THE MEASUREMENT OF STROKE RATE AND STROKE COUNT

By David Pyne, B App Sc M App Sc

Introduction

One of the oldest but most valuable coaching tools available to swimming coaches is the measurement of stroke rate and stroke count. Coaches Gennadi Touretski and Jim Fowlie have extensively used stroke rate analysis in their coaching at the Australian Institute of Sport. We reported on this work with the 1992 Olympic 50m and 100m Freestyle Gold Medallist, Aleksandre Popov, in a previous issue of Australian Swim Coach (Vol.10 No.5). In this article, I wish to further examine the issue of measuring stroke rate and stroke count.

There are a number of ways to measure stroke rate and stroke count. The most accurate is by filming and computer analysis, although this is obviously not available to most coaches. There are several more practical methods available to measure these factors in the pool using a stopwatch and swimming over a measured distance. To simplify this process even further, a revised method has recently been proposed. A series of six 50m swims of progressively increasing intensity is used to establish the relationship between swimming velocity (V), stroke rate (SR) and stroke length (SL) or distance per stroke (DPS). This relationship can be summarised as…

Velocity (V) = Stroke Rate (SR) x Distance Per Stroke (DPS)

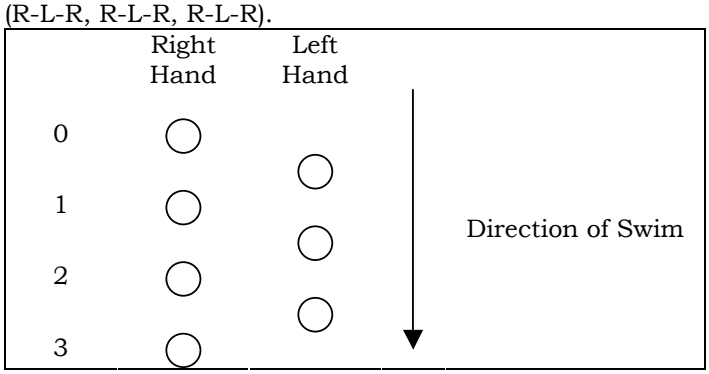
In practice, distance-per-stroke is difficult to measure and requires a time-consuming test protocol or the use of biomechanical filming. By measuring stroke count (i.e. the number of strokes required to swim 50m) we can substitute this as an indicator of distance per stroke … e.g. as the stroke count increases we assume that the distance per stroke is decreasing.

How to Measure Stroke Rate and Stroke Count

1. The protocol for this test is 6x50m swims on a 2-minute cycle. All swimmers are to use their preferred stroke. For Individual Medley swimmers, the coach should nominate the stroke to be used. A 50m pool is preferred for this test.
2. The target times for the test are determined as follows. The slowest swim (i.e. swim No.1 is undertaken approximately 10 seconds slower than the predicted best time on the day. Each of the following swims is then undertaken approximately two seconds faster than the preceding swim, until the sixth and final (and maximal effort) swim is completed.
3. All swims utilise a push start.
4. Using manual timing, the first observed movement is used as the starting time and hand touch at the 50m is used as the finishing time.
5. Record all times to a tenth of a second.
6. Record stroke rate and count.

Stroke rate is measured using the base 3-stroke rate facility on the stopwatch. The stopwatch is started as the swimmer's hand enters the water to commence a stroke. At the completion of three complete stroke cycles, the stopwatch is stopped as the same hand enters the water for the fourth stroke cycle (Figure 1). Alternatively the stroke cycles can be timed and stroke rate calculated using the above equation. For Breaststroke, it is often easier to use the point where the head comes up rather than the hand entry.

Figure 1. In this example the stopwatch is started on the entry of the right hand (0). Three complete stroke cycles are timed (R-L-R, R-L-R, R-L-R).



On the completion of the third cycle … i.e. when the right hand enters the water for the fourth time (3) … the stopwatch is stopped.

The stroke rate should be measured twice in each 50m swim: in the first 25m and again in the second 25m. The value should be similar and, if not, then averaged to give a representative figure.

5. Calculate velocity and plot stroke rate and stroke count against velocity.

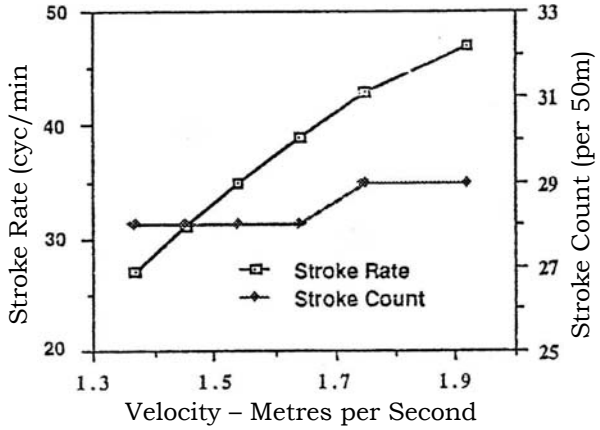
The following example is given for a male 100m Freestyle swimmer. His predicted fastest time for 50m on the day is around 26 seconds. In this case, he will be asked to swim his series of six at the following speeds…

1. 36 (26+10) seconds
2. 34.0
3. 32.0
4. 30.0
5. 28.0
6. 26.0

Here we see the results with the initial time a little slow (37.5), but then an even descent and a pleasing final time of 26.0, which equalled the predicted time.

Swim No.	Time (Secs)	Velocity (M/s)	Stroke Rate (Cycles/min)	Stroke Count (Strokes/50)
1	37.5	1.37	27	28
2	34.5	1.45	31	28
3	32.5	1.54	35	28
4	30.5	1.64	39	28
5	28.5	1.75	43	29
6	26.0	1.92	47	29

Figure 2 shows a graphical representation of this data showing the linear increase in stroke rate. The stroke count is held relatively constant through the set indicating that distance per stroke was maintained.



Data Interpretation

The basic premise of this test is to provide a qualitative analysis of stroke mechanics during a series of progressively faster swims. This information should be used in conjunction with the subjective assessment of the technical quality of the stroke by the coach (using video tapes analysis if possible). It is desirable for good quality stroke mechanics to be maintained from the slowest to fastest swim. Elite swimmers are able to "hold their stroke together" at the fastest speeds whilst less skilled performers lose control, evidenced by a significant increase in stroke count … i.e. a decrease in distance per stroke. The aim should be to hold the same or similar stroke count throughout the test and increase swimming velocity by simply accelerating the stroke rate. Inspection of the graph should indicate the speed at which control of stroke mechanics is lost. Data can be viewed on a group basis, although the most appropriate interpretation is achieved by comparing an individual's result to his or her previous data.

Stroke Analysis at the 1993 Pan Pacific Championships

The best means to familiarise yourself with the interpretation of stroke rates and counts is, of course, to practice on your own swimmers. However, a great deal of information can be gained from analysis of results from elite swimmers. The following is from the 1993 Pan Pacific Championships held in Kobe, Japan. For interest and information, here are some results for Australian swimmers, kindly provided by the Medical and Scientific Committee of the Japan Amateur Swimming Federation (averaged in some instances).

Kieren Perkins 800m FS, 1st place, 7:50.51

Velocity	1.65 metres/sec
Stroke Rate	45-50 strokes/min
Stroke Length	2.10-2.23 metres

Susan O'Neill 100m FS, 2nd place, 55.80
Velocity 1.74 metres/sec
Stroke Rate 55 strokes/min
Stroke Length 1.85 metres
Darren Lange 50m FS, 4th place, 23.17
Velocity 2.001 metres/sec
Stroke Rate 63 strokes/min
Stroke Length 1.91 metres
Philip Rogers 100m BR, 1st place, 1.01.56
Velocity 1.53 metres/sec
Stroke Rate 58 strokes/min
Stroke Length 1.59 metre
Rebecca Brown 200m BR, 2nd place, 2.28.42
Velocity 1.30 metres/sec
Stroke Rate 49 strokes/min
Stroke Length 1.64 metres

A comparison between Rebecca Brown (AUS) and Anita Nail (USA) in the Women's Final of the 200m Breaststroke – one of the best races at the 1993 Pan Pacs.

Anita Nail, USA, 1st place					
Lap Stroke Length	Time	Split (m/s)	Velocity (s/min)	Stroke Rate (m)	
0-50m	33.57	33.57	1.38	46.3	1.79
50-100m	1.11.47	37.90	1.27	40.7	1.88
100-150m	1.50.03	38.56	1.27	40.5	1.84
150-200m	2.28.40	38.37	1.26	41.1	1.84

Rebecca Brown, AUS, 2nd place					
Lap Stroke Length	Time	Split (m/s)	Velocity (s/min)	Stroke Rate (m)	
0-50m	34.20	34.20	1.37	39.5	1.66
50-100m	1.12.37	38.17	1.29	46.9	1.64
100-150m	1.50.25	37.88	1.28	48.7	1.58
150-200m	2.28.42	38.17	1.27	52.4	1.46

Summary

The preceding results indicate that there is a great deal of variation in the stroke patterns of elite swimmers. Apart from different style, the stroke mechanics will depend on several factors including body size (height and limb length), tactics, and fitness. There is, of course, no perfect stroke pattern. Each individual swimmer will have their own stroke and stroke mechanics – the more important feature is consistency. As every wise coach will confirm the ability to "hold the stroke together" is a telling one. Armed with a stopwatch, every coach is able to check their swimmers stroking patterns during training and competition.

