# A Fundamental Approach to Middle Distance Running <br> by Kevin Prendergast 

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## ABOUT THE AUTHOR

Kevin Prendergast is an engineer and mathematician by profession, and he is an accredited Level 3 coach with the Australian Track and Field Coaches Association. His special interest is the application of scientific principles to running, and he has been published often in New Studies in Athletics and Modern Athlete and Coach. Two of his works are in the fourth edition of the book Middle Distances, published by Tafnews Press. He was one of the most successful middle distance coaches in Australia during the 1990s. His squad has included athletes from interclub to international standard. The most prominent is Brendan Hanigan (1:45.03) , the third fastest Australian ever over 800 m at the time of printing, who finished fifth in the 1994 Commonwealth Games and fourth in the 1994 World Cup.

## DEDICATION

For Wendy, whose love makes everything possible.
To Murray, Big Pete, Little Pete, Tim, Simon, Keals, Brendan, Bernice, Johnny, Lordy, Mark, Cools, Bruce, Jo, Clare, Simon, Marcus, Matt, Rachel, Nick, Pete, Lauren, Monique, Lauren, Alisa Ed, Emily, Tristan and Julia, who have stood the test of time and provided so much fun.

## INTRODUCTION

It might sound elitist but it has to be said. Middle distance is for intelligent people. This is not to say that there are not intelligent people involved in other athletic events. Obviously there are. But the nature of the middle distance events is such that a person really has to be intelligent to run them or coach them successfully. The event group is quite complex because it takes characteristics from the event groups either side, namely speed and endurance, and blends them with a phenomenon that characterises itself. It is no simple matter to devise a training program that brings about this blending, nor is it simple to understand the blend and put it all together in a race. This is why there has been such a preponderance of highly intelligent people in the middle distance events over the years, people who have made their mark in the world outside sport on the basis of their intelligence. Names like Roger Bannister, John Landy, Herb Elliott, Jack Lovelock, Peter Snell, and Ralph Doubell immediately come to mind, and there are many more.

This book is an attempt to provide an intelligent approach to middle distance running, in which everything is reasoned, and based on scientific concepts, evidence and logic. Anything else would be unworthy of events that are complex to prepare for, tactical minefields to compete in, and fascinating to observe. That it purports to be intelligent
should not deter the interested reader, because it is not deep in sports scientific theory, nor does it require a great mass of knowledge. Rather it looks at the evidence to decide what middle distance running is and what characterises it, determines the attributes required, and deduces a training regime that will develop those attributes. It relies on solid thinking to investigate the event group and to work out what is required to be successful in it. Such thinking is within the capabilities of most of us, and is certainly necessary for success in middle distance running. From time to time most of us shirk from hard thinking and rely on that of someone else (or what we hope might be their hard thinking). However this is rarely successful in the long run. The reader might reason that the same would be true of this book - that it is the author's thinking and therefore inferior to that of a person who might apply it. There is some truth in this, and therefore the book is more about an approach to middle distance running than a recipe, and it is the author's hope that it might encourage people to develop their own thinking about the topic, and to continually subject it to the rigor of reason.
In this book the author is stuck with the usual problem of how to say "she or he", "him and her", etc., because it is as much about women's middle distance as men's. In the absence of suitable all-purpose pronouns, he has settled for the convention that, unless it is otherwise obvious, masculine personal pronouns apply to both genders.

The book begins in Chapter 1 with a look at the history of middle distance running, from the 1850 s to the present day. In the men's events it takes us from 4 minutes 17 seconds down to 3 minutes 44 seconds for the mile, and from 1 minute 58 seconds to 1 minute 41 seconds for the 800 metres. That represents a $13.8 \%$ improvement for the longer event and a $14.3 \%$ improvement for the shorter one, a minor difference that is probably explained by the greater popularity of the mile in Britain, where most of the action was, in the middle of the 19th century. For women of course the history is fairly recent, because universal wisdom up until the 1960s was that anything further than 200 metres was injurious to them. There was a brief concession to women in the 1928 Olympics, when the 800 metres event was included in their program, but so many girls collapsed at the finish that it was another 32 years before men deemed it safe to allow them to try again. Women did not thank their "masters" for being so concerned about their wellbeing, and eventually won the right to contest every event that men do. The champions of this history are some of the great names of athletics, and indeed of sport, and they are remembered for years, even generations, after they have departed the track. Indeed many of them have gone on to success and even fame in the larger world. The intelligence that they displayed as athletes was put to greater use in their careers.

Chapter 2 discovers where middle distance is located in the running spectrum, and why middle distance is an appropriate name for it. It does this by an analysis of men's world record running speeds from 100 m to $10,000 \mathrm{~m}$. The graph of speed versus race distance is very revealing, because the distances we know as middle distance, namely 800 m and 1500 m , occupy a special and distinct place on the graph. The graph emphasises what every athlete who has ever tried to run them knows only too well - that the speed is very much distance dependent. This is because of the phenomenon that characterises middle distance running, namely the lactic effect.

The lactic effect leads us into a discussion of the energy systems, and this is what Chapter 3 is about. One of those systems is the lactic system, but the middle distance runner also uses the other two systems, the creatine phosphate system and the aerobic system, so a knowledge of all three is necessary. The chapter is not a deep analysis of the energy systems, requiring a thorough knowledge of biochemistry. It is a simple but not simplistic treatment, containing all that is needed in order to be able to apply energy systems to running, and anyone with a passing knowledge of high school chemistry will easily be able to follow it. The concepts of energy and power are discussed, because the difference between them is important in understanding the application of energy systems.

Chapter 4 looks at speed distribution in 800 m and 1500 m races, and considers the energy system implications entailed. This shows us what energy systems are required in these races, and to what extent. Speed triggers for the energy systems are determined. Optimum speed strategies and tactics are discussed.
This leads to Chapter 5, which is about training the energy systems. Now that we know what is required by way of energy systems and to what extent, we need to know what is required in order to train them. Training sessions for the different systems are discussed.

The runner is a human running motor, albeit with certain valuable attributes which a motor does not have. But to the extent that he is a motor, there are two essential parts. One is the fuel and this is in fact the energy systems, which have already been discussed. The other is the physical motor, which for the runner is the muscular system. Chapter 6 is partly about developing and training the muscular system. Of course it is not possible to train the energy systems without also training the muscular system, but this chapter looks at whether training other than running might be required. More importantly it also considers some non-athletic issues that impinge on an athlete's life, and the place of athletics among these issues.

Chapter 7 is about the principles of training. The concepts, which indeed apply to all athletics and perhaps most sport, are discussed, but they are applied to middle distance training. These concepts include progressive loading, specificity, needs-based training, and, most importantly, recovery. Questions such as how long an effect takes to train, and how long a training effect lasts, are examined. The importance of understanding the purpose of training is emphasised (this is not as trivial as it sounds), as is the use of controls to ensure the purpose is being met.
This brings us to the stage where we know what the building blocks are and we know the rules for putting them together. Chapter 8 brings it all together in the form of designing training programs. It begins with a discussion of objectives, and planning to achieve those objectives. With so many different types of sessions necessary for a middle distance runner, and it not being possible to progress all of them together, sequencing them is necessary, and this is no easy matter. Various sequences and the advantages and disadvantages are discussed. Some possible annual programs are examined, and long term programs are mentioned. The importance of the individuality of training programs is emphasised. The importance of good training records is also stressed.

The purpose of training is to race well, and Chapter 9 is about racing. The difference between championship races, in which times are less important than finishing position, and non-championship races, in which the aim is to run as fast as possible, is discussed. Championships usually involve preliminary rounds and in these the tactics are often different from the final, so they are worthy of special attention. 800 m races and 1500 m races can be quite different, and so each is explored separately.

Chapter 10 is about the young athlete, who we hope will be a successful mature middle distance runner. The young person is not a junior adult, and we do well to remember this when we are coaching or guiding him. The particular needs of the young runner are discussed, and so are the mistakes to avoid. The emphasis is on preparing him for the future, while still giving him enough interest and fun to keep him coming back.

There is no bibliography in this book because it is essentially from first principles, and does not call on any authority for foundation. In the few instance where a source is used, this is acknowledged in the text. The outstanding example of this is two fine books on history and statistics of middle distance, which provide the data on which Chapter One, the history chapter, is based.

## CHAPTER ONE

# History of Middle Distance 

All at once Oileus led the race;
The next Ulysess, meas'ring pace with pace.
Behind him, diligently close, he sped,
As closely following as the running thread
The splindle follows, and betrays the charms
Of the fair spinster's breast, and moving arms:
Graceful in motion thus, his foe he plies,
And treads each footstep e'er the dust can rise.

This passage is one of the oldest written descriptions of a foot race, mythical or historical. It is from the Twenty Third Book of Homer's The Iliad, written in the eighth century BC. The race takes place during the Funeral Games, called by Achilles after the Trojan War to commemorate the fallen Greek heroes of the war. Interestingly the other side in the war, the Trojans, also had Funeral Games, and these are related in the Fifth Book of Virgil's Aeneid. In these games there was also a foot race, and in both races the winner prevailed in the same manner. In both, the leader for most of the race had the misfortune to slip in blood and dung from sacrificed animals, and the runner who had been shadowing him came through to snatch victory. Perhaps thus began the prejudice in favour of "sitting and kicking", but fortunately front-runners have had their share of success. We can surmise from the description of the two races that they were middle distance. In any case it is obvious that running races were popular enough in ancient civilisation to become part of the culture. Indeed the ancient Olympics date from the time of Homer; the first in a long series of Olympic Games, held every four years over a thousand year stretch, took place in 776BC. But Games had been going long before that, and it is believed that the first of the Games occurred at Olympia in about 1370BC. So the instinct for human beings to race each other, and for people to be interested in who is the fastest, is a fundamental feature of human nature.

It does appear that striving to be the fastest afoot for its own sake was considered to be a noble pursuit in ancient Greece, from which so much in the present civilised world comes.

The ancient Olympics lasted a thousand years, into the fourth century AD. Initially they consisted only of running, and although other contests were later added, foot races continued to be the most important events. Games champions were famous because they epitomized some of the highest ideals of ancient Greece. One name that survives even to this age is Leonidas of Rhodes, who won the three foot races in four successive games - something of a Carl Lewis of the ancient world. Unfortunately the Games were banned by the Roman Emperor Theodosius the Great in 393AD. They then lay dormant for a millenium and a half, until resurrected in the late $19^{\text {th }}$ century by a Frenchman with similar ideals to the ancient Greeks. His name was Pierre de Coubertin, and it is worthwhile to reflect on his words, which have become, and hopefully will remain, the embodiment of the Olympic spirit:

## The most important thing in the Olympic Games is not to win but to take part, just as the most important thing in life is not the triumph but the struggle.

With the demise of the ancient Olympics foot races disappeared until the seventeenth century, when races between "footmen" became popular in England. Footmen were servants who used to precede the horse drawn coaches of the "gentry". These men of means used to bet on races between their footmen. The motivation behind these races was far removed from the ideals of the Olympics; for the wealthy it was a gambling diversion and for the poor footman it was a matter of survival. The modern Olympic movement was needed to harness these interests and energies and to put them in a more noble context. Before that however, by the early $19^{\text {th }}$ century, foot races for prize money had become well entrenched in England. These were the days of little alternative entertainment, and large crowds gathered to watch. Crowds of up to 30,000 were not uncommon, and there was little by way of facilities for their comfort. By this stage timing had become reasonably accurate, for watches with second hands had been available for 100 years. However the courses were often on roads or race tracks, the gradient was variable, and the distances were unreliable. Nevertheless interest was great, ability was there, and it was time for the re-establishment of athletics in general, and running in particular, as an organised sport. The most important and popular race in those days was the mile, and so began the great tradition of middle distance running.

