry climates. (Remember, the loss of fluids is also a problem during the dry winter months and training at high attitudes).

Summary

This section is not exhaustive and is intended only as an introduction to the topic of nutrition. For further information, the interested reader is encouraged to read a paper presented at the I4th FISA Coaches Conference in Peterborough, England by Dr Stephen Wootton of Great Britain or consult a doctor, a dietician or nutritionist.

5.3 Altitude training

It is clear that training at altitude is good preparation for competing at altitude and that performance at altitude will improve as adaptation continues. But, it is somewhat contentious that altitude training will improve performance on returning to lower altitudes.

However, altitude training is often used by top international athletes as an important part of their competition preparation to achieve the best possible performance.

In the event that an athlete travels to an altitude training site, these are guidelines for training at altitude:

a The training site should be about 1800 to 2000m above sea level.
b Length of time should be a of minimum 20 days (with 3 to 4 days to acclimatise) for maximum effect.
c Altitude training will supplement a good training programme but it is not intended to substitute for proper preparatory training.
d Training loads should be reduced and recovery time increased during the initial period at altitude.
e Consumption of fluids should be increased and the appropriate clothing worn because of the lower humidity and temperatures at altitude.

Further information about altitude training will be presented in the FISA CDP Level III.

5.4 Overtraining

It is obvious that athletes who do insufficient training will not increase their performance level. But, this may also be true of athletes who do too much, too soon and for too long. In these circumstances, the performance level may, in fact, decrease. This is a result of overtraining.

The athlete will generally display a "feeling of tiredness" and may be described as suffering from "staleness". The effect essentially arises from the athlete's inability to recover between training sessions. If this condition persists, the general symptoms of overtraining appear, namely:

1 Behavioural symptoms
a Increase in nervousness or depression.
b nability to relax or sleep.
c Loss of appetite.
d Loss of motivation.
e General fatigue.

2 Physical symptoms
a Extreme muscular soreness and stiffness the day after hard training.
b General increase in muscular soreness over time.
c Decrease in body weight.
d A sudden or gradual increase in morning heart rate.
e Predisposition to infections.

This condition will be rectified by permitting the athlete an opportunity to decrease or even stop training for a few days. If the condition persists, the athlete may require a longer rest followed by a gradual increase in the training load to allow the body to build up its reserves.

The best solution to this problem is prevention. This includes:
a a gradual increase in training load, particularly during the early season or after periods of reduced activity;
b a proper recovery after heavy training sessions, controlled by taking morning heart rate, observing physical appearance and monitoring muscle soreness;
c a balanced diet; and
d observing changes in personality.

The most important fact for the coach and athlete to understand is the value of rest since it may be necessary to provide the athlete with an opportunity to take one or more days of rest. This allows the athlete to adapt better to continual training and to maintain the necessary enthusiasm for the sport.

5.5 Summary

This booklet has introduced a number of topics related to the medical aspects of rowing. The FISA CDP Level III will provide further information about these and other related topics.

5.6 Appendices

Appendix A – Food chart

Note: Athletes will obtain the necessary nutrients for body development by both eating the recommended number of daily servings and choosing a variety of foods from each food group. The most important nutrients supplied by each food group are listed.

This chart has been adapted from How To Select A Diet For You by the National Diary Council. Rosemont, Illinois, 60018 USA.

Four Food Groups	Basic Diet recommended daily servings	Training Diet recommended daily servings
Milk Group Milk, cheese, yogurt and ice cream (For calcium, riboflavin and protein)	Teenagers = 4 or more Adults = 2 or more	Teenagers = 4 or more Adults = 2 or more
Meat Group Meat, fish, poultry, eggs, dry beans, peas and nuts (For protein, niacin, iron and thiamin)	2 or more	2 or more
Fruit-Vegetable Group Fresh, frozen, canned, dried and juiced fruits and vegetables. (For vitamins A and C)	4 or more	8 or more
Grain Group Cereals, breads, rolls, pasta, muffins and pancakes (For carbohydrate, iron, thiamin and niacin)	4 or more	8 or more

Appendix B – Weight control study

A practical stratagem to evaluate participation (minimal weight) in the lightweight category in rowing.

Material:

- A skinfold calliper (Harpenden, Holtain and Lange).
- A constant pressure of 10 g/mm2 is exerted by the jaw surfaces at all openings.
- A calibrated weighing balance.
- A pocket calculator (optional).

Method:

1 Estimation of adiposity (%FAT).

Skinfold measurement. Six skinfolds (triceps, subscapular, supraspinacle, abdominal, front thigh and medial calf) were measured twice, (mean value as actual value), following the measuring standards in Carter (1982) and Ross (1983). A fold of skin and subcutaneous tissue is picked up firmly between thumb and forefinger and pulled away from the underlying muscle. The sites and direction of the skinfold are indicated in the figure 1.