STEPPING UP FROM STATE TO NATIONAL LEVEL

By Ken Wood, Master Coach

If we take the trouble to go back, say over the past five years, and assess the performances of our State Champion Age Groupers and compare their winning times with times achieved at National Age Championships, we find that there is nearly a 40% fall off on times these swimmers achieved at State Championships against those achieved at Age National level, and this jumps to 60% when their swims at National Open level are compared with their State Championship performances.

Even outside the top echelon we have only to compare almost any of the National results, Age or Open, to see the relatively large numbers of competitors who comfortably swim National qualifying times at State level but then fail to qualify at Australian Championships. In this paper, I will put forward three main ideas that I believe are the reasons for these statistics.

The first reason obviously is the Taper and whether the individual coaches are peaking their swimmers for a "once off" meet or for a "mini peak" at State and then up again for the Nationals, or perhaps swimming through the State Championships and easing them a little for the Opens with the main emphasis on to the Age Nationals. Even if a coach were to rest his or her swimmers three or four times in a season, for every Meet of reasonable standard, they should, all things being even, be able to at least match the PB times at National level. Let's look at some other reasons for these statistics.

PHYSICAL STRENGTHS AND SKILLS VERSUS PSYCHOLOGICAL SKILLS VERSUS TECHNICAL SKILLS

It has been proved on many, many occasions in the past and it will continue into the future where we see athletes with perhaps only one of the three "skills" above still perform personal best times at National Level, but the one skill that they do possess is developed to the point where they are able to, for the want of a better description, create a "margin for error".

A swimmer may have developed, or be naturally tough by nature (they take pride in this attribute), and without good technique and perhaps a perfect preparation are still able to come up in the pressure meets because they feed off the one attribute they have. It surrounds them. Likewise, a swimmer who possesses a high degree of natural ability with near perfect technique can produce personal best performances at a high level of competition with perhaps a less than adequate preparation and perhaps a fairly low level or mental toughness.

The third scenario may be the swimmer who is an excellent physical specimen, has worked hard in the Gym to further develop strength and flexibility and has eaten the right foods. This person is quite capable of producing P.B. times at National level without perhaps perfect technique and little psychological preparation; just by having a physiological advantage. The same applies to a swimmer who goes into the Nationals with a cold or some other minor disability and still does personal best performances.

I am sure that every coach who has swimmers competing at this level will have experienced one or all of the above. The fact remains that these things do occur, and will continue to occur despite deficiencies in certain areas. The winners and the Age Groupers that ultimately go through to higher honours will always nearly possess all of the necessary traits above.

I think when we get right down to why we get this drop off in performance between State and National Swims, we must look at the swimmer's perception of the meet and their ability to use the right focus for the specific events to be swum.

The Australian Institute of Sport psychologist, Jeff Bond, covers the subject really well in a recent paper. He said, "There is little doubt that there is a combination of psychological factors which is associated for each of us with both poor and excellent performances." That is, there is a set of factors which correspond with our IPS (Ideal Performing State), and when we create these conditions for ourselves in a more consistent way, quality performances will result. When conditions are not right for us, we cannot approximate our IPS and our performances consequently are not as good. If each athlete could learn exactly which psychological factors are important, and then learn to control (produce the best conditions) these in such a way as to become very skilled at consistently arriving at an IPS, then perhaps we would be in a better position to predict high quality performances. I would suggest that there are at least five main categories of factors which might explain both the performance drop off which occurs when an athlete is outside his/her IPS, and the achievement of the IPS and corresponding peak performances. However, it is essential that we look at an important aspect, which underlies this, I am referring here to the attitudes that an athlete has about…

1. The nature of the competition
2. The nature of the task

These attitudes are fundamental to this whole issue concerning psychological readiness and control during performances, and they may have a very dramatic effect on the five factors listed below.

Attitudes about the nature or importance of a competition or training performance constitute a major input to the degree of pressure an athlete may experience prior to, during and/or after the performance. Pressure is a self-perceived thing. No one can make us feel pressured unless we allow that to happen. What is pressure for one athlete may not be for the next one. Our feelings and the perception of pressure are very much connected with our perceptions of the importance that we or other significant people attach to the competition performance. The five categories of factors Jeff Bond covers fully in his paper are…

1. Cognitive Factors (thinking, self, talk, images)
2. Physical Factors (the body's physical responses to excessive stress or pressure)
3. Emotional Factors (mood states, or how we feel)
4. Concentrational Factors (the extent to which our concentrational focus matches the requirements of the task at hand)
5. Pre-performance and Performance Routines (we each have a number of established routines or preparatory strategies which serve as the basis for consistent performances)

Any coach with swimmers who are experiencing difficulty in achieving good performances when stepping up to the Nationals or higher standard meet should read Jeff Bond's paper "Psychological Factors and Peak Performances". To continue on … the acquisition and development of hard-nosed or tough-minded athletes is not as daunting or undesirable as many may think.

DEFINING A TOUGH MENTAL ATTITUDE

We can see that the ways athletes behave in real life sporting situations are measures that we coaches can use to grasp what is commonly called mental toughness. These measures of task selection, persistence intensity, etc., can be specifically tailored for various program environments. As these behaviour patterns all relate to how swimmers are incited, pushed, driven or motivated towards a certain goal oven an extended period, they are related to mental toughness.

Finding a tough minded or mentally tough swimmer is not a problem for most coaches – but it is not normal for us to confine our talent identification to a single factor such as mental toughness. We all know there is a complex interaction of factors relating to body build, state of training and, as we have discussed, psychological disposition. But with the training process under the control of the coach and the swimmer, the greatest potential for developing tough mentally prepared athletes along with other physical and psychological qualities necessary for success certainly exists within this controlled environment. Although tough mindedness can be found more frequently among under privileged individuals, coaches are not often faced with finding, but with developing this quality.

Before considering the ways to develop mental toughness, let us be clear when we answer the question "Mental toughness relates to what?" It would be treading a tightrope if we maintain that achievement is the only reason swimmers participate in your program. If the swimmers were questioned individually as to why they are swimming or why they dropped out, their answers would include achievement, making friends, belonging to the squad or the love to feel the thrill of racing. Others like the sport because they like an activity where they can make their own decisions, which fulfil a desire for self-control. If the squad direction is solely on achievement, then loss of those people who would have persisted if their needs for other of the above factors were also considered.

PERSISTENCE

It is difficult to develop the ability to work hard over an extended period since often only small margins of improvement occur. While the coach may have advanced knowledge on how to reach the final goal, the swimmers need to have efficient ongoing information accompanied by short-term strategies for success. If the short-term goals are realistic, the swimmers are able to receive constant and positive feedback on their individual progress, rather than receiving the results of their work at the end of the season through a championship or a record, etc. This is important, particularly for Age Groupers, since they don't have the ability of senior swimmers to delay the need for rewards. The reasons for the Age Grouper's persistence in sport goes beyond simple achievement. It is also important for the coach to help ensure that their needs for affiliation and self-control are met.

INTENSITY

Intensity of activity is believed to be important in understanding tough mindedness. A swimmer can maintain long term or persistence – just continue to go through the motions. Intensity of effort is the type of intensity that peers and spectators most admire, but its instability also makes it the most fallible.

It's easy to understand why top intensity levels are hard to maintain – they cause the swimmer to hurt. Intense, prolonged intensity builds up lactic acid, one very difficult to maintain, and it causes extreme discomfort. It becomes the coach's job to explain the beneficial relationship between full intensity workouts and the body's adaptation to ensure these stresses. Pain tolerance increases as the body is exposed to progressively higher doses. It is equally important that the swimmers understand the beneficial effects of these workloads.

I have tried to show in this paper the need for an intimate knowledge of yourself psychologically and the "nuts and bolts" of mental toughness – or tough mindedness in practical terms. Success breeds success, perhaps because of the powerful effects of modelling or copying the admired qualities of other people. There are countless examples of how the presence of one or two top athletes will cause the work behaviour and performances of the groups' mediocre swimmers to lift to much higher standards.

Once winning environments are established, they tend to perpetuate themselves along with the necessary behaviours that lead to high achievement. The need for self-control is met by allowing individuals to take part in responsibility such as decision-making.

Tough mindedness should essentially come down to allowing an achieving athlete to seek and maintain standards of performance through hard and constant effort. One is most likely to find tough-minded competitors in squads that value this characteristic. Hopefully, this performance level will also be accomplished within a balanced life perspective.

In closing, I read an interesting article in the daily paper that is pretty relevant.

"Most faults can be corrected by attitude.

Past glories are nice, but in recalling them, the mind tends to block out the pain and effort needed to achieve them.

Natural ability counts for nothing without that filthy four letter word – WORK!"

DESIGNING TRAINING SETS TO IMPROVE ENDURANCE

By David Pyne

Given the importance of endurance training in the preparation of all types of competitive swimmers, it is worth examining some of the different ways to construct endurance sets. Endurance training is used to develop three basic areas of aerobic fitness: sub-maximal or low-intensity aerobic (A1, A2), anaerobic threshold (AT) and maximal oxygen uptake (VO_2 max or MVO_2) capacities, as defined by the AIS Swimming Program's Classification of Training (Pyne, 1993). The aim of this article is to discuss some of the criteria used in the design of endurance training sets. Thirty examples are provided to show some of the different combinations that can be used for an endurance set with a volume of 2400m.