By the 1860s the popularity of running had percolated through to those who could afford to indulge in running races as a pleasant pastime. Thus was born amateur athletics, and though its spirit was purer, it was the province of the wealthy class because only they could afford the luxury of running for fun. This was the time of the industrial revolution, with its flight to the big cities in search of work, and for those of the masses blessed with fleetness of foot, prize money was an excellent escape from their grinding poverty. They certainly could not afford to do it for fun, and there was honesty in their endeavour because they were paid what they were worth to people for entertainment. The amateurs might have had purer motives for running, but these were marred by a certain snobbishness towards those who had no real alternative but to do it for money. However what the amateurs did manage to do was to establish the framework for ongoing competition at all levels - school, university, town, county, national, and, eventually, international. From this emerged the Olympic Games and a number of other international contests. Also out of it came the uniformity necessary for ongoing, widespread
competition. Now there was a system whereby events were there for the athletes, rather than athletes only existing to enable events to be staged. Perhaps most important of all, the framework provided for participation by all who were so inclined, regardless of their ability. Admittedly this participation took some time to eventuate, because leisure time for the masses, and the means to use it, only came about with the higher standard of living resulting from the industrial revolution. There was one notable exception to this, one person who did not wait for the increased standard of living, and he will figure prominently in the early part of our middle distance story.

The story of middle distance running, which begins in the 1850s, will be told in two parts. Although there are other distances in the middle distance group, middle distance is basically about the 800 metres or half-mile, and the 1500 metres or mile. The fortunes in the two couplets have not always run in unison, nor have the protagonists always been common to both, so it seems advantageous to tell the stories of each separately. What will be apparent in both is the high level of intelligence of many of the athletes, which enabled them to have successful careers that were perhaps even greater than their sporting success.

It would be easy to write a book on the history of middle distance running; there is so much interesting and exciting information. However this is a chapter, so it is necessary to be reasonably succinct. In both the shorter and longer events the story unfolds in a series of waves, not always one immediately following the other, but sometimes with long troughs between them. Usually there was not just one athlete riding the wave, but two or three, pushing each other onto better and better performances. We will follow these waves because they set the scene in middle distance running. Unfortunately in so doing we will leave out many great runners, but in a sense, admittedly a very exacting sense, they have been followers rather than leaders.

Unfortunately the history of middle distance running contains little about women, because they are only relatively recently on the scene. Until the feminist revolution of the 1960s women were regarded as delicate creatures, to be protected from physical excesses. In this respect athletics was no different from any other sphere of activity men knew what was best for women and made their decisions for them. One of those decisions was what athletic events women should contest. Our history of middle distance covers the period from the 1850 s to the 1990 s, and it is only in the last 30 of those 140 years that women have gained access to whatever events they wanted. A comprehensive book written in 1912 on athletics by E.H.Ryle (ex president of Cambridge University Athletic Club) makes absolutely no mention of women or girls; it is as if they did not exist. Athletics was probably worse than other sports. It was not until 1928 that the Olympic Games had any athletics events for women, and then it was only $100 \mathrm{~m}, 800 \mathrm{~m}$, $4 \times 100 \mathrm{~m}$, high jump and discus. The 800 m was a disaster, and set women's middle distance back by another 32 years. So many women were distressed at the end of the race that it was decided this "killer" event was unsuitable for them, and another 32 years were to elapse before they could run it again in the Olympics. Even as late as 1951, in another book entitled Athletics, edited by Harold Abrahams (of Chariots of Fire fame) and Jack Crump, it was stated that women's events are "wisely limited to the following: sprinting, track-running and walking up to 1 mile distances...". In the same book Sir Adolphe Abrahams, honorary medical officer to the British Amateur Athletic Board, confesses to a
prejudice against highly competitive athletics for girls and young women. Needless to say, the experience of women's athletics over the past 30 years has completely demolished all of the old arguments.

Much of the data for this chapter come from two excellent books. The first is Wizards of the Middle Distances by Roberto L. Quercetani and Nejat Kok (published byVallardi \&Associati 1992) and the second is The Milers by Cordner Nelson and Roberto Quercetani (published by Tafnews Press 1985).

## THE MILE AND THE 1500 METRES

## Introduction

Ladies and gentlemen, here is the result of event number nine, the One Mile: First, number 41, R.G.Bannister, Amateur Athletic Association and formerly of Exeter and Merton Colleges, Oxford, with a time which is a new meeting and track record, and which, subject to ratification, will be a new English Native, British National, British Allcomers', European, British Empire, and World's Record. The time was three....

This announcement is a classic example of British understatement and suspense, used so effectively to convey a message, be it serious or comic. It was made in a deadpan voice, without hint of excitement, by Norris Mc Whirter at an athletic meeting at Oxford University on 6 May 1954. It was fitting attire for what is probably the most important piece of information in the whole noble history of Athletics. Here at last, after years of striving and waiting, was the sub- 4 minute mile. Everything in mile racing to that day had been pointing towards it. Everything after remembered it and was measured by it. Four minutes was a barrier like no other barrier, and to break it ensured immortality. It was a unique achievement, because only one can be first, and everyone afterwards who ran less than 4 minutes was, in a sense, only following Bannister through the barrier.

It was a pivotal achievement; once attained the balance swung from concentration on the four minute mile to a more performance based approach. Once the barrier was down there was a deluge of runners through the gap, and performances improved dramatically as they chased each other through. But the barrier had to be broken first.

Figure 1 below shows the progression of the world record (or the known world best time in the early days) from the 1860 s to the 1990 s, a span of 130 years. A few very interesting facts emerge from this graph, and they tell us much about mile racing. Perhaps the first is that, with one notable exception that we will discover soon, not much happened for the first fifty or so years. In fact it was not until 1923 , nearly 60 years after the first record, that there was any real improvement. Considering the whole historic period, we see that in 134 years there have been 33 records, and the record has improved by 34 seconds. This means that on average there has been a record about every four years, and each record was about one second better than its predecessor. This makes the period 1979 to 1981 inclusive very interesting. In this period there were 5 records and an improvement of 1.6 seconds, i.e. 2.5 records a year and an improvement of 0.3 seconds a record.

## Mile Record History



Figure 1. Progression of world mile record
The period of greatest long-term rate of improvement was the 50 years from 1931 to 1981 . In this period there were 24 records and an improvement of 22 seconds. Thus on average there was a record about every two years, and each was an improvement of 0.9 seconds. The average record steps were about the same as the long-term average, but the frequency was twice as much. A straight line of best fit drawn through the scatter of records in the 50 year period shows that there is not too much deviation from the line, indicating that the improvement was fairly steady throughout at 0.44 seconds per year. Since 1981 we seem to have returned to the historic rate of improvement of a quarter of a second a year.

It is interesting to note that if the historic rate of improvement of one quarter of a second per year were to persist for 150 years, the word record would reach 3 minutes 40 seconds some time in the second decade of the new millennium. It would be a brave person who would predict that it will not happen by then.

The reason so much of the history of longer middle distance concerns the mile is that the 1500 m was later starting and the earlier performances were considerably inferior to the mile. This came about because, on the whole, $19^{\text {th }}$ century athletics took place in the United Kingdom and the United Stares, and consequently the mile rather than the 1500 m was the longer middle distance race. It would be an interesting study for a sports social historian to determine why the interest and participation were greater in the English speaking world, but it is beyond the scope of this book. The first major 1500 m race was the French Championship in 1888, and the earliest record in that country was 4 minutes 24.6 seconds in 1892. Probably the first recognised world record was 4 minutes 10.4 seconds, set in 1896, and this was about 16 seconds or 6.4 percent behind mile record pace. National records at the turn of the century presented a bleaker picture - 4 minutes 21.4 seconds in Sweden and 4 minutes 26.2 seconds in Germany.

## The Early Days

The beginnings of middle distance running in Britain, and the world, almost entirely belonged to the professionals. However races were mainly on roads or horse racing tracks, and there was not the uniformity in it which could enable reliable comparisons to be made. The sport was well enough established by 1865 for there to be staged a race for The Champion Miler of England. This was held in Manchester, which was the centre of pedestrianism, as it was called. The race was run on a properly measured grass track and the nine best professionals were assembled. A crowd of fifteen thousand eagerly gathered to watch. They were not afraid to "have a go" in those days, as can be seen from the quarter mile splits. They passed the quarter mile in 60 seconds, the half-mile in $2: 05.5$ and the three quarter in $3: 14$. From there it was a furious battle to the finish, and the judges awarded a tie to William Lang and William Richards. The time
was 4 minutes $17 \frac{1}{4}$ seconds, which was the fastest recorded time ever run, and undisputed world's best. It was quite an amazing achievement because the time was not bettered for 16 years.

In the mid 1860 s, by which time foot races were well established under the professional banner, amateur athletics began. In 1861 Charles Lawes won the School Mile at Eton, but the time was not recorded. Three years later, at Oxford University, Lawes won the Mile at the first ever Oxford versus Cambridge Sports, in a time of 4 minutes 56 seconds. Thus began the long quest for the 4 minute mile, which was to finish in the same place 90 years later. A further two years on, in 1866, the Amateur Athletic Club, the fore-runner of the Amateur Athletic Association, held the first amateur championships meeting in England, and again Lawes was victorious in the Mile, winning in 4 minutes 39 seconds. It could hardly said that he was a mile specialist; He also managed to fit in winning the Diamond Sculls in 1863, the Wingfield Sculls in 1865, and he was a champion cyclist. Fittingly his name was honoured in the Challenge Cup for the Mile, which he donated to the Amateur Athletic Association (AAA) in 1880 for perpetual competition in the AAA Mile Championship.

Across the Irish Sea there was also a healthy beginning of amateur mile racing. In 1862 George Farran of Ireland ran 4 minutes 33 seconds at the Dublin University track, which must have been one of the first to be 440 yards (a quarter mile) in perimeter. The best amateur time had progressed to 4 minutes $24 \frac{1}{2}$ seconds by 1875 .

Meanwhile, back in the professional ranks, there was plenty of activity but no improvement in the record, perhaps due to the brilliance of that first Champion Miler of England race in 1865. However another king appeared - a Scot named William Cummings. He became a professional in 1876 at the age of 18 , and two years later had impressed sufficiently to be invited to race for the Champion's Belt- a variation of the ornate belt awarded to champion boxers. Though an outsider, he won in 4 minutes 28 seconds, to become Champion of England. But that was just the start. Over the following few years he won up and down the country, and he might well have been the death of professional running because he was invincible at any distance. The high point of his running career was the Champion's Belt race of 1881, which he won, in the rain, in a mighty 4 minutes 16.2 seconds. After 16 years there was finally a step forward, a new world's best.

At this time there was an exciting development in the amateur ranks, and it occurred in the person of Walter George. He must rank as one of the greatest ever milers, because of the absolute dominance of his performances, and because he was a pioneer. To take the last point first, he was unlike his amateur predecessors in that he did not have the luxury of leisurely competition at University. He was a workingman, and consequently became quite disciplined and organised about his training, so that he could fit it into his life. He was apprenticed to a chemist at the age of 16, and he worked from 7 a.m. to 9 p.m. He devised an exercise that he called ' 100 -up', a high knee, springing, on-the-spot running action, for training indoors. This became quite famous, and was even prescribed in the above-mentioned 1912 book by E.H.Ryle. Just before he was 20, in1878, he predicted he would run the mile in 4 minutes 12 seconds, and he even determined what his splits should be:-59, 2:02, and 3:08. Anyone following his career closely would have seen the pattern. He always ran 59 seconds or thereabouts for his
first quarter mile, and as his career progressed he became increasingly on target for the rest of his prediction.