Calculation of estimated fat percentage (%FAT). The equations in Yuhasz (1977) and Carter (1982), where SUM6 is the sum of the six skinfolds, was used.

Men % FAT	= (Sum 6 x 0.1051) +	2.585
Women % FAT	= (Sum 6 x 0.1548) +	3.580

2 Calculation of the lean body weight (LBW). With Body Weight = BW

Fat Weight (FW)	= (BW x %FAT) x 0.01
Lean Body Weight (LBW)	= BW – FW

3 Estimation of minimal weight for lightweight rowing (MW)

Men % FAT	= LBW + (0.06 x LBW)
Women % FAT	= LBW + (0.1 x LBW)

If the estimated minimal weight is (MW) is over 72.5 kg (men) or 59 kg (women), participation in the lightweight category should not be recommended unless close professional monitoring of health and nutritional status makes it possible to change the body composition of the athlete mainly by reducing his or her body mass which will probably reduce his or her physical potential for rowing.

4 Examples:

Subjects	BW	% FAT	FW	LBW	MW
Male A	78	14	10.92	67.08	71.1
Male B	78	10	7.8	70,2	74.41
Female A	65	18	11.7	53.3	58.63
Female B	65	14	9.1	55.9	61.52

Subjects MALE A and FEMALE A can be considered as “true” lightweight rowers.

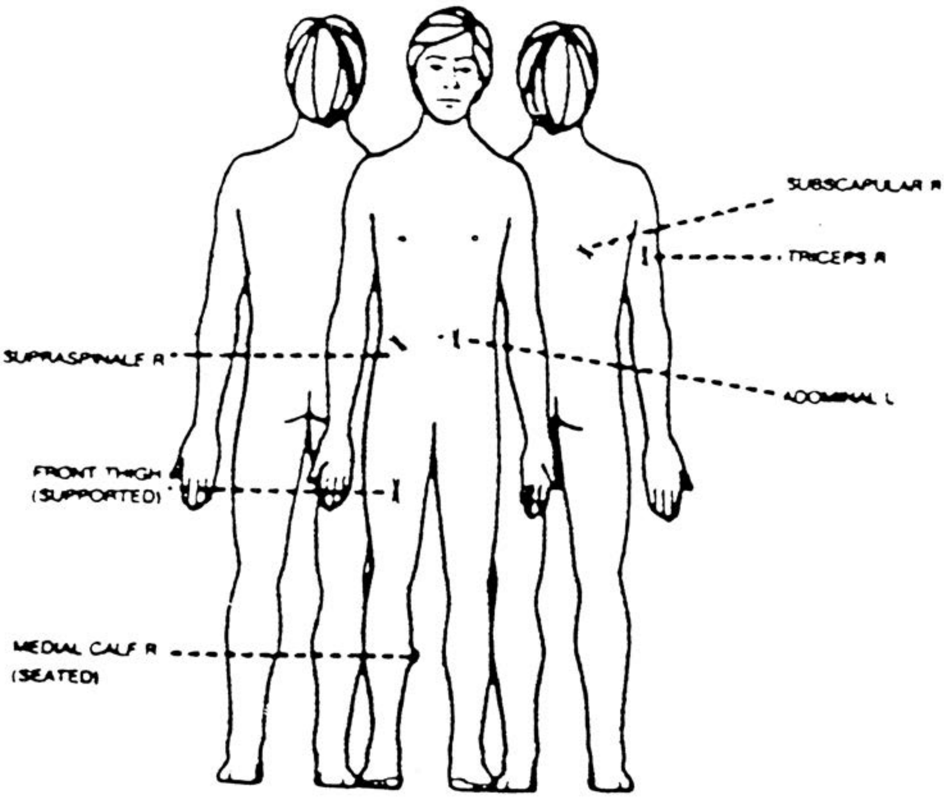


Figure 1. Skinfold site.

6 Specific Fitness Training

6.1 Introduction

The FISA CDP booklet titled GENERAL FITNESS TRAINING defined fitness as the successful adaptation to the mental and physical stress encountered in life. General fitness training was defined as a scientifically based and systematic training programme to provide the athlete with the basic means to adapt to the training loads encountered through controlled exercise.

The booklet emphasised the establishment of a broad base of general physical development as a prerequisite for specialisation in the sport of rowing. As in many sports, specialised training is necessary given the high level of competition in sport today. This applies to all aspects of training and results in the amount of specialised training being progressively and constantly increased both during the season and from season to season.