Endurance fitness can be improved by both continuous and interval training. The evolution of training for competitive swimming has involved the universal usage of interval training for developing both aerobic and anaerobic capacities. Continuous or over-distance swimming is still a useful, if relatively uncommon, form of endurance training. Swimming speed should be monitored closely to ensure that the correct intensity is being maintained – heart rates should be below 150bpm or between 50 and 70 beats below its maximum level for each individual swimmer. Low-intensity aerobic (Al) intervals should be completed at the slowest possible speed at which correct technique can be maintained. Overdistance work of this type may include sets such as…

1. 1 x 2400m FS continuous
2. 3 x 800m FS on 11:00 with FIR <150bpm
3. 6 x 400m FS on 5:20 with HR <150bpm

This type of training is usually undertaken in Freestyle and incorporates short to very short rest periods. Most well trained swimmers can tolerate work/rest ratios of around 6:1, and therefore, rest periods of a few seconds to a minute are most commonly used in the longer interval work. However a mix of strokes and drills should be integrated into this work to develop and maintain technical skills – good technique is required at all times. Breathing control should also be emphasised and practised (breathing to both sides and co-ordinated with stroke counts). Some variety in the continuous or long interval work will also limit the problems of boredom and loss of concentration … for example…

4. 3x800m [alternating 200m FS breathing 5:5/200m BK] with 30s rest
5. 6x400m [1,3,5: FS; 2,4,6: pull] on 5:00
6. 6x400m [1,3,5: FS; 2,4,6: kick] with 10s rest

The most common methodology employed to develop and maintain endurance capacities is interval training. The specific nature of the adaptations necessary for the different components of endurance fitness … e.g. moderate-intensity aerobic (A2), anaerobic threshold (AT) and maximal oxygen uptake (VO_2 max), require different types of interval training sets. The integrated programs used by most leading coaches combine endurance training, lactate tolerance and sprint work. There are six basic variables that can be manipulated in the prescription of interval training sets for swimming (Sharp, 1993)…

(i) Volume (total metres)
(ii) Duration (distance of each repetition)
(iii) Intensity (speed of each repetition)
(iv) Frequency (number of repetitions)
(v) Recovery (time between each repetition or set)
(vi) Type – Stroke (FS, BK, BR, FLY, IM) or combination – Drill, Kick, Pull

Changing one or more of these variables, even slightly, may substantially alter the physiological effects and benefits of the training set. Clear and concise instructions should be given to swimmers to ensure that training sets are completed to the requirements of the program. The following symbols are used in the examples shown below…

FS = Freestyle
BK = Backstroke
FLY = Butterfly
BR = Breaststroke
IM = Individual Medley

The first consideration is to determine the **volume** (i) of the endurance set. This will depend on a number of factors including the age and level of the swimmer, the event (sprint, middle-distance or distance), and the phase of training season. This may range prom 1000 to 4000m with most endurance sets for well-trained swimmers being between 2000-3000m. The next consideration is the **repeat distance** (ii) – most coaches use intervals from 50-400m with 100's and 200's being the most common distance. Studies in the swimming flume at the International Center for Aquatic Research in Colorado

Springs (Troup, 1991) have shown that 100's and 200's are very effective in developing aerobic capacities (endurance fitness) … for example…

7. 24x100m FS on 1:40
8. 12x100m FS on 1:40, 24 x 50m FS on 0:50
9. 4x [200m FS on 2:30, 2x150m FS on 1:50, 100m FS on 1:20]

The **intensity** (iii) and **number of repetitions** (iv) of each interval are then determined to ensure the appropriate stimulus is being achieved …i.e. low-intensity aerobic (Al), moderate-intensity aerobic (A2), anaerobic threshold (AT) or maximal oxygen uptake (VO_2 max). The intensity (pace) of interval training is one of the most important determinants of the physiological effects of the set. Interval training can be divided into two broad categories: simple repeats or combination sets. Repeat sets, as the name implies, involve the repetition of the one interval, most often at the same intensity … for example…

10. 24x100m FS holding 1:05 on a 1:40 cycle
11. 12x200m BK holding 2:30 on 2:45 cycle
12. 48x50m FS holding 32.5 on 40 cycle

This form of training would be familiar to all swimming coaches. There are, of course, an endless number of combinations that can be used, if the distance of the repeat is varied … for example…

13. 2x (4x100m FS on 1:30, 8x50m FS on 45s)
14. 8x (2x100m BK on l:30, 2x50m FS on 45s)
15. 6x400m FS on 5:00

Variations in the speed or pace of the intervals provide a stimulus for different aspects of aerobic fitness. The short 50m efforts in these endurance sets are performed at a relatively higher intensity (200m race pace or faster) than the longer 100 or 200m efforts. Quite often a set time base or cycle (time per 50m interval) is used … e.g. 50m: on 45 seconds, 100m: 2 x 45s = 1:30, 150m: 3 x 45s = 2:15, etc.

16. 3x [4x100m BR holding 1:20 on 1:45, 8x50m BR holding 36s on 1:00]
17. 3x [200m (2:20), 2x150m, 2x100m, 2x50m (28.0)] FS on 45s time base
18. 3x [400m (4:40), 200m (2:15), 100m (1:05), 2x50m (28.0)] FS on 45s time base

The nature of the set can also be altered by manipulating the **rest or recovery period** (v). By increasing or decreasing the recovery time it is fairly easy to vary the physiological demands of the training set. It is also possible to use active or passive rest – active rest or low to moderate intensity aerobic swimming (Al-A2) is the most effective form of recovery when there is sufficient time built into the set. For this reason, it is often worthwhile to include some active recovery swims during a long endurance set, particularly when more intensive anaerobic threshold (AT) or maximal oxygen uptake (VO_2 max) work is being undertaken.

19. 5x [4x100m BK holding 1:20,1:15,1:10 and 1:05 on 1:25 cycle] + 100m FS recovery
20. 5x [400m FS holding 4:40 on 5:00, 100m FS recovery on 2:00]
21. 4x [5x100m BR holding 1:25 on 1:40,100m FS recovery on 2:00]

The need to **mix strokes** (vi) in sets for individual medley and form swimmers is an additional consideration. Switching and mixing strokes in IM order … i.e. Butterfly-Backstroke-Breaststroke-Freestyle in various combinations, provides specific training for IM swimmers and general conditioning for swimmers of Freestyle and form strokes. Care is needed with the planning of Butterfly (less efficient at low and moderate intensity levels than Freestyle and Backstroke) and Breaststroke (the slowest stroke which requires a longer cycle time than the others).

22. 24x100m [odds: Fly/BK on 1:40; evens BK/BR on 1:50]
23. 2x [8x150m alternating Fly/BK/BR and BK/BR/FS]
24. 6x [2x50m Fly, 100m BK, 100m BR, 2x50m FS]

The other type of interval work is where there is a mixture of different training speeds. In this work, moderate and higher quality intervals are combined to provide a better balanced training session. This may be in the form of a descending set, an alternating set, a spike set with one or two fast efforts, or a set that includes some explosive short sprints (high velocity overloads) of 10-25m in length. Example of this training would be sets such as…

25. 4x [500m on 6:30 + 2x50m fast on 1:30]
26. 4x [600m + 15m dive start]
27. 4x [4x100m FS on 1:40 holding 1:04.1x100m FS on 2:30 holding 58]

In this set of 100's, the majority of the work is completed at controlled speeds (e.g. 1:04) at the anaerobic threshold (AT) level, with the final 100m repeat in each set undertaken at race speed (VO_2 max level and above). This set may be more beneficial in the long term than a simple set like 16x100m on 1:40 holding 1:02. In the example, the swimmer would receive the physiological and neuromuscular

benefits of fast work at 58.0 with the accumulative effects of holding 1:02-1:04. Most leading coaches will include both simple and combination (integrated) type endurance sets in their training programs.
The advantages of this type of set include that it is more manageable for those swimmers with less-developed aerobic capacities such as sprinters, younger or older swimmers, and those coming back after a break. The swimmer is able to maintain better control, the fast 100m repeat provides a greater stimulus to the development of VO_2 max capacities and is specific to the neuromuscular demands of competitive speed. Measurement of stroke rate may assist in ensuring that neuromuscular demands (i.e. speed of limb movement) are at the appropriate level. An integrated interval set also reduces the risk of excessive fatigue, which often manifests as an inability to maintain the repeat times towards the end of the set.

28. 3x800m FS on 12:00 hold 36 strokes per 50m
29. 4x [400m FS on 5:00, 4x50m holding 30s with 30 strokes]
30. 4x [200m BR on 3:00, 2x50m BR holding 35s on 0:50 with 20 strokes, 1x100m BR holding 1:12 on 1:40, 200m FS]

It is likely that endurance training will be enhanced by a combination of both simple and integrated VO_2 max training sets. We have outlined previously the aim of this type of work is to improve the swimming speed at a given metabolic cost (oxygen uptake). (Pyne and Touretski, 1993). Whilst many training programs will result in the improvement of maximal oxygen levels per se, the most important aim is to have faster swimmers, and not just those with the biggest aerobic capacities. The examples presented in this article are given as a guide only. There are, of course, as many different ways of designing training sets as there are swimming coaches.