George swept all before him in the amateur ranks, and in 1882 won the AAA titles in the half mile, mile, 4 mile, 10 mile and cross country. He would have won the steeplechase, but his shoe came off. It was natural that he would want to race Cummings, and he applied to the AAA for permission, offering to give his share of the prize money to charity. But the AAA settled what they saw as a vital question of principle, and refused permission. Later that year he sailed to America for a series of three match races in New York against Lon Myers, the best in America. He lost the half-mile, then won the mile, and in the decider, the three quarter mile, he was victorious. Sixty thousand people watched the final race. In 1885, with nothing and no one else to conquer in the amateur sport, and heavily in debt, he turned professional and challenged Cummings to a series of races. The first was on 31 August 1885 , and thirty thousand fans turned up to see this 'mile of the century' at Lillie Bridge in London. Special trains were put on to transport the excited fans. Betting was heavy, with Cummings the favourite because of his professional experience. The race was highly competitive, with George right on his prescribed pace despite heavy rain, and Cummings right with him. Half way through the last lap though Cummings gave up the struggle, and George slowed to a walk. Winning was all that mattered, but the run told George that he could now run his predicted 4 minutes 12 seconds.

The second Challenge Mile took place about a year later. Again George was right on his schedule, but this time Cummings challenged him at the three quarter mark. The latter pulled away with about 350 yards to go, but George knew his opponent could not hold that fierce pace. He backed his own judgement and gradually began to close the gap. He drew level going round the last bend and moved two yards clear going into the home straight. This was the finish of Cummings - he collapsed, and with the pressure off George coasted to the finish. On this occasion the time mattered, to George and everyone else. There was uproar as it was written up on the blackboard - 4 minutes $123 / 4$ seconds. This was a new world record of some magnitude - it was to last for 29 years. It could well be said that George was a man ahead of his time, but we must remember that he did not do it alone. It was the intense competition with Cummings that pushed his performance well into the next century. Again and again in the story of middle distance racing we will see this unsurprising happening of a group of athletes being responsible for establishing a new level of performance, although only one gains the record. It is a pity that recognition only goes to the winner, because often good competition is responsible for his performance.

## The Long Winter

The latter years of the nineteenth century saw the demise of professional running in Britain and the establishment of amateur athletics under the control of the Amateur Athletic Association. Professional running retained its popularity in other parts of the world, particularly Australia, but it was the amateur sport that had the system for ongoing competition and setting of standards throughout the globe. It gave rise to proper international competition; previously the only international competition had been ad hoc match races between unbeaten champions either side of the Atlantic. The first of these
were between English and American universities, but these were soon followed by a competition in 1895 between the London Athletic Club and the New York Athletic Club. These clubs had their ranks swollen by some of the best athletes from both countries, and the meeting can be regarded as the first international competition. Of course the first of the modern Olympics took place the following year.

What the meeting between the two clubs demonstrated was that the Americans had arrived, not only in middle distance but across the whole athletic program. No longer was the best in England the best in the world. It has so often happened in the history of sport that Britain, having invented the game, was to find that other countries took it more seriously and did it better. Although Britain had some notable runners, and won the 1500 m event at the 1900 and 1912 Olympics, by the end of 1919 the US had the seven fastest mile times ever. In the early years of the twentieth century athletics also gained popularity in Europe, but they were running metric distances. As we saw earlier, the first continental efforts over the metric mile were considerably inferior to the English speakers' performances over the mile, but by the end of the second decade of the twentieth century the 1500 was about on a par with the mile. By this time a Swede had the world record for the 1500 m . After a late start Europe, or at least Scandinavia, was catching up to Britain and the United States.

Although many more countries were now involved in middle distance running, for 29 years there was no advance on Walter George's mile record. This makes George's performance quite remarkable. Perhaps almost as remarkable is the fact that by 1915 only about 10 runners had bettered the time of Lang and Richards in 50 years, and all by less than 5 seconds. This signifies very little improvement in the first half century of mile racing. However in 1915 there was finally a breakthrough. An American, Norman Taber, ran 4 minutes 12.6 seconds in a specially constructed "race" at Harvard University to beat George's record by 0.15 second. Considering the possible errors in timing in those days, this hardly constitutes an improvement at all. Furthermore Taber had the assistance of some very helpful handicapping out in front of him. Taber had finished third in the 1500 m at the 1912 Olympics in Stockholm and then went to Oxford University as Rhodes Scholar.

A very interesting British athlete competed in both the 1912 and 1920 Olympics in the 1500 m . He was Philip Baker, and despite being a double Olympian he accomplished greater deeds outside the world of sport. In 1912 he finished sixth, which was a commendable effort considering he ran with a dislocated bone in his foot. This was only remedied in 1918, after he had had commanded the First Friends Ambulance at battlefronts in World War I. Then in the 1920 Olympics he finished second to fellow countryman Albert Hill. In later life Baker was a Member of Parliament and three times minister in the United Kingdom Government. He was awarded the Nobel Peace Prize in 1959 in recognition of his work for world disarmament.

## The Europeans Arrive

It took a great runner, for whom the mile and 1500 were really too short, to achieve a major breakthrough and properly take the event into the twentieth century. This was the Finn, Paavo Nurmi. The Finns had already made their mark on the world
scene in longer events; at the 1912 Olympics Hannes Kolehmainen had won the 5000m, $10,000 \mathrm{~m}$ and Cross Country, setting a world record in the shorter race. A great Scandinavian tradition in middle distance and distance running was launched. Nurmi himself had arrived as a distance man at the 1920 Games, narrowly losing the 5000 m and winning the $10,000 \mathrm{~m}$, Cross Country and 3000 m Teams Race. Absolute dedication had brought him to this point. He always wanted to run, and joined a club at the age of ten. However this pleasant preparation ceased at the age of 12 when his father died, and young Paavo had to go out to work. Like George before him, he was not going to allow the inconvenience of having to work a long day deter him from his resolute ambition to be a great runner. They are object lessons to so many runners today, who must have everything laid on so they can pursue their running careers.

The breakthrough in the mile came about because of the rise of Swedish runner Edvin Wide in the 1500 m and 5000 m events. In 1923 Wide set Swedish records in both events, was among the fastest in the world in both, and had scored some impressive international victories. The Swedes were eager for a showdown with the best - namely Nurmi - and issued a challenge to the Finn for a race in Stockholm. It was expected that Nurmi would choose to race over $10,000 \mathrm{~m}$, considered to be his best distance, but he was not a man to dodge the issue or deflect a real challenge. He chose to race over Wide's best distance, the mile. This made Wide the favourite, which only increased Nurmi's determination and made him a more ruthless opponent.

Indeed Wide, full of confidence, led for the first quarter mile in 60.1, but then Nurmi took over, determined to assert his authority on the race. Wide tried to regain the lead and the initiative but the Finn would not allow it, and he passed the half way in $2: 03.2$. Now surely he would ease off, in preparation for a final effort? To the contrary, he kept the pressure on, with the game Wide desperately hanging on. He reached the three quarter mark in 3:06.7, and by that stage a perceptible gap was developing, with Wide going through in $3: 07.3$. Wide was spent, and although he fought on bravely the gap continued to widen. It was seven metres at the 1500 m mark, which Nurmi passed in a new world record of 3:53.0. With everything wrung out of poor Wide the gap was 16 metres as Nurmi crossed the line. The race provided a worthy result - a new world record of $4: 10.4$, a significant improvement at last on George's 1886 time of $4: 123 / 4$. Wide finished in 4:13.1, a last quarter of 65.8 against Nurmi's 63.7, indicating the latter's superb fitness. But would he have attained the record by such a significant margin, would he have attained it at all, if Wide had not pushed him so hard in the middle stages? Perhaps, because he was so determined. But he was more determined to dominate and to win, so it seems unlikely that he could have achieved the time he did without Wide's spirited competition. Again we must give credit to the "loser" for the winning performance and the new record.

Nurmi went on to win four events at the 1924 Paris Olympics - 1500m, 5000m, Cross Country, and the 3000 m Teams Race. He was not permitted by the Finns to run the 10,000 , or he might have won that too. The first two events prove his greatness, if any further proof were needed. The finals were 55 minutes apart, but that did not deter Nurmi. The 1500 m was first, and he set out in that at a cracking pace, passing the 400 in 58.0 and the 800 in 1:58.5. That was enough to destroy the only runner brave enough to go with him, and he eased off then to conserve energy for the 5000 . In the longer event
his opponents tried to take advantage of his very recent exertion, and tore off at a pace that would hurt him. But he was too smart; he ignored them and the pace hurt them instead. Soon they came back to him and then faded behind him. He was invincible.

The European onslaught continued. Through to 1926 Nurmi was supreme, particularly in longer events but also in the mile or 1500 m . Other Europeans were also running well, including Wide. Then in 1926 a 1500 m race took place that finished Nurmi as a miler. Now a German, Otto Peltzer, gained supremacy with a new world record of 3:51.0, with Wide second. To the amazement of all, Nurmi "only" finished third, the first third placing in his career. He seemed dispirited after that and lost a few more races that he could have been expected to win. He put the shorter events behind him but was not done yet, going on to win the $10,000 \mathrm{~m}$ and finish second in the 5000 m and 3000 m Steeplechase at the 1928 Olympics. Europeans dominated the 1500m at the 1928 Games, with the first three placings going to Finland, France and Finland. The same was true outside the Olympics; hardly a non-European figured in the 1928 rankings.

The Europeans continued to dominate into the 1930s. The world records for both the 1500 m and the mile passed to a Frenchman, Jules Ladoumegue, and he was the first below $3: 50$ and $4: 10$. By now this exciting longer middle distance was spreading right throughout the continent, and an Italian, Luigi Beccali, gained the upper hand in the 1932 Olympics. However the English speaking world was re-awakening, and by 1933 the wheel had turned, though initially only in the mile. Beccali still dominated at the metric distance and in fact had three of the four fastest runs ever, including the world record. But there was Anglo-Saxon movement in their own distance. First Jack Lovelock of New Zealand brought the record down to 4:07.6, then a year later Glenn Cunningham of the United States lowered it to $4: 06.7$. Finally in 1937 Sydney Wooderson of Great Britain, with $4: 06.4$, brought the record back to Britain again after 22 years. Fittingly Walter George was there to see the run. By the mid 1930s the Anglo-Saxons were also in the ascendancy at the metric distance. Lovelock won the 1500 m at the Berlin Olympics and also captured the 1500 m record. Although he was a New Zealander he had spent those prolific running years in England. He was at Oxford University as Rhodes Scholar.

Nurmi's breakthrough lasted 8 years, a measure of its value. Then over the next 6 years four runners took the mile record down another 2.8 seconds. There it stalled, as the black clouds of World War II were gathering.

## Swedish Leapfrog

During World War I it had been the Swedes who brought the 1500m standard up to that of the mile, and in so doing had brought Europe into what had been an AngloSaxon scene. They had been able to do this because they were not combatants in the war. Similarly they were neutral in World War II, and so had the opportunity to continue competitive running during the war years. The opportunity might have come to naught if there was no worthwhile competition, if one runner had dominated the Swedish scene. But there were two brilliant runners, and they leapfrogged over each other to bring the record within reach of the magic 4 minutes by war's end. They were Gunder Hagg and Arne Andersson. Even these two brilliant runners probably could not have achieved what they did without the helpful threat of a whole host of Swedish middle distance runners
snapping at their heels. Running had captured the popular attention of the Swedish nation, and there was considerable depth in athletic clubs. In 1945 there were 60 runners in Sweden under 4 minutes for 1500 m .

The Swedish assault began in a small way in 1941 with Hagg breaking Lovelock's world record for the 1500 m with a run of $3: 47.6$. At this stage the mile still stood with the Anglo Saxons - Wooderson's 4:06.4. Then in 1942, 82 days of brilliant running changed the face of longer middle distance and shorter distance events. Andersson was brilliant but Hagg was even more so. Three times in three weeks in July Andersson ran world record times, only to lose to Hagg. But he was never dejected, never gave up, and there was a great deal of respect between the two champions, who became close friends. In those astounding 82 days Hagg set ten world records at seven distances ranging from 1500 m to 5000 m . He could not have done it without Andersson. At the end of this period Hagg had the mile record at 4:04.6. He truly is one of the greats of all time.