Therefore, specific fitness training may be defined as a scientifically based and systematic training programme to provide the athlete with the means to adapt to the specific requirements of a sport.

6.2 General preparation for rowing

The general preparation for rowing requires a broad base of physical development. The base is established during the early years of athletic training and emphasised during the preparation period of each training season.

Specific preparation for rowing requires a training programme that emphasises the physical, technical and psychological needs of the sport. This requirement is important during the latter part of the preparation period and during the competition period of the training season, and increasingly important throughout the athlete's career.

It should be noted that it is important not to increase disproportionately the amount of specific training at the expense of general physical development.

Therefore, the main features of general fitness training must be emphasised:

1. Mobility training enhances the learning of good technique, decreases the risk of injury and provides an opportunity for better development of strength and endurance; this type of training should commence early and continue throughout the athlete's career.

2. Strength is a basic physical characteristic that determines performance efficiency in sport; improvements in strength specific to rowing is dependent on the proper establishment of a base through using general conditioning exercises, particularly during the basic training stage of athletic development and the general preparatory period of the training season.

3. Endurance is the capacity of the athlete to resist fatigue during applications of work. As a medium term endurance event, rowing requires the specific development of both aerobic and anaerobic capabilities, but as the aerobic energy system accounts for about 75-80 per cent of the required energy for the rowing race and takes a longer period to be established and maintained, aerobic endurance training must be emphasised throughout the athlete's career.

6.3 Specific preparation for rowing

In designing a specific training programme for rowing, it is necessary to consider the three components of training: physical activities, technical skills, psychological factors and tactical skills. This concept is introduced and explained in the booklet titled INTERMEDIATE TRAINING METHODOLOGY.

A programme for developing the psychological factors and tactical skills will be presented in Level III of the FISA CDP while a programme for developing technical skills is presented in the booklet titled INTERMEDIATE ROWING TECHNIQUE.

This booklet will provide more information about the specific physical activities necessary to enhance performance in rowing.

6.4 Specific physical training

This section will present this topic by examining the main features of fitness training introduced in GENERAL FITNESS TRAINING, namely:

1. mobility training,
2. strength training, and,
3. endurance training.

But, it is first necessary to expand upon the basic principles of training discussed in BASIC TRAINING METHODOLOGY.

Principles of Training

The important principles of training are:

1. Progressiveness of training: the training load must be progressively increased to obtain further improvements in physical performance as the athlete adapts to the quantity and quality of the work.

2. Specificity of training: the adaptation by a physical performance factor of an individual is specific to the type, quantity and quality of the training load.

3. Reversibility of training: the adaptation to a training load will decline when the training load is stopped or even lessened. The longer the adaptation period, the slower the decline and vice versa.

4. Rest: this principle has been called the most important principle of training because a period of reduced training or complete rest will allow the body to adapt and overcompensate for the applied training load.

Mobility training

It is only necessary to refer to the comments written above and in section 4.0 of GENERAL FITNESS TRAINING for this topic. Remember, mobility training provides a base for all physical activity and is important for the optimum application of force throughout the range of movement used in the rowing stroke. Reference should be made to either Appendix A in GENERAL FITNESS TRAINING or one of the numerous texts that are avail- able for mobility exercises.

Strength training

Although specialisation is a complex process, special exercises may be divided into two groups:

1. The first group comprises exercises that are similar to the sequence of the body movements in the sport (for example, utilisation of the rowing ergometer or on the water technical exercises).
2. The second group comprises exercises that represent partial movements of the whole sequence of movement (for example, utilisation of a strength training programme). This group has exercises that activates single or multiple muscle groups in a way similar to the body movements in the sport.

As the athlete matures and become more experienced, the special exercises become more specific to the sport and are performed against the increasing resistance offered by the use of equipment (for example, barbells). This will result in the greatest development of strength relevant to the sport.

A strength training programme should commence with a general conditioning programme followed by a programme of gradually increasing training loads. This progression was demonstrated through the use of circuit training and with reference to Strength Training Guidelines (see figure 2 and Appendixes B and C in GENERAL FITNESS TRAINING).

The Strength Training Guidelines may be expanded to include the following relationship between repetitions and percentage of maximum load for one repetition:

Type:	1	2	3	4
Purpose:	General Conditionings	Strength Endurance	Power	Maximum Strength
Repetitions:	30-40	20-25	10-12	4-6
% of Max	40-55	60-65	70-75	80-90

Remember young or beginning athletes should not attempt to develop maximum strength either during maturation or the first year of training. It is recommended that young athletes emphasise exercises that utilise their own body weight, working with a partner or simple equipment (see Appendix C in GENERAL FIT- NESS TRAINING).