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THE SPECIFICITY OF TRAINING
A Fresh Look at an Old Principle
Using Aerobic Training to Improve both Aerobic & Anaerobic Fitness

By David Pyne, Sports Physiologist
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Most coaches are aware of the basic principles of training such as overload, progression, specificity, reversibility and individuality. These principles form the basis of training plans for swimmers at all levels. Specificity is one of the most important in terms of designing effective training programs. The basic theme of this article is that some coaches may be misinterpreting the principle of specificity and consequently, are implementing training programs that may not be as effective or productive as possible. The effect of this misinterpretation is that training is focussed incorrectly on high intensity anaerobic work at the expense of aerobic work.
The specificity principle is known, at least in intuitive terms, to every coach. All textbooks on coaching and training methodology will espouse the importance of specificity. The highly regarded and successful coaching accreditation courses run in Australia also give prominence to this principle. These courses discuss the categorisation of different sports and events into the various energy systems – the aerobic system, the anaerobic glycolysis (lactic acid) system and the muscle phosphagen system (ATP-CP) system. The specificity principle, taken at face value, suggests that training programs should be designed to equate the volume and intensity of training with the energy demands of the sport of event … e.g. for a 100m swimming race that is approximately 50% anaerobic and 50% aerobic … there should be a similar proportion of training time devoted to each energy system. However, experience has shown repeatedly that this is generally not the most effective approach.
Analysis of training programs at the Australian Institute of Sport shows that about 80% of training is aerobic and only 20% is anaerobic, even for sprint swimmers.
In one sense most athletes possess sufficient natural speed for all but the most explosive events. For example, most swimmers can perform several fast sprints (i.e. at competitive race pace or faster) over a short distance (25m) … e.g. senior male Freestyle swimmers can hold around 11.0 seconds for 25m (approximately equivalent to 44.0 seconds for 100m). However the ability to repeat these sprints many times during a training session or to hold this speed over a longer distance (e.g. 50m, 100m or 200m) is

determined by a combination of anaerobic and aerobic capabilities, and neuromuscular limitations. The doyen of Australian Breaststroke coaches, Terry Gathercole, says that every swimmer has the natural speed to break the world record (over a short distance), but only the champions have sufficient endurance to sustain it over the full race distance. On this basis, both the endurance and speed capabilities of sprint swimmers need to be developed.

It is apparent that it is possible for transference of adaptations (improvement) from one energy system to another. We have demonstrated previously that it is possible to develop aerobic and anaerobic capacities using this concept in a three-week aerobic macrocycle (Pyne and Touretski, 1993). We consider this to be one of the most important aspects of preparing high-level swimmers. Our experience, developed with elite sprint and distance swimmers over many years, is that carefully planned and well-monitored aerobic training will lead to the development of aerobic (Al, A2), anaerobic threshold (AT) and maximal oxygen uptake (max VO_2) components of fitness. Gennadi Touretski uses this concept at the Australian Institute of Sport, and he expects to see an improvement in all areas of fitness from moderate intensity aerobic work. Lactate and heart rate testing is used to monitor this process.

Aerobic training is used to support anaerobic training both between and within different training sessions. Most coaches would be familiar with the concept of alternating hard and easy sessions in a given micro-cycle (i.e. a week's training). Moderate intensity aerobic sessions are used to facilitate adaptation, recovery and regeneration from high intensity or quality training sets. This situation represents the utilisation of aerobic training between anaerobic sets to support the development of aerobic and anaerobic capabilities, and ultimately speed. Whilst this basic task of planning is well understood, the concept of designing interval sets that incorporate aerobic work within an anaerobic session is vitally important but sometimes overlooked or misunderstood.

The concept of specificity applied to sprint training has traditionally meant high quality training sets. These sets generally prove to be very demanding for the swimmer and often result in high levels of fatigue. A reduction in skill and technical precision as fatigue sets in is commonly observed. The basic prescription of interval training involves constructing sets using various combinations of distance or duration of work, the distance or duration of rest or recovery activities, the number of repetitions, and the work to rest ratio (Pyne, 1994). Some coaches have used sets such as 20x50m holding 30 seconds on a 60 seconds cycle. This set would represent good quality aerobic work for a female 200m Freestyle swimmer, but the speed is too slow for a 100m swimmer trying to achieve a competition time of 58.0 seconds or a 50m swimmer aiming for a time of 27.5 seconds. Application of the specificity principle is important in these shorter and faster interval sets. In this case, it may be more appropriate to undertake some work over 25m and having the swimmer hold 13.0 seconds or faster in order to meet the specificity and overload principles … e.g. 4x25m holding 13.0-13.5 seconds on a 2 minute cycle.

For true sprint work, many coaches will plan a number of sprint sets through the training week. Rather than concentrating on sprints in just three or four sessions a week, many of the successful Australian sprint coaches incorporate some sprint work into every session. Coaches like Ken Wood and Bernie Wakefield have built solid reputations on this type of work – the so-called high velocity overloads (HVOs) where a number of shorts sprints (commonly over 25m) are undertaken. For the preparation of 1992 Olympic Champion and Men's 100m Freestyle World Record Holder (48.21) Aleksandre Popov, his coach Gennadi Touretski also uses small but liberal doses of sprint work. Touretski will often finish a session with some sprint work such as 4x25m dive or 6x15m sprint (see article by Pyne and Touretski, 1993). The integration of this work with aerobic work appears to be a successful way of simultaneously developing both endurance and speed.

Where the specificity principle breaks down is in the implementation of longer intervals in a simple interval format, which if undertaken with sufficient intensity, can be very fatiguing. The demands of a very stressful set of 100's and 200's would be etched permanently in the minds of most current and former Australian swimmers. These sets will be characterised by high heart rates and blood lactates (i.e. high energy cost) but often at slower than competitive speeds. Whilst sets of this nature are important, they need to be well planned and closely monitored. The current thinking is that two to three of these sets in a single week is the upper limit. In terms of testing, the 6x100m maximal effort test was deleted from the National Tests after criticism that it was too demanding and provided limited information to the coach.

Another approach to this type of work is the use of combination intervals. An example of this work might be a set such as 4x (3x100m FS holding 1:06 on 1:40; 2x50m FS holding 32.0 + 100m FS recovery on 2:00) for a female 400m Freestyle swimmer with a PB of 4:16. In this example, the swimmer undertakes the 3x100m at VO_2 max speed, the 2x50m at race pace, and then an easy 100m for recovery. By breaking the set into a number of parts, the swimmer has a better chance of maintaining

the required speed throughout the set. Control of the set can be achieved with the timing of repeats, the use of heart rate monitors, and if available, the measurement of blood lactate.

The specificity of training is also important in both long-term (months to years) and short-term (days to weeks) planning. Most coaches follow a program where training volume and intensity is periodised through a season or competitive preparation. Again the traditional interpretation of the specificity principle, has involved the season being divided into meso- or macro-cycles which consist of early-season endurance work, followed by mid-season work characterised by a combination of endurance, speed and technical development. This is followed by the pre-competitive phase or taper that is characterised by a systematic reduction in the volume of aerobic work and the development of muscular power and swimming speed.

Integrating endurance and speed throughout the yearly plan is a key element of planning. Rather than rigidly adhering to the notion that only endurance work is undertaken in the endurance phase, and only speed work in the speed phase, many coaches integrate different types of work throughout the training year … i.e. the early season endurance phase contains some sprint work and the mid-season phase contains some endurance work. This approach appears to be quite successful when the training programs of the best Australian and international coaches are examined. A feature of elite swimmers is their ability to swim fast (i.e. close to competitive speed) throughout the training cycle. This is possible only when endurance and speed work have been correctly integrated. The failure of some Australian sprint swimmers to consistently reproduce their best or near-best form may be indirect evidence that their long-term training programs need a thorough evaluation.

Individual endurance sports that are repetitive and cyclical in nature … e.g. running, swimming, rowing and cycling, require a high volume of training. This is particularly evident for the weight-supported sports such as swimming, rowing and cycling. I contrast, the musculoskeletal stress of running limits the volume of work that can be undertaken before fatigue and/or injury occurs. Sports such as swimming (e.g. up to 90km/week) and cycling (up to 120km/week) are characterised by very large, and some times prodigious, training volumes. However these large volumes are necessary to support the development of the fitness levels required to be successful national and international levels. Aerobic training also required to support the development of technical abilities and speed (anaerobic power and capacity Although many events within these sports am considered to being largely anaerobic, it is clear the training of many successful athletes features a large volume of aerobic work.

The classic sporting example quoted by many to justify the concept of specificity is swimming. Many onlookers question the need for sprint swimmers (i.e. those swimmers competing in the 50 and 100m events) to undertake large volumes of aerobic training. In the 1980's there was a trend towards low volume – high intensity training which was popularised, initially in the United States and later adopted by some Australian coaches. This form of training appealed to both coaches and athletes who looked forward to fast swimming, whilst enjoying a substantial reduction in the time devoted to training. In a popular book on swimming written in 1983 by high profile US coach and a leading sports scientist, it was stated that sprinters should devote 60% of the total workout to the ATP-PC system, 25% to the lactic acid system and only 15% to the aerobic system (Troup and Reese, 1983). This breakdown of training is considerably different from the traditions Australian approach, and that of the successful European swimming nations, who favour a more aerobically-based program.

Despite a great deal of initial interest, it became apparent that the low volume-high velocity approach has several shortcomings. Firstly, it is only applicable to the sprint events over 50m, and possibly, the 100m. Secondly, it appeared to be successful only in the older, more mature, swimmer who already possessed a substantial training background developed over a number of years. Thirdly, it became apparent that while the low volume-high intensity training was sufficient to maintain current, or return to previous, performance levels, it proved difficult to develop or improve competitive performance to a higher level. Many national level swimmers who adopted this form of training remained just that, national level, and could not advance to international levels or, ultimately, to international success.

It appears that the nature of the misinterpretation of the specificity principle is that it is applied too generally. The principle of specificity needs to be applied rigorously in some parts of the training program. Obviously speed and sprint work must be undertaken at a sufficient intensity to provide an overload to stimulate the physiological and neuro-muscular adaptations required for improved performance. A number of coaches and scientists have questioned the need for apparently excessive amounts of high quality aerobic work that many leading Australian coaches have built their reputations on. Of course, there is a fine balance, as many of the "work ethic" coaches would question whether some other coaches are too soft and their swimmers under-prepared.