1943 was Andersson's year. He learnt much from his defeats of 1942, and put his learning to good effect. It was not as productive a year as Hagg's in 1942, but it provided two world records. The first was for the mile, and it was a run of extremely high quality. He ran 4:02.6, to carve a massive 2 seconds off Hagg's great 10-month-old record. He did not have Hagg to push him but there was no shortage of very good Swedish runners. Second place ran 4:04.6 to equal Hagg's record and third at 4:06.6 was only just outside the time that had prevailed until a year previously. Andersson had improved by 3.6 seconds since his world record performance a year before. Then 16 days later he ran 3:45.0 for 1500 m , to remove another Hagg entry from the record book. Of the 7 records Hagg held at the end of 1942, Andersson now had the two shorter ones while Hagg had the five longer ones. Hagg had been on tour in the United States while this was going on, so the stage was set for an exciting 1944.

Amazingly both continued to improve, though the cascade of records of 1942 could not be repeated. The highlight for Hagg was his recapture of the 1500 m record. Once again Andersson was under the old record, in fact it was a one second improvement on his own mark. But Hagg was a further second in front of Andersson, in 3:43.0. Andersson had his glory 4 days later in the mile, and for once it was Hagg who went unrewarded for a record run. Andersson improved his own record by a full second, with 4:01.6, and Hagg at 4:02.0 was 0.6 seconds better than the old mark. The enduring friendship between the two was manifest that night when Hagg and his parents entertained Andersson and his wife. He said, "It's not every day I can invite a world champion to dinner". Hagg twice lowered his 2-mile record that year, but his opponent still had victories over him at 2000 m and 3000 m . Andersson certainly had the better of their duels that year, winning 6 times to Hagg's solitary 1500 m victory. Overall it was at this stage 14 to Hagg and 7 to Andersson. Nurmi ventured the opinion that the reason for the pair's superiority was their better build up during winter.

It was nearly all over as they entered the 1945 season; they had almost reached the top of the mountain. But there was one final glorious fling before they were done. On 17 July at Hagg's hometown, Malmo, there was a mile race between the mile world record holder and the 1500 m world record holder. Seen from the vantage point of more than half a century later, it was as though they knew this was the finish, and they were
determined to make it memorable. Not only they but everyone involved sensed that it was going to be momentous. The meeting was a sellout well before the race and over 14,000 people packed into the stadium. So keyed up were the five runners in the race that they all broke at the first attempt. Once they were underway Hagg's tactics were clear. He had to take the kick out of the fast finishing Andersson, who had dominated in 1944 with his finishing bursts. So he followed the good pace provided by the pacemaker and pressed on when left out in front after the half way mark. He kept up the pressure and Andersson clung to him. There was a gap of 0.4 second at the 1500 , but Andersson was not finished yet. At this stage they were ahead of world record schedule so a new record seemed certain, but to whom? Those who remembered the 1944 season, including Hagg, waited for Andersson to strike. He did not disappoint them, and with a supreme effort he drew level with about 75 metres to go. Here were the two greatest milers in history battling for and only seconds away from a new world record. They were like two boxers in the final round of an even contest, throwing all they knew and all they had into this pinnacle of their careers. But drawing level was all Andersson could do and slowly but surely Hagg edged ahead again. Andersson had to let go and the margin grew to about 5 metres at the finish. His time was $4: 02.2$, and only he and Hagg had run faster. The depth of Swedish running was indicated by the time of the third place- 4:03.8. Hagg's time was 4:01.4, a record that was to last for 9 years.

In those four years from 1941 to 1945 these two Swedish friends had knocked five seconds off the mile record, an improvement of $2 \%$, and 4.8 seconds off the 1500 m record, an improvement of $2.1 \%$. They had taken mile racing into a new era, to within reach of the four-minute mile, and, at last, far removed from Walter George's $4: 123 / 4$ of the nineteenth century.

## The Race for the Four Minute Mile

After 1945 it appeared certain that the mile would be run in under 4 minutes quite soon. Paradoxically the apparent certainty of such a feat created a barrier to its fulfilment. The pressure to break 4 minutes was immense, and it took 9 years of trying by athletes throughout the world to achieve any improvement on Hagg's record, and then it was 2 seconds. Hagg and Andersson had achieved a 5 second improvement in a mere 3 years. This underlines the role of direct competition in driving performances upward.

The Swedes continued to lead after the war, though not as dominantly. There was really little movement until 1952. In the Olympic 1500m that year improvement across a wide front became apparent, as national records were set for Luxemburg, United States, Great Britain, France and Australia. Then in December in Melbourne the race came alive when an unknown, who had been run out in his heat in the Olympics, ran 4:02.1. Only Hagg and Andersson had run faster, and this run was a solo effort in an ordinary low-key interclub competition. He was John Landy, and he has the enviable reputation of being perhaps the finest gentleman ever to set foot on an athletic field. In the fashion of intelligent runners he was able to learn and apply, and he learnt much at the 1952 Olympics. He learnt that until then his training had lacked both quality and quantity. He also learnt that middle distance and distance running in Australia were being inhibited in quite an innocent way by the tradition of professional running in the nation. Professional running was very strong in Australia, and a running shoe manufacturing industry had
developed with it. This determined to a large extent the type of running shoe available, and these were suitable for sprinting, which was the mainstay of professional running. But they were not suitable for anything longer than sprinting.

Landy's run in such ordinary circumstances convinced the athletic world that the four-minute mile was indeed possible and the race was on. Over the next year and a half Landy had a number of attempts in Australia, but it was always thus far, no further. He realised that if he was to break through he needed to get to Europe and into some good races with people at least approaching his own ability. His perception was correct, and he was successful, but of course he was a few weeks too late. In purely performance terms it is surprising that Landy is so well remembered. Admittedly in quite adverse circumstances he did show the world that a four minute mile was indeed possible and he kick-started the race for it. But apart from that he was what some would call a "loser"second through the four minute barrier, second in the 1954 Commonwealth Games, and third in the 1956 Olympics. He says that he does not know why there is so much fuss about a person who was second. The reason for the fuss, and for his enduring reputation, is encapsulated in the 1956 Australian mile championship. This race provided his best chance ever in Australia of running under 4 minutes, because by then he had developed what he had previously been lacking, namely a finish. But he threw away the opportunity by stopping to look after a fallen runner whom he thought he had spiked. The interlude cost him seconds, and he still ran 4:04.2 to win. Why did he do it? He claimed not to know himself. But it was obviously the instinctive act of a man who sees sport in proper perspective, who puts concern for others above personal glory, who epitomises all that is good and noble about athletics.

Landy loved the world of nature, and in later years it was this by which people knew him. He is an author in this field. And from the end of the year 2000 he will be known in a new role. His athletics achievements, his gentlemanly conduct on the athletic field, and his contribution to the community, have been recognised by the government of the State of Victoria, and in perhaps the most popular decision of its kind in Australia he has been named as Governor of the State of Victoria.

Roger Bannister is hardly less noteworthy. He also kept sport in perspective, knowing that his work as a doctor would be far more important, and a greater contribution to the wellbeing of mankind, than any success he might have as a runner. Consequently he curtailed his training to what his studies and later his work would reasonably allow. He was intelligent enough to know that his restricted training regime would place limitations on his performance. When he heard that there were to be three rounds in the Olympic 1500m in 1952 he knew that his chances were diminished. His finely tuned training had prepared him well for two rounds, but three would be too many. This was very prescient of him, for he finished fourth, under the old Olympic record, despite lacking his usual finishing kick. He did some soul-searching following the Games, and decided to give running another two years. He had something to prove to himself and others - that barring surprises like three rounds in three days, he could excel without being obsessive about athletics.

Following Landy's great run at the end of 1952 Bannister knew he had to get serious if he was to be first through the barrier. Every week through the English winter he expected to hear that Landy had been successful, and when the Australian season was
over he thought that 1953 would be his last opportunity. He had decided previously that he would like his attempt to be at the Oxford University track, of so many happy memories for him, and also the track of Jack Lovelock and so many others in the history of British miling. The first opportunity came at the AAA v Oxford match in May. This produced a very encouraging 4:03.6, and Bannister knew that he could do it. However circumstances prevented another serious attempt that year, except for a rather artificial 4:02.0, aided by Chris Brasher falling a lap behind and pacing him for the last lap. So again he had the agony of waiting for Landy through the Australian summer. But despite training harder Landy was not able to do any better. Bannister could breathe again, but not for long; Landy was heading to Scandinavia in 1954 for the northern summer. Again the AAA v Oxford match, on 6 May 1954, provided an opportunity, and it could be the last. The race was on in earnest with a player from the United States also in on the act. Wes Santee had run 4:02.4 in 1953, and now, after a good 1954 indoor season, was ready to pounce. The day of 6 May was a day of suspense. Bannister knew he was ready, but the wind was blowing a gale. Would he go for it or wait for another day? Just before race time the wind abated somewhat and Bannister decided that now was the hour, or rather the four minutes. In perhaps the most important and best remembered race in the history of athletics Chris Brasher's and Chris Chataway's pacing provided the perfect launching pad for Bannister's assault on the barrier, and Bannister unleashed everything he had in the last lap to cross the line in $3: 59.4$. The moment in history had finally arrived, and from now on everything would be after the first four-minute mile.

Less than 7 weeks later Landy, in a more conducive environment and with good competition, crashed through the open gate, improving his best Australian performance by 4 seconds and taking 1.4 seconds off Bannister's record, with a run of 3:58.0. About six weeks later the only two men to have gone under 4 minutes met in the Commonwealth Games Mile. Bannister proved his superiority in a narrow but clear victory in a race that produced the best of both of them. Landy ran aggressively, trying to take the kick out of Bannister. Bannister controlled Landy's lead, while trying to conserve energy for his finishing burst. It was the perfect race, and Bannister graciously acknowledged that it was Landy's courage that made it so. Both finished in under 4 minutes.

There were another three through in 1955, a further five in 1956, and seven in 1957, and by this time there were more than 20 sub 4 -minute miles. After so long it was now seemingly easy. But it was still a feat worthy of mention in the press and to go under four minutes was still the measure of a great runner. It took a 20 -year-old Australian to change that.

## The Invincible and the Enduring

This section is about two runners, an Australian and a New Zealander, who took the Mile and 1500 to new levels in the late 1950s and the 1970s respectively, in terms of time and also command. It is also about an American of the 1960s who bridged them with his times but never achieved their dominance.

The Australian was Herb Elliott, and he has the distinction of never losing a mile or 1500 m race. By 1960 there was nothing left to conquer, and he retired at the age of
22. His brilliance is perhaps as much illustrated by his utter determination to win in close tussles when he was not running at his best, as it is by his destruction of a field when he was at his top. He was a ruthless runner who drove himself intensely, in racing and training, and there was no one of his period who could match him. Whether any of any period could is a matter of interesting but idle debate. Elliott already had many sub 4minute miles to his credit when he raced at Santry track in Dublin in 1958, following his mile/half mile double at the Commonwealth Games. He won in 3:54.5, which demolished the world record by a massive 2.7 seconds. In so doing he made the 4 minute mile irrelevant; the bar had been raised. Four years later the bar was cleared and the mile moved on, but Elliott's audacious run had shown the way. It was the same in the 1500 m . At the 1960 Olympics he began his finishing run after only 800 m , and he left the best runners in the world floundering in his wake. After he took off they were running for second. His time was $3: 35.6$, a new world record that lasted for seven years. And this without special pacing! Elliott went on to become a very successful company executive and businessman in later life.

In 1966 a young American, not yet 20,made the $3: 50$ mile a credible objective, with a $3: 51.3$ run. He was Jim Ryun, and a year later he lowered that to $3: 51.1$. Also in 1967 he set a new world mark for $1500 \mathrm{~m}-3: 33.1$. These were extraordinary times, well ahead of what Elliott had achieved, and a 2 second improvement on the prevailing records. It should have meant that Ryun would be one of the all-time greats, but bad luck and bad judgement dogged him throughout his career. His best result was second to the master of all distances, Kip Keino, in the 1968 Olympics 1500m.