During the latter stages of maturation, the young athlete should be taught proper barbell lifting techniques in conjunction with a more structured training programme. These types of exercises (that establish and maintain a preparation base) and the proper teaching of barbell lifting techniques should be continued throughout the athlete's career.

Before maturation or during the first training year of older athletes, the athlete should follow a programme of increasing loads by utilizing sets of 10-25 repetitions at 60-75 per cent of maximum.

This level of training is used to develop an anaerobic base that will translate into greater work capacity in ensuing years. It also offers advantages of muscle growth and markedly reduced risk of injury.

Athletes should only progress to 80 per cent of maximum or higher after one solid year of training. It should be noted that it is not necessary for beginners or even experienced athletes to test for maximum load capability for one repetition. This should only be attempted by experienced athletes with a high degree of skill. If the programme designates the performance of 20-25 repetitions and the athlete is not able to perform 20 repetitions then the load is too heavy. If the athlete is able to perform 25 or more repetitions, it is necessary to increase the weight. This simple trial and error process will enable the determination of the proper load.

It is generally accepted that during the first stages of training, twice weekly sessions (but not on back-to-back days) is enough to stimulate gains. Further, each session during the first weeks of training should be comprised of 1-2 sets. This will also demonstrate ample performance improvement.

An increase in the number of sets should occur when the athlete has adapted to the training load and is maintaining the required skill level. These increases should be gradual and with no attempt to try big progressions.

More training sessions will be needed when the athlete encounters the law of diminishing return from the number of weekly training sessions. In rowing it has been demonstrated that three training sessions per week are practical and will result in sufficient gains to benefit the athlete.

Generally, as the season progresses and the athlete develops from season to season, the number of exercises will decrease. This is a result of the athlete becoming more specific in training for the sport.

At the end of this booklet, Appendix A has been presented to assist you in organising your strength training programme for the training year. Further, Appendix D has been presented to provide an example of a strength training programme which emphasises the use of barbells for strength training.

It is recommended that an experienced coach of strength training, particularly of lifting techniques, be consulted to provide further guidance for the design, instruction and supervision of strength training programmes.

Endurance training

This booklet will provide further information on this topic by providing Appendices B on Guideline for the Periodisation of Endurance Training and Appendix C on Endurance Training Methods for Rowing. The latter appendix is an expansion of Appendix D in GENERAL FITNESS TRAINING.

6.5 Summary

The information presented in this booklet expands on the presentation in GENERAL FITNESS TRAINING and will assist you, the coach, in a better understanding of and ability to prepare training programmes for your athletes.

6.6 Appendices

Appendix A – Guideline for the periodisation of strength training

Type:	1	2	3	4
Purpose:	General Conditioning	Muscular Endurance	Power	Maximum Strength
Preparation Period General:				
Early	+	+	-	-
Late	+	+	+	+
Specific:	+	+	+	+
Competition Period: Early:	+	+	-	-
Late:	+	-	-	-
Near Competition:	-	-	-	-
Transition Period:	+	-	-	-

Appendix B – Guideline for the periodisation of endurance training

Type:	1	2	3	4	5
Purpose:	Aerobic Utilisation	Aerobic Transport	Anaerobic Threshold	Anaerobic Tolerance	ATP – CP
(Sessions/ Week) Preparation Period:					
General	4 – 5	0 – 2	0 – 1	-	-
Specific	3 – 4	1 – 3	1	-	-
Competition Period:					
Early	2 – 4	3 – 5*	1 – 2	1 – 2**	-
Late	2 – 4	3 – 5*	1	2 – 3 **	1 – 2
Transition Period	3 – 4	-	-	-	-

* Emphasize aerobic transport and, if time permits, add extra aerobic utilisation sessions.
** Anaerobic tolerance may be either special sessions to prepare for racing or actual racing.