The importance of using aerobic work to support anaerobic or speed training is highlighted by the challenge of the taper or pre-competition planning. All coaches would acknowledge that this is a vital

stage of the preparation for major competition, and often can be the "make or break" time. The traditional approach has been for a systematic reduction in the volume of work, with the maintenance, or sometimes an increase, in the amount and intensity of speed or quality work. Some swimmers are renowned for wanting a "longish taper" where they largely rest up and sharpen their fitness with some sprint work. If this work is not supported by some aerobic training, and/or the reduction in aerobic work is too severe, the process of adaptation and super-compensation may become unbalanced, and ultimately fail. This may be one explanation for some tapers that simply have not worked and the swimmer performs poorly at competition despite a lengthy preparation.

In summary, there are several reasons for a balanced and integrated training program should include a sufficient volume of aerobic work.

1. Aerobic work is necessary for the development of the various components of aerobic fitness … e.g. maximal oxygen uptake, anaerobic threshold and efficiency or economy.
2. Aerobic work is necessary to support the development and maintenance of anaerobic components.
3. Aerobic work is necessary to facilitate the recovery from high intensity competition or training.
4. Aerobic work assists in the maintenance of an ideal body composition by manipulating the energy expenditure: dietary intake ratio.
5. Aerobic work is essential for the development of technical skills at lower training speeds, before they are transferred to faster competitive speeds.
6. Aerobic work is an essential element in the taper process that coaches use prior to major national and/or international competition.

Summary

1. The specificity of training is one of the basic principles used in the design of programs.
2. It is suggested that the specificity principle has been misinterpreted by some coaches and applied too generally in the programming of training.
3. Whilst most competitive swimming events have a substantial anaerobic (speed) component, it does not follow necessarily, that a similar proportion of training should also be anaerobic in nature.
4. Highly specialised programs may be appropriate in some circumstances where older athletes in some sprint events can sustain elite levels of performance. However for the large majority of developing and competitive swimmers it is suggested that a balanced program of aerobic and anaerobic fitness work is more appropriate.
5. The process of tapering training prior to competition may also benefit by the inclusion of an appropriate amount of aerobic work to support the processes of super-compensation.

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INDIVIDUALISING MEDLEY

By Bill Nelson

INTRODUCTION

The Individual Medley (IM) as an event was introduced on the international scene at the 1964 Olympic Games in Tokyo. A review of Australia's performance on the international and national scene, both past and present, shows that the IM has not enjoyed the same amount of success as other events. However, I do not believe this can be blamed on the fact that Australia does not possess the talent, but more likely, there has been a greater degree of interest in single stroke training programs.

An accomplished IM swimmer must have sound techniques, well-developed speed and a solid endurance base in all four strokes. All disciplines concerned with the pursuit of excellence in the IM should be associated with the concept that it is an event – and not just the collection of four strokes performed in a sequence.

The IM is certainly one of the most exciting events on the competition program. With all four strokes systematically involved, the combination of all energy systems, the pacing strategy, and the training necessary to support the international swimmer, the IM events have become very specialised and demanding for both coach and athlete. Therefore the philosophy should be that the race is a total unit, swum with specific individual strategies, and trained and rehearsed as such.

Although one has to train all four competitive strokes with equal enthusiasm and discipline, the probability of success will be enhanced if the program is designed around the four individual strokes

and the ability to put them together. Over the years, many have discussed the comparison between IM swimming and track and fields decathlon. The need for competitors in both events for all-round excellence in strength, speed and endurance is generally acknowledged.

Australia, and to a certain extent world swimming, has always had some people who have been able to achieve reasonable success in the IM events via specialised training for single stroke events. But for the real success in IM swimming it should be viewed as a specialist event, requiring specialist training. This is dependant on the acquisition of a broad base of skills, developed in a tactical and systematic manner, with the main goal being the total development of the individual swimmer.

IM training is very important to the long-term development of all swimmers regardless of whether they swim at local, regional, state, national or international level. IM training provides a great deal of variety, keeps both the swimmer and coach stimulated and motivated in training sessions and allows the coach a great deal of variety and flexibility in the design and implementation of the training program. Preparation for the IM is the most stimulating training of all competitive events. The challenges are many and varied but the pursuit of a career as an IM swimmer will provide the athlete with the most exciting and demanding program of any swimming event.

TRAINING PREPARATION FOR THE INDIVIDUAL MEDLEY

As with all competitive sports programs, success will be influenced strongly by the coach's philosophy and the training program developed. This is certainly emphasised when we look at the long-term development of the IM swimmer. The total integration of all aspects of the training program related to IM swimming places a lot of responsibility and time constraints on the coach. For the program to be successful, the coach must be fully committed to the development of the IM program, experienced and successful in all areas of stroke technique, and must be dedicated to see the implementation of all aspects of the IM training program.

In the early years of the swimmer's development the 200m IM should be the main competitive focus, and then as the aerobic endurance base begins to take shape the emphasis moves towards the distance freestyle and 400 IM events. When the swimmer has fully matured then the emphasis returns back to the 200 IM if that is where the preference lies.

ATTRIBUTES OF AN IM-ORIENTED PROGRAM

If we are to look at the long-term development of all our young age-group swimmers, then I believe it is imperative that their training in the early to mid-development and competitive years be directed towards the IM program. Therefore we should look upon the majority of our younger swimmers as IM swimmers. This coaching philosophy will have the following long-term benefits to the program.

1. Provide all swimmers with correct technique and skills in all four competitive strokes.
2. Develop an effective aerobic endurance base in all four competitive strokes.
3. Provide a continuous flow of IM prospects into the training group without detracting from the individual strokes.
4. Delay unnecessary early specialisation of single stroke training and racing.
5. Avoid the development of overuse injuries from repetitive swimming of single strokes.
6. Improve flexibility and coordination.

Basically the IM program provides a swimmer with the ideal base from which to build a long and successful career in **all** events associated with competitive swimming. As with all other events, there are certain aspects of any athlete's make-up that indicate a bright future. However, I believe it would be incorrect to think that IM swimmers must possess certain physical or physiological characteristics in order to reach international standard. There are many variations in their physical and psychological make-up. If you name any of your five favourite swimmers, you will find that physically they are different, their training programs are different, and their diets are different.

However, we can look at certain physical and psychological traits that are associated with success in IM swimming. These are some of the few similarities that exist amongst the better IM'rs and certainly should be looked at carefully.

Physical/Technical Attributes of the IM'r…

1. Arm length in relation to body length (long arms)
2. Trunk length in relation to leg length (long bodies)
3. Lower leg (tibia) tends to be concave
4. There are no weak strokes
5. They can vary their race tactics depending on the race situation

Psychological attributes of the IM'r

1. A mature, committed and enthusiastic approach to training and competition
2. Preparedness to be open minded and challenged

3. Patience in understanding that for long-term benefits, some short term results must be put 'on hold' so that a long-term training process can be instigated
4. They are a student of the sport (they know the strengths and weaknesses of their opposition)
5. They can control their emotions

Many athletes can and will be successful in a competitive training program without all the attributes outlined above. It is impossible, however, for anyone to be successful without a properly designed program for long-term development and improvement.

MODEL OF DEVELOPMENT PLAN

In designing the program for IM'rs or other swimmers, the program must suit the needs of the athlete, without necessarily changing the individual to suit the needs of the program. In the plans that I will outline, I am looking at the development of the 400 IM; the 200 IM usually evolves out the 400 IM as the swimmer matures and develops. However in the initial development stages the competitive emphasis is oriented towards the 200 IM.

The long-term development plan will be outlined in four levels. The length and time spent on any one level should be determined by the athlete's physical maturity, and the attainment of all necessary skills that allow the transition into the next phase to be smooth and comfortable. The athlete's program should not be determined by other aspects such as suitability of training times and external considerations. As this plan does depart from the normal age group program it is imperative that the philosophy and long-term benefits of the program is communicated to all swimmers and parents.

LEVEL 1 – Preparation

This level starts at the athlete's earliest stage of development (i.e. first level of elementary coaching). The major areas of development in this phase are…

- The formation of the base for the development of aerobic capacities
- The acquisition of proper technique and skill development in all four competitive strokes. This is single most important aspect of any athlete's development plan.

The earliest possible development of technique in all four competitive strokes is the foundation on which a swimmer's competitive abilities will be developed. Without the proper technique an athlete's future is certainly limited.

The early teaching of the good technique is of great benefit to the athlete's career in both the short term and long term. The combination of long-slower swimming with correct technique is the base on which all other aspects of the athlete's development will be built. It is very important at this time for the coach to communicate with their swimmers that is not necessarily the most skilled swimmer that wins the races at this level but sometimes the athlete who is a little stronger and bigger. Many champion age-group swimmers are not necessarily successful at the older ages and elite levels.

The coach must point out the obvious long-term benefits of training at a reduced workload that create the ideal base from which the long-term competitive stroke can evolve. It is important to communicate to the athlete at this stage of their career that the focus should be on slow sustained swimming with correct technique. The difference between sustained or continuous swimming as compared to distance training is that the latter, is usually oriented by the equation time over distance.

The program should include all aspects of stroke development (e.g. full stroke swimming, kicking, stroke drills and pull. All four strokes should be covered but with the underlying philosophy that it is technique and skills that are trying to be developed. The main competitive emphasis at this level is the 200 IM. The areas pointed out earlier should dictate the elevation of an athlete to Level 2 but this is usually as they approach peak growth rates – i.e. 11 and 12 years for girls and 12 and 13 years in boys.