The enduring, and also invincible for a good part of his long career, was John Walker of New Zealand. For a small country of only 3.5 million people, New Zealand has a wonderful tradition in middle distance and distance running. As we saw above, Jack Lovelock won the 1500 m at the 1936 Olympics, and then from the 1960 to the 1976 Games the nation's success rolled on. In 1960 Peter Snell and Murray Halberg won the 800 m and 5000 m respectively, and Barry Magee was third in the marathon. Snell repeated the 800 m in 1964 , and as well won the 1500 m , in which fellow countryman John Davies was third. In 1968 Michael Ryan was third in the marathon and in 1972 Rod Dixon was third in the 1500 m . In 1976 John Walker won the 1500 m and Dick Quax was second in the 5000 m . Not many nations have been this successful over such a long period, and none as small as New Zealand. So this was the tradition out of which John Walker came. Like their famous rugby team, New Zealand athletes expected themselves to do well and they did.

In 1975 Walker took miling into a new era - the sub 3:50 era. In Gothenberg in August he ran 3:49.4, 10 seconds faster than Bannister's first sub 4 minute run 21 years earlier. A year earlier he had been second to Filbert Bayi, when Bayi ran a 1500 m -world record by an amazing display of all-the-way front running at the Commonwealth Games. That was the end of seconds for Walker, and for the next three years he dominated mile and 1500 m races around the world. In 1976 he raced 50 times over 1500 m and lost once. One of his wins was the Olympic 1500 m , in which his superiority seemed so taken for granted that everyone else was running for second. It was not until 1978 that Walker's star was eclipsed, and it took an injury to do that. He was out for that year, and when he returned there was a new breed on the scene, who would not allow him to take
up his dominance again. Nevertheless he remained very dangerous, and raced everyone everywhere. He was in the race in which his mile record was broken, and he was still racing when his conqueror retired. In 1982 he ran faster than his 1975 world record, though this was now not good enough to win. In 1983 and 1984 he was still within a whisker of his world record time. He was still racing into the 1990s, by which time he had accomplished 100 sub 4-minute miles. No one before or since has been so good for so long.

## The British Again

All imperial distances have now disappeared from the athletic calendar and record lists with one exception - the mile. This is a British legacy to the athletic program, and it is interesting that it, rather than the continental measure of long distance, the kilometre, captures the imagination of the athletic community and the sporting public. It is fitting therefore that, generation after generation, British athletes return to be masters at it. It happened again in the late seventies and early eighties. Again it was not just one runner but two, then three, and others snapping at their heels, who held centre stage. By the time they were finished the mile record was three seconds better (and Walker was still going).

Steve Ovett in his mid teens was a promising 400 m runner, until he decided that middle distance was more challenging. Middle distance fans have good reason to be thankful for his enterprise. After finishing fifth in the 1976 Olympic 800m he took to the longer middle distance events more seriously in 1977. By 1978 he was at the top of the pile, though not with the fastest times. In 1979 he was ready to rewrite the record book, but someone else beat him to it. That someone else was Sebastian Coe, who until 1978 was no more than a promising international runner, and at 800 m rather than $1500 / \mathrm{mile}$. Coe burst on the scene in 1979 , seizing world records at $800 \mathrm{~m}, 1500 \mathrm{~m}$, and the mile, all in the space of 41 days. For the next few years the rivalry between these two runners excited the athletic world, and interested the wider sporting public more than any athletic happening since the days of Bannister and Landy. At first Ovett's priority was racing, and he was superb at it. Despite Coe's marginally better times, Ovett was undefeated in 1979. But in 1980, stung by the regard given to records rather than victories, he decided to play the game and go for records. Then began a magnificent see-saw between the two Englishmen, mainly played out in Europe, as they won, lost, and regained records.

The battle began in July 1979 at the famous Bislett Stadium in Oslo, which had seen many great runs in the past. On this occasion the world record holder, John Walker, was in the mile race, but seeing what was happening in front of him, he knew his record was gone. And indeed it was, with a run of $3: 48.95$ by Coe. This was 20 days after setting a new world record in the 800 m .21 days after the mile run the 1500 m record also fell to Coe. Ovett, undefeated in that year, was only 0.08 second behind Coe in the 1500 and 0.62 in the mile. So the stage was set for an exciting Olympic dual in 1980.

After losing the Olympic 800, for which he was hot favorite, Coe proved his superiority over his conqueror Qvett and everyone else, with a convincing win in the 1500. This was not before Ovett had taken the mile record from Coe, in a run a few weeks earlier at Oslo. So Ovett's profile had changed. Once the racer, and in fact with an unbeaten streak of 41 races up to the Olympic 1500, he had to bow to Coe as a racer
but had the world mile record for compensation. The difference between fast times and races became apparent. Races like the Olympic 1500 go to athletes who can produce as much speed as they need when they need it. They are usually not won in fast times, but parts of the race, in the second half, can even be faster than the corresponding part of an 800 m race. On the other hand record attempts are more evenly paced, to give a better overall distribution of effort and consequently a faster time. Ovett followed up after the Olympics with a new world record in the 1500 m , in a race which saw three runners go under Coe's old record.

In 1981 it was on again. In the space of 9 days Coe won the mile record back from Ovett, lost it to him again, and won it back yet again. The record now stood at 3:47.33, leaving the $3: 50$ mile as a memory and the 4 -minute mile as a page in history. 1982 saw both Coe and Ovett out of action and then below par due to injury. In 1983 Coe was ill, but Ovett improved on his 1500 m world record. So once again the stage was set for a showdown in the 1984 Olympics. Coe's focus seemed supreme. He did not do much else, but he had a magnificent Olympic Games. He had four rounds of the 800 m , culminating in a very good second placing, then had three rounds of the 1500 m , the last of which provided him with a repeat gold medal in an Olympic record. Unfortunately Ovett was unwell, so they did not have a fair contest.

That was the end of the Coe versus Ovett show. They both continued running, but did not rise to their former glory. Interestingly they had been fierce rivals competing for international supremacy for five years, yet in that time they only raced head to head at the 1980 and 1984 Olympics. There has been much comment about this, and even some criticism of either or both of them for not being willing to find out who was better. Why couldn't they be like Hagg and Andersson? Both might have been even better. But this criticism is unrealistic. They were in a different system than prevailing in earlier days. It was a system driven by meet promoters who wanted world records and wanted a superstar ethos. These things made their meets successful. They did not want tactical races that produced slow times. Fans accepted these in championship events but did not want them in promoted meets. Furthermore in this superstar system athletes needed to keep winning in order to remain superstars, and to continue to be able to dictate terms that suited them. Coe and Ovett did not invent the system. They simply played according to it. It is as realistic to have expected them to race each other as to be amateurs like the great Englishmen of the past. Those days, and the days of being prepared to continually try to knock each other off the pedestal, were simply gone.

While Coe and Ovett were overtaking each other with records another great Englishman was developing. Steve Cram was only 17 in 1978 when he ran a mile in 3:57.1 and 1500 in 3:40.1, and he went into the 1980 Olympics as a 19 year old with bests of $3: 53.8$ and $3: 35.52$. He struggled in the Games, finishing eighth. But by 1982, the year Coe and Ovett were virtually out of action, he won the European and Commonwealth Games and earned world No. 1 ranking. In 1983 he had the best of Ovett, winning both the World Championship and an eagerly awaited head to head clash over a mile at Crystal Palace. In 1984 he had to bow to Seb Coe in the latter's great repeat of his Olympic gold. With the best of Coe and Ovett behind them, Cram resumed his reign in 1985 with a new world mile record of 3:46.32, a full second under Coe's 1981 record.

It is worthy of note that these three great Englishmen, who between them moved middle distance running to a new level, were all together in the 1984 Olympic 1500m final.

## The Africans

There had been African middle distance runners before. There was Kip Keino, who won the 1500 in 1968, and Filbet Bayi, one of the few to run a world record in a championship 1500 (the 1974 Commonwealth Games). But from the mid 1980s they were on centre stage in great numbers. At first there were the former British colonies like Kenya and Tanzania, but then came the Moroccans, the Algerians and others, and they provided both quantity and quality.

In the latter days of the British ascendancy Said Aouita of Morocco was beginning to make his mark. He was third in the 1983 World Championship 1500. Then in 1984 he chose the 5000 instead of the 1500 for the Olympics, but still finished the year with No. 1 ranking for fastest times in both the mile and the 1500 . But it was in 1985 that he really began to sparkle, when he took the 1500 m world record from Cram. Also in that year he set a world record for 5000 m . Then in 1987 he took his 5000 m record below 13 minutes and established a world record for 2000 m . But he was not finished yet. In 1989 he took the 3000 m world record below 7:30, i.e. faster than a minute a lap for twice 1500 m . That indeed was a milestone. His versatility was astounding - 800 in 1:43.86 and third in the 1988 Olympics, the above performances, and $27: 26.11$ for the 10,000 . He ran up 44 straight victories in international events ranging from 800 m to $10,000 \mathrm{~m}$ from July 1985 to September 1987. He is arguably the greatest endurance runner ever.

By the early 1990s the mantle had shifted and it was the turn of Noureddine Morceli of Algeria. In 1992 he took the 1500 m record from Aouita, and he improved it to $3: 27.37$ in 1995, the year in which he won the World Championship 1500m. In the meantime, in 1993, he took the mile record down to $3: 44.39$. Inexplicably he could only finish seventh in the 1992 Olympic 1500m. However he returned in 1996 to claim victory.

After 1996 the pendulum swung back to Morocco, this time to Hicham El Guerrouj. In fact the 1500 m at the 1996 Olympics was to have been the showdown between Morceli and El Guerrouj, but the latter tripped with a lap to go. From then on however he was supreme, and was unbeaten between Olympics. In 1998 he achieved the inevitable- the world record for the 1500 m with a time of 3:26.00- and he followed that in 1999 with a world record for the mile in a time of $3: 43.13$. Also in 1999, two months after his mile record, he gained the world record for 2000 m . He went into the 1500 m at the 2000 Olympics one of the hottest favourites of the Games, but was beaten by yet another African- Noah Ngeny from Kenya. Ngeny had been beaten by El Guerrouj so many times he must have lost count, but he could not have been ignored because he held the world record for 1000 m . He was able to produce his best performance when it really mattered.

Lang and Richards, the holders of that first recognised world best for the mile, would be still in the back straight when El Guerrouj finished, such has been the progress
of mile racing. However progress is the operative word. El Guerrouj could not have run nearly that fast if others had not shown the way. All have been an essential part of the pursuit of excellence in mile running.

## THE HALF MILE AND THE 800 METRES

## Introduction

Many would regard the 800 m event as more exciting than the mile or 1500 m , having more sustained speed, less tactical dawdling, and less margin for error. However the shorter event has never captured the popular imagination in the same way as the mile, and by association the 1500 m . There was no magic target like the four minute barrier. It was not fixed in people's everyday thinking as a unit for measuring distance as was the mile. It, or rather its imperial equivalent, was not on the original English universities program, and did not appear in the Oxford versus Cambridge match until 1899. The quarter mile tended to meet the requirements of those wanting something shorter than a mile but not a sprint. It was bracketed with the half mile as middle distance, in which a waiting game could be employed.

Even this century, when the half mile and 800 m have been well established on the athletic program, they have remained the concern and the joy of the athletic purist rather than the general sporting enthusiast. The latter usually knows about the 100 m and the marathon as well as the mile, but would have little idea of performers and good performances in the 800 m . The greats of the $800 \mathrm{~m} /$ half mile have not become household names, unless they have also been greats in the mile. In short, the half mile and its metric equivalent have lacked the glamour of the mile. Nevertheless the history of the event is rich in wonderful athletes, titanic struggles and great breakthroughs.