Appendix C – Endurance training methods for rowing

Energy System	Training Effect: Fuel	Quantity		Quality		Recovery	
		Number Reps/ Sets	Duration	Heart Rate	Stroke Rate	Duration Reps/ Sets	Heart Rate
Aerobic	Aerobic: • Primarily Fatty Acids With Glycogen • To Fatty Acids With Glycogen	1	60'-90'	130-150	18-22	-	-
		1-2	20'-90'	140-160	18-22	1'-3'	130-140
		2-3	15'-20'	150-170	20-24	1'-3'	130-140
	Transport: • glycogen	2-4	8'-10'	170-185	24-30	4'-8'	120-130
		3-8	3'-8'	175-190	26-32	3'-6'	120-130
		10-20/	20"-60"	180-190	28-34	10"-45"	130-150
		1-3				3'-6'	120-130
	Anaerobic Threshold: • Primarily glycogen with fatty acids	1	20'-90'	160-170	24-28	-	-
		2-3	8'-12'	165-175	26-30	6'-10'	120
		3-5	3'-6'	170-180	28-32	4'-8	120
Anaerobic	Tolerance: • glycogen	2-3	3'-5'	180-190	32-34	6'-10-	120
		3-6	1,5'-3'	MAX	MAX	4'-6'	120
		8-12/	45"-90"	MAX	MAX	1'-3'/	120
		1-3				6'-8'	120
ATP-CP*		8-12/	10"-15"	MAX	38-44	1'-3'/	120
		1-3				4'-6'	120

* Provides a small (< 5%) portion of the energy requirements during a rowing race.

Appendix D – Strength training programme / guideline

Type	1	2	3	4
Purpose:	General Conditioning	Strength Endurance	Power	Maximum Strength
Exercises:	General	Specific		
TYPE:				
Legs:	3	3	2	1
Legs & back:	2	2	1	1
Back:	2	1	1	1
Abdominal:	2	1	1	1
Arm flexion:	1	1	1	1
Arm extension:	1	1	1	1
TOTAL:	10-12	8-10	6-8	4-6
Repetitions:	30-40	20-25	10-12	4-6
Sets:	4-6	4-6	3-5	3-5
Method:	Circuit/station	Circuit/station	Circuit/station	Circuit/station
Rest:	Continuous	Continuous/ intermittent	Intermittent	Intermittent
Mode:	Individual	Pairs/ medicine ball	Apparatus/ equipment	Apparatus/ equipment

General conditioning:
A training programme to systematically exercise all parts of the body to provide a broad base of strength on which to build higher levels of strength.

Strength endurance:
A Muscle or muscle group´s ability to withstand fatigue during extended periods of strength utilisation.

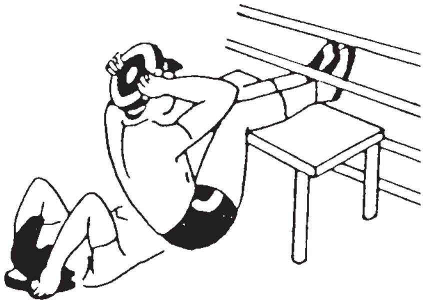
Power:
A muscle or muscle groups ability to overcome resistance with a high speed of contraction.

Maximum Strength:
A muscle or muscle group's maximum ability to develop mechanical force.

Strength training programme – Weight lifting technique

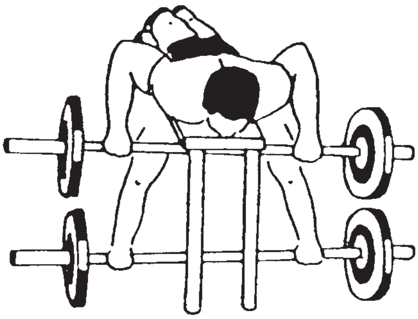
Augmented sit-ups

- The knees should be bent and the legs placed on a bench with the feet fixed in place.
- The up position should be the maximal upward flexion of the trunk.
- Return to the down position slowly and carefully.



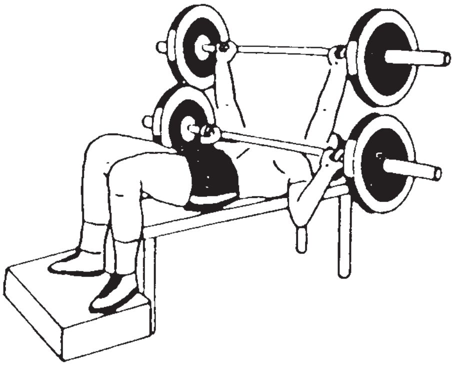
Bench pulls

- The chest should be in contact with the bench throughout the lift.
- The hands should grasp the bar at about shoulder width.
- The bar should touch the bench at the top of the lift.
- The bar should be lowered slowly and carefully.



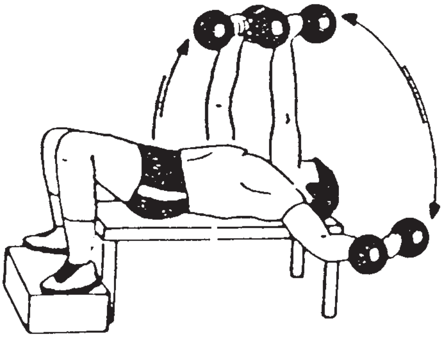
Bench press

- The back and buttocks should be touching the bench throughout the lift.
- Always begin the exercise with the barbell resting on the pectorals.
- Grasp the bar equidistance from the centre.
- Press up the barbell with a slight angle towards the head until the arms are extended and perpendicular to the body.
- Pause for a moment in the up position and then bring the bar down in a controlled manner.