LEVEL 2- Development

The main emphasis of this phase is the further development of aerobic capacities. Although there is still a strong development of all four strokes, the importance of overdistance freestyle training takes on a greater role. The coach must understand that it is the philosophy of developing the 'aerobic base' at this stage that will give the necessary foundation for further advancement in other strokes at the next level.

The aims of this level are…

- Development of an endurance Freestyle base
- Introduction of aerobic training in the other strokes
- Formation of specific goals for this period
- Introduction of flexibility program

The competition program is also oriented towards the longer Freestyle events. If we are to look at many great IM'rs, it is obvious that the endurance background cannot be underestimated. It will also show that the early competitive years involve the middle distance and distance Freestyle events, and most swimmers continue to maintain the distance Freestyle events in their competitive program. The constant refinement of stroke technique and skills continues to be emphasised.

As the competitive program expands, it is vital to stress the importance of swimming fast with good technique as the common goal, and NOT just swimming fast. This is certainly one area of the athlete's development that needs to be pointed out to parents so that they understand fully the implications for the long-term development of their child's swimming career.

As this level usually begins at around the same time as the major growth spurt, it is vitally important for the coach to observe carefully technique to see that it is not hindered or altered in any way by the changes in the athlete's physique. As the athlete's body changes so will the strength and flexibility ratios. The body may make compensatory changes to counteract these.

The continuing progression up to Level 3 should be determined by the athlete's physical maturity and attainment of necessary skills and technique. In most cases this will take somewhere between 2.5 and 3.5 years after the commencement of organised training.

LEVEL 3 – Specialisation

This level brings together the real backbone of Medley swimming.

- The continued improvement of the endurance Freestyle program
- The attainment of a well-developed endurance base in all four competitive strokes
- The continued refinement and specialisation of stroke and **skill** technique
- The incorporation of racing the 200 metre events of all three form strokes as well as the middle and distance Freestyle events

If we are to develop the base to swim great 400 IM'rs, it is vitally important to increase the distance of form strokes swum during this phase. Although an IM can be swam off a distance Freestyle background, it must be realised that it will be far more effective with the attainment of a solid base of aerobic endurance in the other strokes.

Once again, the distance swum should be determined by the physical capabilities of the athlete … i.e. the ability to swim these distances in training with sound technique … it is no good swimming long distances with improper technique.

The increase in distance should be carefully planned and monitored at all times.

As this is the most specific phase of the long-term plan, the emphasis on stroke technique should switch from development to refinement.

The basis of the stroke should be firmly in place – it should now be refined to mirror the desired racing technique. The emphasis should be on distance per stroke – efficiency of the stroke – swimming.

As this is the level for developing the IM as a race, the importance of racing the 200-metre event is stressed. Over a period of time, strengths and weaknesses of the individual strokes will begin to show through. The basis for swimming the 200 metre events is to look at the second hundred split and to develop and refine it so as to mirror the 400 IM split time. With the weaker strokes, it is important to develop and refine these and not just favour the stronger or faster strokes.

One must be careful at this stage not to get carried away with the total time of the IM but to look at the four splits in relation to PB 100m times and to the second 100m of the 200m time. Refine the paces and splits so that the overall times will continue to improve and not plateau. The attainment of goals in this stage is usually reached after 2-3 years of training at Level 3. Once again look at the physical maturity and **skill** acquisition of the individual involved.

LEVEL 4 – International

This is the final stage in the development of the Medley swimmer. It involves the four strokes coming together successfully to produce the desired result of medley swimming. This does not necessarily, in the first instance, mean a specific time or placing in a particular race.

The aims of this level are…

1. Develop a season training plan
2. Designate the 200 and 400 IM as the main competitive focus
3. Refine racing technique and skills
4. Training emphasis should be event specific including splits, stroke rates and counts

It is more directed at the attainment of specific skills and stroke rates and counts, and the ability to switch effectively from one stroke to the next. The ability to change strokes is one of the great attributes that medley swimmers possess compared with their single stroke counterparts. The adjustment from one stroke to the next usually takes 20-30 seconds, causing the first 50m to be usually slower than the second. The ability to change from one stroke to the next is something that should be developed right throughout the athlete's career, but must be totally refined during this particular period of the training plan.

The next step in the model is to integrate all strategies and skills so as to reach the desired outcome at the pre designated major event.

SPECIFICITY OF TRAINING FOR THE IM

It is important to understand that there are some general training principles related to IM swimming. Probably the first and foremost principle is that the IM is an endurance based event and must be coached and trained that way.

Because of this high level of endurance swimming and the training principle of stroke efficiency it is vitally important that the coach monitors the technique of all swimmers at **all** times. It is a necessary skill for the coach to be able to differentiate between the breakdown of technique due to fatigue and breakdown of technique due to a technical deficiency.

The ability of the athlete to train at proper stroke rates and counts cannot be underestimated. The IM is a very tiring event, and therefore the strokes must have high level of efficiency and control. This must be emphasised in every session. Remember the old adage…

Practice does not make perfect

Perfect practice makes perfect.

STROKE SPECIFICS AS THEY RELATE TO THE IM

Since IM consists of a combination of all four strokes there are some specifics of stroke techniques that need to be outlined.

Butterfly

The training of the Butterfly stroke is oriented around length of stroke and smooth and fairly flat technique. The main skill for Butterfly when relating it to the IM is that you want to be able to swim the Butterfly leg fast but at the least amount of effort or cost possible … i.e. efficiency of stroke technique … is emphasised.

The most commonly asked question in relation to Butterfly training is how long should the repeats and sets be. The best and most common sense approach is the distance of sets and repeats is determined by the quality of technique. It is of no use swimming long hard Butterfly sets if the standard of the technique is falling away.

Butterfly training can be done using fins which does aid the swimmer in their ability to hold their stroke together better. A good way to keep the quality of technique up during the endurance phase is to swim a lot of your Butterfly repeats as drills, or swim longer sets of shorter distances.

For example…

40 x 25m on 15 secs rest, 1 min after each set of 10

20 x 50m on 20 sees rest

3 x 600m on 1 min rest

600 Backstroke every 4th 50 Butterfly

600 Backstroke every 3rd 50 Butterfly

600 Backstroke every 2nd 50 Butterfly

Backstroke

Backstroke training for the IM can be done in two ways. Firstly, full stroke or normal Backstroke with the legs being used as a propulsive kick. The second is more specific for the second half of the Backstroke leg and that is training Backstroke using a band to tie your ankles so that swimmers learn to maintain speed by using arm-dominated swimming and your legs are used to balance the stroke. This second skill is very helpful in the later half of the Backstroke, so that the swimmer can maintain their speed by using arms only and saving the legs so that they can be used during the first leg of the Breaststroke.

Combination type training sets that help this type of **skill** are:

12 x 100 with 30 secs rest

1. Pull 25 metres Backstroke, kick 75 Breaststroke
2. Pull 50 metres Backstroke, kick 50 Breaststroke
3. Pull 75 metres Backstroke, kick 25 Breaststroke
   But sprint the middle 50 metres (e.g. 25 Backstroke pull 25 Breaststroke kick). This set is done just using a pull buoy, no bands or paddles.
4. Pull 20 x 50 Backstroke band around ankles – no paddles

Breaststroke

There are two different types of Breaststroke for the two different IM races … the Breaststroke in the 200 IM is a lot higher and with a narrower arm pull and a stronger kick, where as the Breaststroke in the 400 IM is swum with a lot flatter body position and a wider arm pull and longer glide. As with the Backstroke, Breaststroke training is divided in two areas of competitive strategy. It is an objective of the training program to incorporate both styles of Breaststroke so that the athlete may develop both styles and become skilled in the ability to change from one to the other when required.

When doing a lot of longer endurance type Breaststroke sets it is also very important to watch that the timing of the stroke and to ensure the standard of the technique does not fall away. The use of fins during these longer Breaststroke sets adds variety and can also help with the fluency of the stroke.

Freestyle

In the early stages of developing the much need aerobic base it is far easier and far more productive to introduce endurance training with Freestyle than any of the other three strokes.

As with Backstroke, the band only pull drill is also important with the Freestyle program, as many times there is not a lot of 'fuel left in the tank' at the end of a 400 IM. It may be difficult to incorporate a six beat kick because of the heavy cost on the legs during the Breaststroke leg – therefore the ability to maintain your speed by using your arms can be very advantageous.

I would like to suggest that it is a well-trained IM swimmer who can six beat kick all the way on the last Freestyle lap. It is important to continually reinforce the use of the legs during longer Freestyle sets and ask your swimmer to practise six beat kicking the last lap of every Freestyle repeat.

The program for the IM swimmer should cover all areas of modem training principles in all four strokes.

TRAINING METHODOLOGY

Straight Stroke Swimming

This can include a wide variety of distances and intensities, but it is very important to do some overloading in single stroke oriented workouts. Single stroke swimming is usually done in the early non-specific aerobic phase of the training season … for example … 5x400 Backstroke on 30 secs rest.

Quality

6 x 100 Breaststroke at 400 IM race pace, with 3 mins active rest after each.

Sprinting

12x50 on 1.30 ... dive and sprint 20 metres Butterfly. These types of repeats can be done doing pull and kicking sets.

Switch Stroke Swimming

This is usually done in straight IM order so that the body gets used to swimming the event in the correct order and with the levels of fatigue that are associated with each of the specific strokes … for example … 1200metres – 4x100 IM, 2x200 IM, 1x400 IM.