A graph showing the progress of half mile and 800 m world records from the 1850s to the present time is given in Figure 2 below. It is a composite graph, showing the better of the 800 m and half mile records prevailing at the time, based on the average speed, which is applied to 800 m . ( 800 m is $99.42 \%$ of a half mile, so this is legitimate.) Generally this enables the graph to fall easily into two parts, because up till the late 1930s British and Americans dominated the scene, and they ran half miles, whereas after that Europeans asserted their influence, and they ran 800 m . Furthermore all imperial distances except the mile became less popular as the sport became more international, and in the mid 1970s the half mile disappeared from the programs and the record books. It is interesting also that the half kilometre never extended beyond Europe as a recognised racing distance. It was popular on European programs until the 1930s, and there was an officially recognised world record for it. Many tracks, including that in Paris used for the 1924 Olympics, were 500 m in perimeter. But the increasing internationalisation of athletics, and the fact that 400 m was an Olympic event, put an end to 500 m .

We see that in the period of records of 143 years there have been 28 records and 27 record improvements. That is an average of a new record about every 5 years, slightly less frequently than for the mile. Over those 143 years and 27 improvements the record has improved by 16.2 seconds. This means that, on average, performances improved by
0.60 seconds per record and 0.11 seconds per year. Thus the overall improvement picture is much the same as for the mile, despite the distance lacking the glamour of the longer event.

The thing that stands out on inspection of the graph is the six large improvements, each followed by a period of stagnation. These six steps account for 9.2 seconds of the total improvement. Thus $22 \%$ of the record holders account for $57 \%$ of the record improvement. That is a measure of the greatness of those $22 \%$, or six runners.

800m Record History


Figure 2. Progress of world best 800 m performances
There have been two really prolific periods during the 143 years, and both have been relatively brief. The first was the period from 1926 to 1939 . This was a really competitive period, because it produced a record every two years. The second, and even more competitive, was the 8 year period 1973 to 1981 , in which there was an improvement nearly every year. The rate of improvement during this period was 0.33 seconds per year, three times as good as the long term average.

If the long-term rate of improvement persists, the mark of 1 minute 40 seconds, or 100 seconds, will be reached some time about the middle of the first decade of the new millenium.

## The Early Days

As in the mile, the half mile scene in the middle of the last century was dominated by British professionals. The first point on the above graph is in fact the first recorded sub 2 minute half mile on a track. The time was 1:58.0, which translates to 1:57.3 for 800 m . It was run in 1854 by Henry Reed in Halifax, and his prize was the Champion's belt and fifty pounds, a significant sum in those days. This time established the benchmark for half miling.

In 1867 James Nuttall, another English professional, improved the record by $21 / 4$ seconds, with a run of $1: 553 / 4$, an equivalent 800 m performance of $1: 55.1$. This was an outstanding run, a fastest recorded time that lasted for 14 years, and was not much improved on for 28 years. In the meantime the amateurs were struggling to break 2 minutes. In the first Amateur Athletic Club championship (the fore-runner of the AAA championships) the half mile was won in 2:05.0. The first official sub 2 minute half mile was not until 1873, and then it was under by the smallest margin possible in those days $1 / 4$ second. Interestingly it was an American amateur rather than British who finally overtook the professionals. We have already met him; it was Lon Myers, whom Walter George went to America to race in 1882. These were certainly not the days of the
specialist. Between 1879 and 1884 Myers won 15 US titles, and he dominated from 100 yards to the mile. He even found time for long jumping. It was in 1881 that he eclipsed Nuttall's time, and also that of the fastest British amateur to that stage ( $1: 57 \frac{1}{2}$ ), with 1:55.6, which translates to $1: 54.9$ for 800 m . He did this in a 1000 yard $(914 \mathrm{~m})$ race in New York.

An Englishman, and then an American, sliced a little off the record over the next few years, but it was still not much more than a second faster than Nuttall ran in 1867. It was not until 1895 that a major breakthrough occurred. The occasion was what was probably the first international athletic meeting. It was a competition in New York between the London Athletic Club and the New York Athletic Club, but both clubs were bolstered by some of the best from both countries. Interest was extremely high, and great things were expected. There were some good performances but they were all American. They won all eleven events on the program, and the British press were not impressed with the performances of their countrymen. The half mile at this competition was won by the American, Charles Kilpatrick, in 1:53.4, equivalent to 800 m in 1:52.7. This was 1.1 seconds under the old record, and a performance that was to endure for 14 years.

## The American Era.

The 1896 and 1900 Olympics did not attract much in the way of 800 m runners, and the winners did not go below 2 minutes. In fact the inaugural Olympics were so little regarded that the winning time, by Edwin Flack of Australia, was only $2: 11.0$. The event began to gain some respectability in 1904 at St. Louis, when the best of America's half milers (but not much else) were present. It was won by James Lightbody (USA) in 1:56.0. This began a run of Olympic victories for USA, demonstrating their dominance in the event. This dominance had begun in 1891, when Walter Dohm recaptured the world record from Britain, and continued with Kilpatrick's great run in 1895. Between the Olympics there was little competition, and Kilpatrick's record remained unchallenged.

The 1908 Games in London saw a welcome increase in standard and also the entry of Europeans into contention. Melvin Sheppard (USA) was the winner, in a new world record for 800 m of $1: 52.8$, but since that was not quite as good a run as Kilpatrick's half mile in $1: 53.4$, it is not included in the graph above. In fact the runners continued on the extra 4.7 metres to the half mile mark, and so much was Sheppard slowing that he only recorded 1:54.0. The reason he was so exhausted was the titanic struggle he had with an Italian, Emilio Lunghi, before he could prevail. Lunghi was only one fifth of a second behind at the finish, and he was the first Italian athlete in any event to be a serious contender at international level. Third was a German, Hanns Braun, so this was a truly international event.

That Lunghi's run in the Olympics was no fluke was borne out the following year when he covered the half mile in 1:52.8 (equivalent to $1: 52.1$ for 800 m ), slicing 0.6 seconds off Kilpatrick's 14 year old record. At last, a middle distance record holder who was not American or British.

In the 1912 Olympics in Stockholm the United States was triumphant again. This time it was Ted Meredith, and he achieved two world records in the one race. Again the runners went on to the half mile mark, but the resultant confusion was too much for the
judges, who made mistakes in the placings beyond third. But there was no doubt about Meredith, who clocked $1: 51.9$ and $1: 52.5$. Four years later, when the next Games would have been conducted except for the Great War, Meredith took his half mile record down to $1: 52.2$, equivalent to 800 m in $1: 51.5$. In the tradition of middle distance runners, Meredith was a man of some intelligence. In 1929 he wrote a book entitled Middle Distance and Relay Racing and there is at least one quote that is probably as applicable today as it was then. He wrote, " There is no particular secret about scientific athletic form or training methods. Science is only an advanced form of common sense and the athlete who would train scientifically must first of all train sensibly. The human body may be compared to any intricate piece of machinery in that it requires a certain amount of attention and care, and if it is subject to overwork and abuse it can hardly be expected to perform up to standard."

Except for the 3 years when Lunghi held the record, there had been an extraordinary period of a quarter of a century when the United States was dominant in $800 \mathrm{~m} /$ half mile racing. It began in 1891 with Dohm and went right through to the time the United States entered the war in 1917.

## The British Era

In the years between the wars the American hold on the record continued except for a few inteludes, but their dominance at the Olympics passed to the British. In the 20 years from 1919 to 1939 USA held the record on four occasions totalling 11 years, but the British won at the 1920, 1924, 1928 and 1932 Games. This was an amazing run of success, only rivalled by USA in the 400 m from 1956 to 1972, and the Finns in distance events up to the Second World War.

Meredith's record lasted 10 years, from 1916 to 1926, but of course the war and its aftermath reduced the opportunity for improving on it. From then on it became an international affair, with the record going first to USA three times, Britain twice, and Germany and France once each. As remarked above, this period from 1926 to 1938 had a rate of improvement which was twice the long term average, and it would be reasonable to attribute this to the growing international competition.

Albert Hill began the British stranglehold on the Olympic 800m in 1920. As long ago as 1910 he had reached the top in Britain, but as a distance runner, winning the AAA 4 mile championship. By 1914 he was the nation's best over the half mile. Then of course the war intervened, and what would probably have been his best years were spent on the French front. After the war Hill took up athletics again in earnest at the age of 29. Then, at 31, the fierce determination that saw him through the war and carried him into training again, triumphed, and he won not only the 800 m but also the 1500 m at Antwerp.

Next was Douglas Lowe. In the 1924 Games in Paris he was one of those illustrious band of Britons who brought glory to themselves and their country, and were celebrated in the film Chariots of Fire. Harold Abrahams won the 100m, Eric Liddell the 400 m and Lowe won the 800 m . The self-effacing Lowe was at Cambridge University, as was Abrahams, but he declined to be featured in the film. Lowe was in the mould of a long line of British middle distance runners, which ran right through at least until Bannister. They put their studies and their career before their running, but what running
they did do was very focused and successful. At Cambridge he studied Law and he went on to become a barrister.

Lowe was to run again at the next Olympics, but he did little racing in the intervening years, as he concentrated on his career. What racing he did was still good. He was obviously a very focused athlete. One race of particular importance was the half mile championship at the 1926 AAA championships. Against him was Otto Peltzer, the German champion, whose range was from 400 m to 1500 m , and included the 400 m Hurdles. He had been unable to compete at the 1924 Olympics because Germany was still excluded after World War I. So this race could be considered to address the question what might have been, had Peltzer been able to compete in Paris. It did more than that. Lowe ran boldly and intelligently, and he was quicker than he had ever been - an estimated 1:52.0 ( 800 m equivalent 1:51.4), and inside Meredith's 10 year old record. But he did not win. He had tried to run the sting out of Peltzer, but the German struck in the home straight, and won in 1:51.6, a new world record and an 800 m equivalent of 1:51.0. Lowe was an astute student of his event, and concluded that Peltzer's superiority was due to his greater speed, which in turn came about because he was a 400/800 runner. So he decided to shift his emphasis from half mile/mile to quarter mile/half mile ( $400 / 800 \mathrm{~m}$ ).

Lowe was a good learner. The result of his revised strategy was victory once again in the 800 m at the 1928 Olympics. This time he was not pressed as in Paris, and yet his time was 0.6 seconds faster. His German rival unfortunately ran with an injury and was eliminated in the semifinals. Lowe, ever the gentleman, wrote to Peltzer on behalf of British half milers, expressing sympathy for the injury that prevented him from showing his best form. In his retirement Lowe continued to contribute to athletics. He was a writer on athletics, and a book written by him, entitled Track and Field Athletics tells us something about the man. In general his advice to young athletes is sound, if cautious. The emphasis is on enjoyment, and learning good technique, rather than amazing performances, and perhaps more juniors would be making it through to senior ranks if that advice were heeded today.

After Peltzer there were a further two record holders prior to the 1932 Olympics. The first was Sera Martin of France, who set a new mark 1:50.6 for 800 m , equivalent to 1:51.2 for the half mile. The second was Ben Eastman of USA, in a run of 1:50.9 for the half mile, equivalent to $1: 50.3$ for 800 m . Then came the 1932 Olympics, and one of those rare occasions when the Games produces a world record. The victor was Thomas Hampson, the fourth Briton in succession to win the event and his time was $1: 49.8$, the first time anyone had gone under 1:50. Firmly in the tradition of British middle distance runners, Hampson was a slow developer, concentrating firstly on his studies at Oxford. He was 22 before he came to notice, and then only with runs around $1: 55$. He became a school teacher, and did not allow running to interfere with his responsibilities. But he was intelligent, and he used his intelligence to great effect in his races. In the Olympic final he ignored the suicidal first lap pace, knowing what pace he could sustain. At the end he had more running left in him than anyone else, and he managed to prevail.