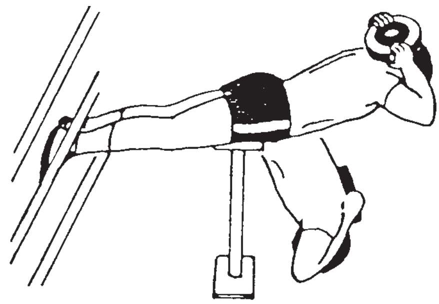
Lateral dumbbell raises

- The back and buttocks should be in contact with the bench throughout the lift.
- The arms are extended out laterally perpendicular to the body and the dumbbells are lifted with a slight bend in the elbows.
- When the dumbbells are overhead, pause for a moment then lower them in a controlled manner.



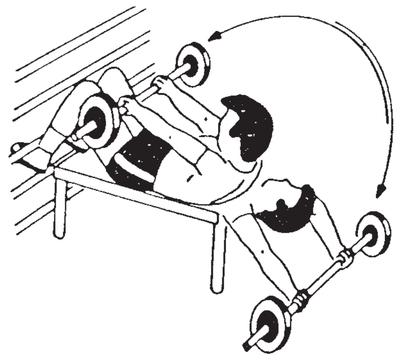
Dorsal raises

- The bench should be adjusted so that it is at waist height.
- The upper arc of movement is reached when the body is parallel to the ground.
- Return to the down position slowly and carefully.



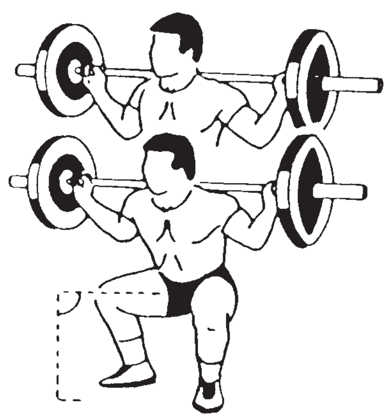
Overhead barbell raises

- The arms should be straight and rigid during the lift.
- Grasp the bar with the hands at about shoulder width.
- In the down position, the lift is complete when the trunk and head are parallel with the ground.



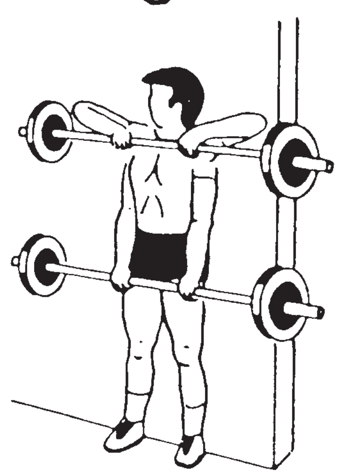
Squats

- The trunk should be erect and the head slightly raised.
- The feet should be placed firmly on the floor at about the width of the pelvis and the toes slightly opened.
- The bar should be resting behind the neck on the upper back and shoulders.
- Slowly lower the upper body by bending the knees while keeping the angle of the upper body constant relative to the ground. The squat is finished when the thighs are parallel to the ground. A momentary pause should take place before coming up to standing position.

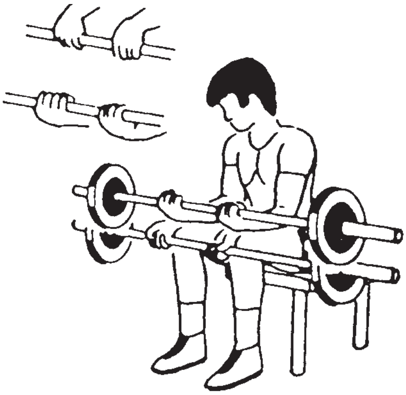


Upright rowing

- The back should be in contact with a wall throughout.
- The bar should be lifted to the height of the chin.
- The bar should be lowered slowly and carefully.
- The hands should grasp the bar about 20cm apart.



Wrist curls



- The lower arms should be in contact with the knees.
- The arc of movement should be the points of maximal flexion and extension of the wrists.
- Return to the down position slowly and carefully.

Clean

Preparation Position: The feet should be about shoulder width apart and the toes pointed slightly out. The arms should be extended and the hands should grasp the bar also at shoulder width. The shins should be slightly touching the bar and the angle described by the knees should be a little more than 90 degrees. The trunk should be erect and hips in a firm position.