This type of set is usually done towards the end of the general aerobic phase of the season, just prior to the specific phase of the preparation. Once again this type of set can be done doing either pull or kick sets.

Specific Switch Stroke Swimming

For a swimmer to be successful in the IM event, this type of training is vitally important, the ability to be able to change from one stroke to next effectively whilst maintaining your speed from the last stroke is the benchmark of a good IM swimmer … for example … Endurance.

1. 3x100 with 10 secs rest 50 Butterfly 50 Backstroke
2. 3x150 with 15 secs rest 75 Backstroke 75 Breaststroke
3. 3x200 with 20 secs rest 150 Breaststroke 50 Freestyle
4. 1x400 IM

Quality

2 x 3 x 150 4:00 mins active rest after each

1. 100 Butterfly fast 50 Backstroke at race pace
2. 100 Backstroke fast 50 breastwork at race pace
3. 100 Breaststroke fast 50 Freestyle at race pace

Sprinting

12x50 on 1:30

Sprint 10 metres in and out of turn in IM switch order … Butterfly-Backstroke, Backstroke-Breaststroke, Breaststroke-Freestyle. As with all other sets these can also be done as either swim pull or kick sets.

Combination of pull and kick sets

The ability to swim either leg-dominated sections of your IM is something that has to be worked consistently. With this in mind, the combination pull and kick sets as outlined in the Backstroke section above makes up a major part of the outline of the IM program. The combination sets should be done in **all** switching sequences in IM order and the changing of which stroke is kick and which is pull, gives the coach a wide scope of variety into their workouts. The total integration of all aspects of training will be the basis for success with the IM program.

The ability of a well-trained IM'r will usually be highlighted by their ability to change from one stroke to the next without losing their momentum and without taking great lengths to get into the rhythm of the next stroke. The stroke switching sets around the turn is a skill that needs to be introduced early in the

swimmer's program and one that needs to be refined constantly throughout their career. The total integration of all these aspects of training will be the backbone of the training program.

PERIODISATION

Taking into consideration my current position at the AIS the development of our IM'rs is usually from the Level 3 and 4 of this plan. However in some cases we have had to go back as far as Level 2, so as to fully develop the athlete's talent. I usually work on the principle of a 24 week training cycle leading up to the trials meet and then a 16 week training cycle leading up to the major meet of the preparation. I believe that the single training weeks allows the athlete more time to adapt to each of the different training loads.

A TYPICAL 24-WEEK PREPARATION FOR THE ELITE IM SWIMMER							
Week Starts	Weeks Out	Week Type	Distance (Km)	Testing Schedule	Internat. Comp.	National Comp.	Camps
Sep 26	24	C/T	20				
Oct 3	23	C/T	20				
Oct 10	22	C/T	25				
Oct 17	21	C/T	30				
Oct 24	19	C/T	40	National		Burl G	
Oct 31	10	End	70	3000			
Nov 7	18	End	80	Step		L Ridge	
Nov 14	17	End	90				
Nov 21	16	Adap	60				
Nov 28	15	End	95	3000		AIS	
Dec 5	14	End	95	Step			
Dec 12	13	End	105	National			
Dec 19	12	Adap	60				Home
Dec 26	11	Qual	80				Home
Jan 2	10	Qual	80	3000			
Jan 9	9	Adap	50			Qld	
Jan 16	8	Sprint	60	Step			
Jan 23	7	Qual	80				
Jan 30	6	Qual	70				
Feb 6	5	Qual	70	Step			
Feb 13	4	Spr	50			NSW	
Feb 20	3	End	60	National			
Feb 27	2	Race P	45				
Mar 6	1	Race P	35				
Mar 13	0	Race P	25			CG Trials	

A TYPICAL 16-WEEK PREPARATION FOR THE ELITE IM SWIMMER							
Week Starts	Weeks Out	Week Type	Distance (Km)	Testing Schedule	Internat. Comp.	National Comp.	Camps
Apr 18	16	End	80	Step			
Apr 25	15	End	80	3000			Fly
May 2	14	Adap	50				
May 9	13	Qual	60	National			
May 16	12	End	90	Profile		ACT	
May 23	11	End	90				
May 30	10	Adap	50	Profile			
June 6	9	End	80			ACT	
June 13	8	Qual	70	National			IM
June 20	7	Qual	70	3000			
June 27	6	Adap	50				
July 4	5	Spr	50		S Clara		
July 11	4	Qual	60				

July 18	3	Qual	60			G Prix	
July 25	2	Race P	50	National		G Prix	
Aug 1	1	Race P	35			Vic/SA	Sing
Aug 8	0	Race P	20		P Pacs	NSW	
Aug 15		End	50			Qld	
Aug 22		Spr	30			SC Nats	

The basic guidelines for each of these weeks is as follows…

ENDURANCE WEEK

- The intensity of this work is at -60 to -40 beats below maximum heart rate
- The majority of this work is done at straight stroke swimming
- Because of the fatigue factor due to the volume a dose eye on technique is a must
- Anaerobic threshold sets at -30 below maximum heart rate

	Mon	Tue	Wed	Thu	Fri	Sat
AM	Aerobic Threshold FS Kick	O'Dist Form B/only Pull HVO's	Short Rest FS Kick Skills + Drills	Off	Aerobic IM + Form B/only Pull	O'Dist FS Kick HVO's
PM	Anaerobic Threshold IM Skills + Drills Kick	Aerobic Fly Race Pace HVO's	Off	Pull Descend Kick HVO's	Aerobic Fly Race Pace HVO's	Anaerobic Threshold Form Kick

QUALITY WEEK

- This is the race specific plan of the preparation
- Anaerobic Threshold sets are used to buffer the endurance base during this period … the intensity of these sets is also slightly higher, with heart rates being in the area of -20 beats off maximum
- IM switching work is increased during this phase
- Lactate Tolerance involve multiple repeats on moderate rest

	Mon	Tue	Wed	Thu	Fri	Sat
AM	Aerobic Threshold FS Kick HVO's	O'Dist IM + Form Skills + Drills Pull FDS	Anaerobic Threshold Kick HVO's	Off	Aerobic Threshold FS Skills + Drills B/Only Pull	O'Dist FS Race Pace Aerobic Threshold Speciality
PM	Lactate Tolerance Aerobic FS HVO's	Aerobic Threshold Fly Race Pace B/Only Pull	Off	Lactate Prod. Kick Aerobic Pull	Anaerobic Threshold Fly Kick HVO's	Lactate Tolerance Kick B/Only Pull

SPRINT WEEK

- The emphasis changes in quality sets from many shorter rest quality repeats to fewer longer rest repeats
- The main filler sets are of an aerobic nature
- MVO_2 sets are at 10 beats off maximum heart rate
- HVO's stands for high velocity overloads (shorts sprints under 10 seconds) … this idea was given to me and explained at great length by Bernie Wakefield and Ken Wood

	Mon	Tue	Wed	Thu	Fri	Sat
AM	O'Dist FS B/Only Pull Kick HVO's	Off	MVO_2 FS Kick Race Pace	Off	Aerobic Threshold B/Only Pull HVO's	Aerobic Threshold IM FS Kick
PM	Lactate Peak Aerobic Pull HVO's	Pull Descend Fly Race Pace B/Only Pull	Off	Pull Descend Kick Aerobic Pull	Lactate Prod. Threshold Fly Kick HVO's	Off

ADAPTATION WEEK

The principle behind this week is just a little of all types of work so that the body doesn't go into a complete rest situation but not too much so as to hinder the adaptation process.

- The intensity remains the same but the distance of the set decreases
- A good time to refine technique
- The main filler sets are of an aerobic nature

- MVO_2 sets are at 10 beats off maximum heart rate … Anaerobic Threshold sets are at 20 beats off maximum heart rate

	Mon	Tue	Wed	Thu	Fri	Sat
AM	Aerobic Threshold FS Race Pace Kick	Descend Pull FS Skills + Drills Kick	MVO_2 O'Dist Pull BK Race Pace	Off	Descend Pull BK Skills + Drills Kick	Anaerobic Threshold FS B/Only Pull Kick
PM	Lactate Tolerance Aerobic BK HVO's	O'Dist IM and Form	Off	O'Dist FS	Lactate Prod. Aerobic FS HVO's	Off

THE INDIVIDUAL MEDLEY AS A RACE

As far as excitement, race strategy and mental toughness are concerned, it is impossible to go past the IM. As a race develops, it is very clear that each individual has a specific race plan and strategy that he or she is swimming to. The placing in the race can, and will, change many times before the final result is known.

With this in mind, you should develop your own race strategies for each individual swimmer. Therefore each swimmer can race the way their own training has prepared them. It is of no use swimming at speed X if you have trained them at speed Y. Although swimmers should only ever concentrate on their own race, I feel it is important that they have a good idea of their opposition and their strengths and weaknesses. I often think of the story of tennis great Ivan Lendl who kept detailed analyses of all players he played against so that when he came to play them he had a fairly good idea of their game plan and strategies.

This certainly applies to Medley swimming, it is no good changing your own race plan … e.g. if someone goes out in the 100 Butterfly faster than you, you should know how to control your pace and not go out with them. Race strategies for the IM are as wide and varied as the people that swim the race. However, there are some general concepts of race strategies that we should look at. Because of the change of strokes involved in the IM, it is not just a matter of going all-out from the dive and holding onto the finish.