Eastman, who had chosen to run the 400 m at Los Angeles, regained the record in 1934, in the first sub 1:50 half mile. He ran 1:49.8, equivalent to $1: 49.2$ for 800 m . This lasted until 1937, when fellow countryman Elroy Robinson took it down to 1:49.6 (1:49.0 for 800 m ). In the meantime another American, Johnny Woodruff, took the 1936

Olympic 800m with ease, breaking the British grip on the event. But the British were not to be dismissed that easily. Along came a most unlikely looking character, Sydney Wooderson. He was a tiny bespectacled London clerk, who already held the world record for the mile. In a specially designed attempt on the record in 1938 he had six runners with progressive handicap marks out in front of him. It worked; he passed the 800 m mark in 1:48.4 and the half mile in 1:49.2.

So at the end of this 20 year period in which the British triumphed in the important races while the Americans had a better grip on the world record, even the record was back with the British. The half mile record stood at three seconds faster than at the beginning of the period, but from that time on the 800 m record became more important than the half mile record.

## Rudolf Harbig

In the history of 800 m no one has had a more profound impact than the German Rudolf Harbig. There are two obvious indications of this in Figure 2. The first is the size of the improvement he achieved, a massive 1.8 seconds on a record which was only a year old and on which there had been a steady reduction over the previous 13 years. The second is the length of time for which the record lasted- 16 years, which was only partially explained by the years of the Second World War.

Harbig reached the international scene in 1936, when he contested the Olympic 800 m in his home country. However he was eliminated in his heat. By the following year he had climbed to ninth fastest in the world for the year, and in 1938 he was fifth fastest. His training had become quite intense and systematic by the standards prevailing. He was as amateur as the British, earning his living as a meter reader for a Dresden gas company. But his approach to running was much more single minded and thorough. He was a pioneer in the same way as George in the mile 50 years before. In many respects he was the first of the modern runners. Systematic interval training, still in use today, was developed by Harbig's coach, Woldemar Gerschler, and used by Harbig. He also did winter training, including long runs, speed sessions, and callisthenics. With all this work behind him he was ready for a good 1939.

As so often happens, Harbig was not alone, and may not have reached the heights he did without a most worthy opponent, the Italian Mario Lanzi. Lanzi had developed earlier than Harbig; in 1934 at the age of 20 he had run $1: 51.8$ for 800 m and he was second in the 1936 Olympics. He was still ahead of Harbig in 1937 and 1938, but the gap was closing. The two men could hardly have been more different. Harbig was puritanical in his approach to life and Lanzi was flamboyant; Harbig trained hard whereas Lanzi did two sessions a week during the competitive season and not much more beforehand. The German was well organised and cautious in racing, but the Italian was extravagant, courageous and injudicious. The combination was great for performances, and unfortunately for Lanzi they were Harbig's. But Lanzi did not consider it unfortunate. He had great respect for Harbig, as the German did for him. Harbig died on the Eastern Front in 1944, but Lanzi retained his memory, and visited Harbig's widow in 1952.

Two magnificent performances of Harbig in 1939 owe much to Lanzi. The first was an 800 m race in Milan in an Italy-Germany match on 15 July. Lanzi set out at a bold pace and passed the 400 m mark in 52.5 seconds. He kept going, defying his opponent to come and get him. But Harbig was a better judge of pace and just kept in touch, knowing that Lanzi could not maintain that pressure. At 700 m he was almost with Lanzi, and when he launched his attack shortly after, the Italian had nothing left. Harbig went on to win in 1:46.6, an astounding 1.8 seconds off Wooderson's year old record.

The next day they fought out the 400 m , with the same placings, but both credited with 46.7 seconds. Two weeks later the placings were the same in an 800 m in Berlin, $1: 48.7$ to $1: 49.2$. Then two weeks after that in Frankfurt there was another world record, this time at 400 m . Again Lanzi set off at a furious pace, and was leading at 300 m . But again Harbig knew what he was doing, kept rhythm and contact, and charged home. The time was 46.0 seconds.

It is interesting that 500 m tracks were still common in Europe up to the Second World War. Both the Milan track and the Frankfurt track were 500m.

On Harbig's tomb are inscribed the words Only the forgotten are dead. As long as athletics is a pursuit of man, Harbig will not be forgotten.

## The Long Reigns

The first significant thing about the post war years was the result of the 1948 and 1952 Olympics. In both, Mal Whitfield of the United States was the winner and Jamaican Arthur Wint was second. Whitfield's time in both races was 1:49.2. Wint could not quite maintain the same consistency; he improved from 1:49.5 at London to 1:49.4 at Helsinki.

At last in 1955, after 16 years, Harbig's record fell. Roger Moens of Belgium was the new record holder, but as usual he did not do it alone. For a while it looked as though Harbig's record would last forever. At the end of 1953 Whitfield was still in charge, and his best performance, 1:47.9, was still well off Harbig's mark. But things began to change in 1954 as Europe recovered from the war that ravaged it. The European championships of 1954 began to change the scenery. Moens was the favorite but he could only manage fifth, despite running to form with a $1: 47.8$, so now Whitfield was pushed down to seventh on the all time list. There were now five, possibly six, Europeans in sight of the record, and a new group of Americans coming along. Out of that swelling mass of talent surely would come a decent assault on that ancient record. Coming into 1955, as with the mile the year earlier, the race was on to be first through the old barrier.

The big opportunity came in August 1955, at the famous Bislett track in Oslo, the scene of so many records before and since. With Moens in the race was the local hero, Audun Boysen, who had finished third in the European Championship the previous year. There had been plenty of media coverage and the crowd was expectant, so the pressure was on. If they were good enough to be lifted by the pressure rather than suppressed by it, this surely was the moment. And yet it still hung in the balance for a second or so. Roger Moens described in his autobiography his thinking on hearing 52.0 called at the
bell. The time was just right, and this was a unique opportunity that he must not let go. Yet here was Boysen right on his shoulder ready to exploit any injudicious pace. The choice was stark: run safely for victory or risk defeat in the quest for a great performance. He remembered the proverb Fortune smiles on those who dare. Fortunately he dared and he did achieve that great performance. But once he committed himself to it he had to keep up the pressure, because there was Boysen, urged on by his home crowd, ready to seize on any weakness. Twice Boysen challenged him, once in the back straight and then in the home straight. Moens said, "My body was empty but the will to win was still alive." So he prevailed, in a new world record of 1:45.7. The gallant Boysen had the satisfaction of also being well under the old record, with a time of 1:45.9.

Moens' effort in slicing 0.9 seconds off the record appears quite remarkable on the surface. It is equivalent to 8 years of historic average improvement. It could be argued that the new record was long overdue, which accounts for the large improvement. It was merely catching up with a few of those years of stagnation. Against that it must be pointed out that Moens record stood for a further 7 years, so it must have been high quality.

In the seven years of Moen's record there were two Olympics. In the first, 1956, the USA retained its dominance, winning its fourth Olympic 800 in a row. In the second, 1960, an unknown burst through to prominence. He was Peter Snell of New Zealand, and he did not stay unknown for long. He came into the Games with a best of 1:49.2 (for half mile, equivalent to $1: 48.6$ for 800 m ), and went out with 1:46.3. In the next Olympic Games he won both the 800 m and the 1500 m , a feat reasonably common in the early days - Flack 1896, Lightbody 1904, Sheppard 1908, and Hill 1920 - but exceedingly difficult in later times when the competition was much fiercer. In between Snell's two Olympic victories he cemented his dominance with a new world record. In February 1962 in Christchurch New Zealand he ran 1:44.3 for 800 m , on his way to $1: 45.1$ for the half mile. Both were world records. The 800 m time was a massive improvement of 1.4 seconds on Moens' record. Not surprisingly this 800 m record was to last for 11 years, though Ralph Doubell in 1968 and Dave Wottle in 1972 equalled it. Also in 1966 Jim Ryun ran a half mile time which was equivalent to it.

Thus three athletes, Harbig, Moens and Snell, were responsible for a succession of records which took the standard up by a total of 4.1 seconds, more than a quarter of the total improvement in the recorded history of $800 \mathrm{~m} /$ half mile running. Moreover their total reign was a remarkable 34 years, nearly a quarter of recorded history of the event.

## Seb Coe

If Harbig warrants his name at the head of a section of this chapter on history then so does Coe. He came along at the end of the seventies, and at the end of a period of 6 years that saw rapid but small changes in the 800 m record. As in 1939, it might have been thought in 1979 that as much as possible had been wrung out of the record for the time being. Then along came Coe, and in two magnificent runs two years apart he raised the bar by the equivalent of 15 years of long term average steps.

It is conventional wisdom that if an athlete has not the speed to excel at a particular distance, she or he could step up to the next distance. This ignores the possibility that the athlete could get faster, which is what happened in Coe's case. In his mid teens he was predominantly a cross country runner, and his times over longer distances were of much better quality than those in shorter races. Peter Coe, his father and coach, recognised the deficiency and actively sought to remedy it. He was so successful that one year Seb was runner up in the AAA 400 m championship. This speed, combined with his wonderful endurance, made him a really great 800 m runner.

Coe's obvious march towards destiny began in 1977, when he ran $1: 44.95$ to be fourth in the world that year. In 1978 he improved to $1: 43.97$ to be the year's second fastest. He was now only half a second off the world record. Then in 1979, shortly after completing his studies for an economics degree, he demolished the record. His run of 1:42.33 took more than a second off the old record of Juatorena, and 1.64 seconds off his previous best. Two years later he improved his own record by a further 0.6 second with a time of $1: 41.73$. Thus in those two runs he had leapt way ahead of history and everyone else by an almost unbelievable margin of 1.71 seconds. It would be 16 years before that record would be bettered, interestingly and appropriately the same life span as Harbig's record.

It is surprising, considering his apparent superiority, that Coe only won one major 800 m title, and that was as late as 1986, when he won the European Championship. In 1978 he was third in the European Championships, but he was still on the way up then. !980 was the year, and the Olympics the opportunity, but he ran a tactically bad race and finished second to fellow countryman, Steve Ovett. Following his 1981 record he was beaten into second place in the 1982 European Championships, possibly due to the early stages of illness, then missed the 1982 Commonwealth Games and the 1983 World Championships. In a great race in the 1984 Olympics he was beaten by Joaquim Cruz of Brazil, and could then have been past his peak as an 800 m runner. Certainly he did not go under 1:43 again after 1981. It is a measure of his greatness however that in the 13 years from 1977 to 1989 inclusive, only in 1987 was he outside the top ten. In 1989 he could still run 1:43.38 for equal second fastest of the year. After he finished as an athlete Coe was elected to the House of Commons.

Coe's era saw another major development in the event, namely its globalisation. Until 1980 the 800 m had been mainly the domain of the Americans, British, and continental Europeans, with occasional incursions from individuals like Snell (New Zealand), Doubell (Australia) and Juantorena (Cuba). A few Kenyans had been on the threshold, but in the 1980s they came in great numbers and quality. Paul Ereng won the 1988 Olympic 800m, and William Tanui the 1992, with his team mate Nixon Kiprotich second. From the late1980s it was not uncommon to have four or five Kenyans in the top ten. And the best was still to come.

It was not just the Kenyans. They came from all over Africa. And it was not just Africa. South American nations were now in there too, of which Brazil was the most prominent. From there came Joaquim Cruz, who not only beat Coe to win the 1984 Olympic 800 m , and was runner up to Ereng in 1988, but also has some of the fastest times ever recorded. As well as his 1:41.77, only four hundredths behind Coe's record, he had four times between 1:42.34 and 1:42.54, and another two 1:43.00 or better. His
was truly a magnificent career. But he was not the only Brazilian. With him were Jose Luis Barbosa who had eight performances between 1:43 and 1:44, and Agberto Guimaraes who had four. Venesuela also had a performance in the same range. A Korean was second in the 1992 World Junior Championships, to show that Asia could do it too. The event had reached the stage where a world record holder or Olympic champion could come from almost anywhere on the globe. It is perhaps the most international of athletic events, or even of any sport.