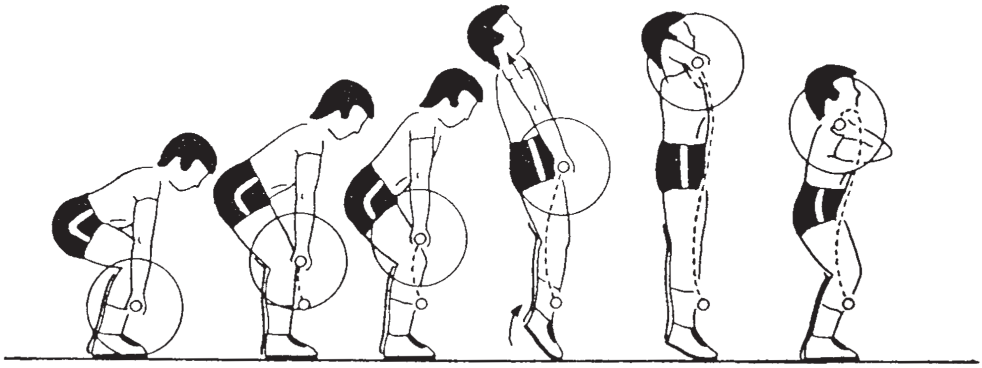
Initial Lift Phase: The barbell should be lifted to knee level, initially, using only the legs, to an opening of about 140-150 degrees. The bar should remain very close to the body, the back properly braced (flexed), the arms straight and firm and the shoulders squared.

Load Phase: The bar passes above the knees by opening slightly the back and drop- ping slightly the buttocks. This is a subtle movement that helps keep the back and hips in a firm and powerful position.

Pull Phase: The angle of the knees and the angle of the thigh/pelvis open simultaneously. At the finish, the feet are extended. The arms are extended and ready to pull the barbell up in a trajectory near to the body.

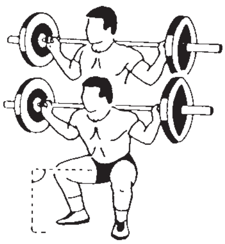
Finish Phase: The barbell is pulled up using the arms and the inertia created by the pull phase. The bar comes to rest under the chin and on the shoulders which are slightly forward with the elbows extended. The feet should be flat on the ground, the knees slightly bent, the trunk upright and the head slightly raised.

Finish position: The athlete should stand up straight with the bar resting under the chin and on the shoulders. The elbows are extended forward and the head slightly raised. There should be a momentary pause before bringing the bar back down to the preparation position and the return down should be done in a controlled manner.

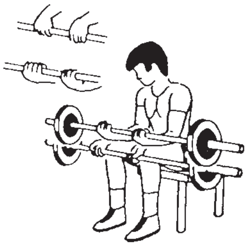


Strength Training Programme – Type II: General strength endurance training

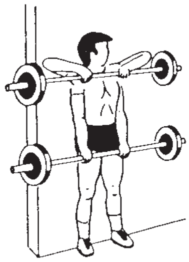
load: 60-65% max.
sets: 4-6
reps: 20-25
rest: 2-3 min.



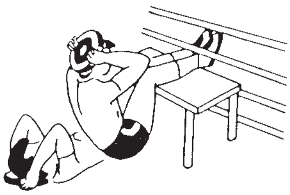
load: 10 kg.
sets: 4-6
reps: 20-25
rest: 2-3 min.



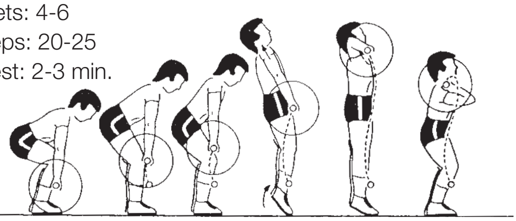
load: 15-35 kg.
sets: 4-6
Reps: 30
rest: 2-3 min.



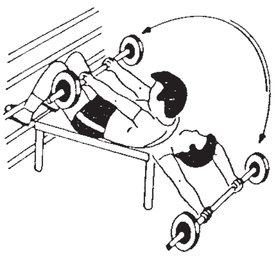
load: 0.5 kg.
sets: 4-6
reps: 40
rest: 2-3 min.



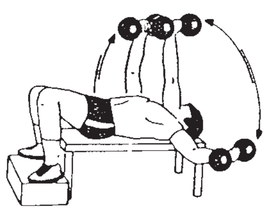
Load: 60-65% max.
sets: 4-6
reps: 20-25
rest: 2-3 min.