We must look at the splits as a percentage of the race time and as a percentage of our PB 100m time. Over the past years, many studies have been done to determine what each split should be in regard to the total time of the IM race. The following percentages are averages of these findings…

Butterfly – 22.4%
Backstroke – 25.5%
Breaststroke – 29.5%
Freestyle – 22.6%

These percentages are useful when determining splits from a particular time that you may be looking at for a certain athlete. For instance, if I am looking at a 5:00 min total time then the Butterfly leg should be 1:07.2, the Backstroke 1:16.5, Breaststroke 1:28.5 and the final Freestyle 1:07.8. THESE FIGURES CAN ONLY BE USED AS A GUIDE, and NOT AS SPECIFIC TTMES.

Another way to look at 400 IM splits has been suggested by Dr Ernie Maglischo in *Swimming Even Faster*. He suggested that the first 100 Butterfly should be approximately 2.5-3.0 seconds slower than PB 100m Butterfly time. Backstroke and Freestyle legs should be 6-7 seconds slower than fastest 100m times in those two strokes and the Breaststroke leg should be 8-10 seconds slower than 100m Breaststroke best time.

He also suggested that a swimmer with equal ability in all four strokes would swim the Butterfly leg 2.5-3.0 seconds slower than their PB 100 time. The Backstroke should be 4-5 seconds slower than the Butterfly leg. The Breaststroke would be 10-12 seconds slower than the Backstroke and the Freestyle leg 14-15 seconds faster than the Breaststroke leg.

For the 200 IM, the splits are …

Butterfly – 1 second slower than PB 50
Backstroke – 3 seconds slower than PB 50
Breaststroke – 5-6 seconds slower than PB 50
Freestyle – 4 seconds slower than PB 50

When comparing different strokes the splits are…

Butterfly – 1 second slower than PB 50
Backstroke – 3-4 seconds slower than Butterfly split
Breaststroke – 3-4 seconds slower than Backstroke split
Freestyle – 6-7 seconds faster than the Breaststroke split

Another method for determining split times for the IM race was developed Dr. Jeno Tihanyi for Alex Baumann's 1984 Olympic gold and world record swims. The method here was to look at the percentages of split times as compared to 100m PB times. Dr Tihanyi determined for success at the national level, the 100m split times should be approximately 80% of your 100m PB time, for international level competition this should increase at 85% and for international success this should once again increase to 90%.

This paper has covered in brief the development of an IM swimmer from the very basic stages in their career to success in the international arena. Success will only come from a well-designed training program that has total integration of all aspects of the training process. I believe that a coach should have a good understanding of the training programs at all levels of coaching from age group to international levels. *If you don't know where you are going you'll certainly not know how to get there.*

The IM is the coach's greatest challenge – to integrate training, racing, and planning is a demanding job. It will however, provide you with the most stimulating and motivating experience available in coaching. It provides you with a vehicle to add variety, stimulation and challenges in a number of ways to your swimmers.

The only restrictions that you face are those that you place upon yourself.

HOW TO DEVELOP OLYMPIC CHAMPIONS … MY PHILOSOPHY

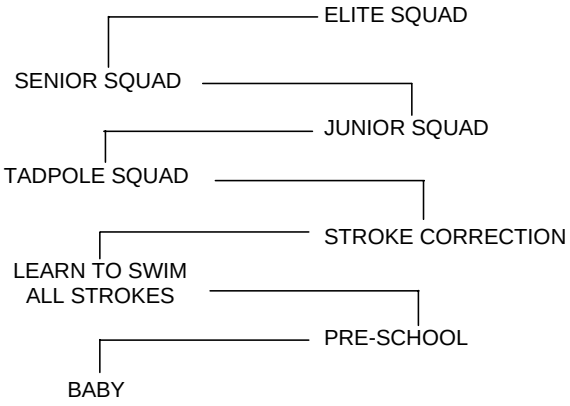
By John Carew, Coach of Kieren Perkins

TRAINING STRUCTURE

I have a mental picture … i.e. a model … of how I believe all strokes should be executed, and this I have gained by the study of champion swimmers for 30 years and copying the best of their skills.

To be successful the head coach must have a staff of teachers and trainers who have been taught the "Model Swimmer" concept and understand that the process from Learn to Swim to Elite Squads must follow a distinct learning pattern.

TABLE 1
LEARN-TO-SWIM & SQUAD STRUCTURE



DRILLS

Swimming stroke drills are the fastest and most effective way of moulding technique without interfering with other facets of training.

One of the things that I can't emphasise enough is stroke drills and working technique. It aids swimmers to get the feel of the water and helps towards the correct pattern of your stroke model.

All stroke drills should be tailored to your model of each particular stroke, rather than a drill some other coach uses. Drills can be effectively incorporated in training sessions. Stroke drills during the taper are extremely important and should be incorporated, at least in one session a day.

STRENGTH TRAINING

My swimmers do not follow a weight pro-gram. I work on flexibility and strength with speed (Biokinetics).

All of my Senior Squad follows the following exercises:

STRETCH CORDS	5x30min sessions per wk
STRETCHING	11x20-30min sessions per wk
BIKE	5x20-30min sessions per wk

Bike work is important to exercise leg and gluteal muscles. Before every training session and before any competition swim my swimmers all do 20 minutes of stretching exercises. Not only does this help with the range of movements for the swimmer but I have found it prevents injuries.

TRAINING PROGRAM

The proportion of each training session devoted to each physiological factor of conditioning work depends on:

1. The phase of the season
2. The particular event being trained for although the emphasis changes from phase to phase and event to event. All types of conditioning are included from one degree or another for each swimmer throughout the training season.

The types of conditioning work are alternated or cycled within each weekly training plan so that the swimmers can recover from one form of stress while applying themselves to another. Distance in kilometres for each training session should range in length, on the phase of the season and the type of event.

My swimmers train at race pace and faster as much as physiologically possible.

HEART RATE SETS

Positive results from heart rate sets can take two seasons or longer. Heart rate sets work like waves with the swimmer going into troughs or adaptations and hopefully coming out of the trough onto a higher wave.

ACTIVE REST

Active rest is important for any high profile swimmer. In training breaks after competition swimmers should swim at least three times per week, distance approximately three kilometres.

TADPOLES

- Train 2- 3 times per week
- Periods ranging from ½ hour to 1 hour 70% drills (stroke)
- 15% swim
- 15% kick
- Swim all strokes
- Swim short distances for correction of stroke
- Emphasis on stroking technique
- 10min Stretch Cords each session – Monday, Thursday, Saturday

JUNIOR SQUAD

- Train 6 times per week
- Period of time from 1-1½ hours
- Short distances for all training swims 500m or less
- 30% drills (stroke)
- 50% swim 20% kick
- Swim all strokes
- Introduction of mini heart rate sets
- Emphasis on stroking technique
- Logbooks
- 15min Stretch Cords each session – Monday to Saturday
- 15min Callisthenics twice a week – Monday and Wednesday

SPRINTERS EARLY SEASON					
AM					
Mon	Tue	Wed	Thu	Fri	Sat
Aerobic (Alactic)	Heart Rate 1000m -20=25 Max HR	Off	Recovery	Heart Rate 100m –20=25 Max HR	Drills Starts Turns
PM					
Aerobic (Alactic)	Recovery (Alactic)	Lactate Sprint Set 800m	Aerobic	Off	Drills

TADPOLE SQUAD					
Mon	Tue	Wed	Thu	Fri	Sat
Sculling			Breaststroke Drills		Starts & Turns
Freestyle Drills			Butterfly Drills		Finishes
Backstroke Drills			Kick Breaststroke & Butterfly		Relay
Kick Freestyle & Backstroke					
10min Stretch Cords			10min Stretch Cords		10min Stretch Cords

JUNIOR SQUAD					
Mon	Tue	Wed	Thu	Fri	Sat
Drills Backstroke	Drills Breaststroke	Distance all strokes	IM work	Distance concentrating on two worst strokes	Starts & Turns
Drills Freestyle	Drills Butterfly		Kick & Drills		
		Alactic work			
Distance	Mini heart rate set 400m	Kick	Sculling	Mini heart rate set	Sculling
20% kick without a board	20% kick				Relay
Sculling					
15min Stretch Cords Callisthenics	15min Stretch Cords	15min Stretch Cords Callisthenics	15min Stretch Cords	15min Stretch Cords	15min Stretch Cords

MID SEASON SPRINTERS					
AM					
Mon	Tue	Wed	Thu	Fri	Sat
Aerobic (Alactic)	Recovery	Off	Recovery	Heart Rate 2000m maximum distance -10 max HR	Short Lactate Set Drills Starts Turns Sculling
PM					

Heart Rate 2000m max. distance -10max HR	Aerobic (Alactic)	Lactate Sprint Set 800m-1000m maximum	Aerobic	Off	Off

DISTANCE EARLY SEASON					
AM					
Mon	Tue	Wed	Thu	Fri	Sat
Aerobic	Heart rate max. distance 2000m -20 max HR	Aerobic	Heart rate max. distance 2000m -20 max HR	Sprint rate 1000m max. distance	Drills Starts Turns Aerobic
PM					
Aerobic	Aerobic or Recovery	Aerobic	Recovery or aerobic	Recovery	Off

DISTANCE LATE SEASON					
AM					
Mon	Tue	We	Thu	Fri	Sat
Heart rate set max. distance 3000m -10 max HR	Lactate Sprint set max. distance 1500m	Heart rate set max. distance 3000m -10 max HR	Lactate max. distance 1000m Sprint set	Heart rate max. distance 3000m -10 max HR	Drills Starts Turns
PM					
Aerobic	Recovery	Aerobic	Recovery	Aerobic	Off