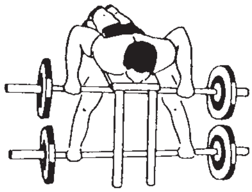
load: 15-20 kg.
sets: 4-6
reps: 30
rest: 2-3 min.



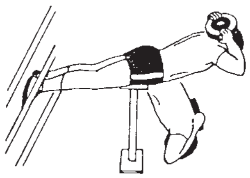
load: 40-45% max.
sets: 4-6
reps: 20-25
rest: 2-3 min.



load: 60-65% max.
sets: 4-6
reps: 20-25
rest: 2-3 min.

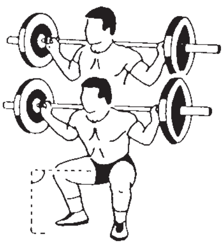


load: 0.5 kg.
sets: 4
reps: 40
rest: 2-3 min.

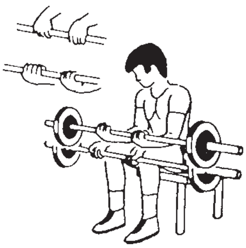


Strength Training Programme – Type III: Power training

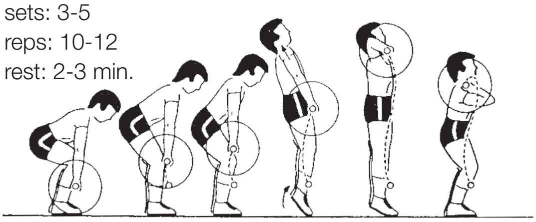
load: 70-75% max.
sets: 3-5
reps: 10-12
rest: 2-3 min.



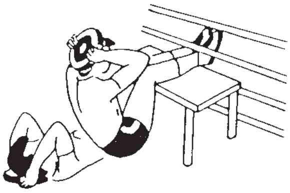
load: 60-65% max.
sets: 3-5
reps: 10-12
rest:2-3 min.



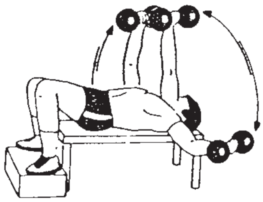
load: 70-75% max.
sets: 3-5
reps: 10-12
rest: 2-3 min.



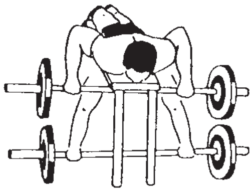
load:1-5 kg.
sets:3-5
reps: 15-20
rest: 2-3 min.



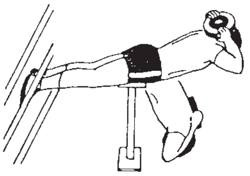
load: 60-65% max.
sets: 3-5
reps: 10-12
rest: 2-3 min.



load: 70-75% max.
sets: 3-5
reps: 10-12
rest: 2-3 min.

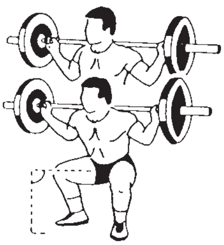


load: 1-5 kg.
sets: 3
reps: 15-20
rest: 2-3 min.

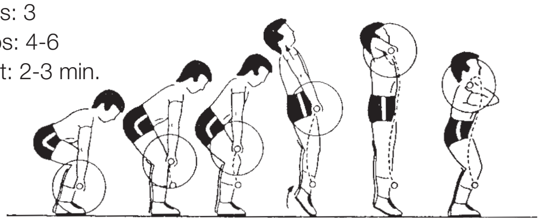


Strength Training Programme – Type IV: Maximum strength training

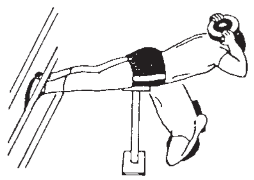
load: 80-90% max.
sets: 3-5
reps: 4-6
rest: 2-3 min.



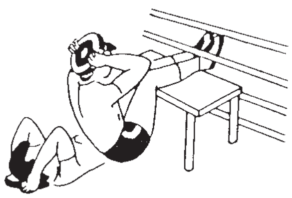
load: 80-90% max.
sets: 3
reps: 4-6
rest: 2-3 min.



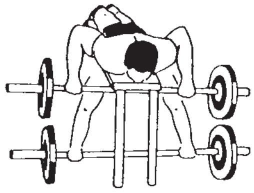
load: 1-5 kg.
sets: 3 reps: 4-6*
rest: 2-3 min.
*hold 5-6 sec. at top.



load: 5-10 kg.
sets: 3
reps: 8-10
rest: 2-3 min.



load: 80-90% max.
sets: 3-5
reps: 4-6
rest:2-3 min.



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