A measure of the quality of Coe's record is the onslaught it had to withstand over 16 years. In the first 10 years alone there were 12 performances (none of them Coe's) under 1:43. Over recent years there was one athlete in particular who always looked very threatening. He was Wilson Kipketer, a Kenyan who settled in Denmark in the early 1990s in order to study engineering. He won the 1995 World Championship with ridiculous ease, and swept all before him on the Grand Prix circuit. He was poetry in motion. It appeared to be only a matter of time. Unfortunately he could not compete in the 1996 Olympics because he had not been resident in his adopted country for long enough. But he was back in force in 1997, winning the World Championship again. Then at last he reached Coe's mark- 1:41.73. That was not enough. A few weeks later he pushed Coe back into history with a run of $1: 41.11$. This was an improvement of 0.62 second, a significant improvement on a remarkable record by a great athlete in a wonderful event.

## CHAPTER TWO

## What is Middle Distance?


(photo from New York Road Runners - www.mensracing.com)

In the athletic program distances of running races range from 100 metres to the marathon ( 42195 metres), i.e. the longest distance is over 400 times the shortest distance. This is an extraordinary range. The range of the duration is even greater. For international class men the duration of the shorter race is 10 seconds, while that of the marathon is about 2 hours 10 minutes, or 7800 seconds, which is nearly 800 times the duration of the 100 metres. Contrast this with swimming, in which the longest race is only 30 times the shortest, and the ratio of their durations is about 40 . You probably could not tell the difference by sight between a 50 metre swimmer and a 1500 metre swimmer, and either would be proficient at the other distance. That could not be said
about runners at either end of the event spectrum. There is quite a difference between running for 10 seconds and running for 2 hours and it is not surprising that the two events attract entirely different types of runner. It is reasonable to ask where middle distance fits into this vast spectrum of events, and what the implications are for a middle distance runner. That is the question this chapter is addressing.

It is instructive to look at running speeds over the range of running events. Because of variation in marathon courses it is better to restrict the investigation to track events, 100 m to 10000 m , and the greater population and longer history of men's track races make these the more meaningful source of data. Table 2.1 below shows men's world records and the associated running speeds for distances from 100 m to 10000 m . The records were as at the end of the northern hemisphere 2000 track season. Given that both the incentive and the means to chase world records are great these days, it is reasonable to assume that all of these records represent the best of human endeavour on the track.

| distance (m) | runner | year | time | speed (m/s) |
| :--- | :--- | :--- | :--- | :--- |
| 100 | Greene | 1999 | 9.79 | 10.21 |
| 200 | Johnson | 1996 | 19.32 | 10.35 |
| 400 | Johnson | 1999 | 43.18 | 9.26 |
| 800 | Kipketer | 1997 | $1: 41.11$ | 7.91 |
| 1000 | Ngeny | 1999 | $2: 11.96$ | 7.58 |
| 1500 | El Guerrouj | 1998 | $3: 26.00$ | 7.28 |
| mile | El Guerrouj | 1999 | $3: 43.13$ | 7.21 |
| 2000 | El Guerrouj | 1999 | $4: 44.79$ | 7.02 |
| 3000 | Komen | 1996 | $7: 20.67$ | 6.81 |
| 5000 | Gebrselassie | 1998 | $12: 39.36$ | 6.58 |
| 10000 | Gebrselassie | 1998 | $26: 22.75$ | 6.32 |

Table 2.1 Men's world record running speeds against distance as at December 2000.


Figure 2.1 Graph of speed of men's world records against distance
Figure 2.1 is a plot of speed against distance for world records current at the end of the year 2000. The plot is formed by joining all of the points (one for each world record) by straight lines. As can be seen it could readily be made into a smooth curve, with no discontinuities and with every record fitting reasonably on it. A mathematician might find that statement a bit loose, and hint that it could depend on the thickness of your pencil. However we can satisfy him by being more precise, and finding a mathematical equation, and a corresponding curve, on which the above points lie. This equation is quite complex, and is of no real concern to us, except that its existence provides assurance that our analysis is solidly based. For those who are mathematically inclined, the equation is given below, and the graph of the equation is shown in Figure 2.2.

$$
\mathbf{v}=10.38 /[1+\exp (-0.391-669 / \mathbf{d})]
$$

where:
$\mathbf{v}$ is the average speed for the event in metres per second $\mathbf{d}$ is the distance of the event.

There are three interesting things about this equation. The first is that for small d, i.e. short distances, the part $\exp (-0.391-669 / \mathbf{d})$ all but vanishes, and $\mathbf{d}$ has very little influence on the calculated speed $\mathbf{v}$. The equation reduces to $\mathbf{v}=10.38$. This tells us that for sprints ( 100 m and 200 m ) the calculated speed is about the same, and is close to 10.38 metres per second. The second is that for large $\mathbf{d}$, ie large distances, the part 669/d all but vanishes, and again $\mathbf{d}$ has very little influence on the calculated speed. The equation reduces to $\mathbf{v}=10.38 / 1.676$, in other words $\mathbf{v}=6.19$. This tells us that for long distance the calculated speed is relatively distance independent, and trends towards a limit of 6.19
metres per second. The third is that for distances in between small and large, and we will be more specific soon, the speed is very much distance dependent. It is not by chance that the number 669 , which is in the equation, is approaching 800 , the accepted beginning of middle distance running.


Figure 2.2 Graph of equation of world record speeds against distance
The speeds 10.38 metres per second and 6.19 metres per second derived above can be regarded as something of an ideal or limit - speeds that records tend towards as distances decrease and increase. Figure 2.2 shows the graph trending towards these speeds at the upper and lower end of distance. An inspection of Table 1 shows that they are reasonable approximations of the record speeds for 100 m and 10000 m . Precise application of the equation above, i.e. substituting100 and 10000 for d, yields closer agreement with actual times. In fact the times calculated by means of the equation above, or mathematical model as we will refer to it from now on, are mostly within about $1 \%$ of actual times for all distances. While this accuracy is 0.1 seconds for 100 m and 16 seconds for 10000 m , and this is not sufficiently accurate for predicting records, it does give a profile of maximum human endeavour over the range of track racing distances.

It is certainly apparent that the graph of the mathematical model, as shown in Figure 2.2, tends towards flatness as the distance increases into the thousands, indicating speed becoming less distance dependent. What is not so obvious, because the scale is so cramped at the short end, is that there is also a trend towards flatness as the distance becomes very short. We obtain a better look at the above graph if we use a logarithm scale for the distance axis. This is not meant to introduce complexity into the story, or to frighten away all those who hated logs at school. It is merely to give us a better appreciation of the effect distance has on speed over the various racing distances. In the graph above, in which the distance axis goes from zero to 10000 , it is not possible to distinguish clearly between 100,200 and 400 . Yet these are separate events, to a large
extent having their own specialists, so it is highly desirable to distinguish between them. We can do this by using a log scale for distance, because it lengthens the short end (100 to 1000 ) and foreshortens the long end ( 5000 to 10000 ). It does no more than that. It gives the sprints the same space on the graph as the distance events, which is how we think about them. The graph is shown below as Figure 2.3.


Figure 2.3 Graph of model of world record speeds against distance (dist. on log scale)

Interestingly the shape of the graph might be something like what a scientist would expect for the population of a species taking over an environment of limited resources. Initially the environment can support a large population, but soon the resources begin to be depleted, and the size of the population that the resources can sustain rapidly diminishes. Eventually the population falls to a level that is in balance with the ability of some resources to regenerate, and a new equilibrium is established. As we will see as we go on, this is not unlike what happens to runners, only instead of population we have speed, and instead of time we have distance. A runner has resources available to him, indeed he needs them to be able to run, but those resources too can be depleted, and he has to find a balance between the speed he wants to run and the resources available to him.

Appendix 1 contains two graphs. The first shows the actual world record plot and the model world record plot both on the same graph, with the distance axis on a linear scale. The second shows the two plots on a graph with the distance axis on a log scale. It can be seen that the model fits the actual data well.

## Limitations of the mathematical model

The model has been developed using data from 100 m to 10000 m , and it provides good fit for record performances in that range. Outside that range however the fit is not as good. There is no recognised record for 60 m , but we know from performances over that distance that if there were, the average speed would be considerably less than 10.38 metres per second- the upper speed limit of the mathematical model. It differs so much from the speed of the 100 and 200 m because the job of getting the body moving from stationary is a much greater portion of the event than it is in longer distances. At the other end of the scale, the model is not a good predictor of marathon times. The long distance limit of 6.19 metres per second, to which records trend, would indicate a world best of less than 1 hour 54 minutes for the marathon. This is some 11 minutes faster than the world best, and it is difficult to argue that marathon runners to date are that far off the pace or that marathon courses are that much slower than tracks. Marathons do not fit the speed pattern of track races, and it seems that different forces could be at play in the longer event.

## Anomalies in the model

Michael Johnson's 200m record does not fit as well on the model as other records. The speed for 200 m calculated from the model is $2 \%$ slower than Johnson's record. This could indicate that the 200 m record is ahead of its time, and the other records will eventually catch up. Or it could suggest that additional forces were at work during that run, which are not normally available. For instance it could be wind, which is only measured in one direction. For a number of years previously the average speeds for the 100 m and 200 m records were very close to each other, but following Johnson's 200 m record they were $1.9 \%$ apart and even after Green's 100 m record in 1999 they were still $1.4 \%$ apart. Certainly a model derived from all records other than 200 m provides a better fit to actual performances.

The women's world records yield a similar model. It is:

$$
\mathbf{v}=9.62 /[1+\exp (-0.291-622 / \mathbf{d})]
$$

There is one record in particular that does not fit. It is the 3000 m record set by Wang Junxia in 1993. It is $3.1 \%$ faster than the speed given by the model, which we need to remember is the best fit to all records. In fact the speed is faster than the average speed for the 2000 m record. Again it would seem that this 3000 m record is way ahead of its time and other records, or other forces were at play.

## Uses of the model

The reader might be wondering where this is leading, because the book is about middle distance. The above is relevant to the question, and the question will be addressed soon. Beforehand however it is worthwhile to consider what other uses might be made of the model. Similar models can be developed for records at any level of competition. They of course will fall below the model of men's world record performances. But whether or not they have the same profile is a matter of some importance. Given the opportunities and incentives to pursue world records these days, it
is reasonable to assume that there are no soft records anymore, and the profile of men's world record speeds represents the best of human running performance. If all profiles are normalised by making their top speed equal to 1, i.e. they all begin at $\mathbf{v}=1$ for $\mathbf{d}=100$, then they can be directly compared. We are not concerned about the absolute values of the speeds, only about their values relative to top speed at the particular level of competition. If a normalised profile is the same as the normalised profile for men's world records, we can conclude that although the standards of performance are lower than world records, all events are equally developed. However if the profile is lower at the long end than the men's world record profile, we can conclude that distance is not as well developed as sprinting, and if it is higher at the long end we know that sprinting is not as well developed as distance. We can compare one nation with the world standard, one nation with another, junior with senior, women against men, and so on. Below in Figure 4 the profile of women's world records is compared to that of men.


Figure 2.4 A comparison of women's and men's world standards
The above shows that the longer the distance the less developed is women's running. Whether there are physiological reasons for this, or whether it reflects the fact that distance, and even middle distance, are comparatively recent events for women, is not an issue for this book. If it is the latter we can expect considerable improvement in longer events for women in the future.

Another use for the model is to determine an appropriate time for an unusual distance, based on the model for the standard being sought. For instance both 400 m runners and 800 m runners sometimes run time trials over 600 metres. For the former it could be to measure endurance and for the latter, speed. We would want to know what would be a reasonable time for 600 m , a time as good as best performances over normal race distances. We can use the model for the standard being considered to determine this, simply by reading off the speed for 600 m on the graph (Figure 1), or by substituting 600 for $\mathbf{d}$ in the equation for the model. It can be seen that the equivalent 600 m world record speed is 8.47 metres per second, which translates to a time of 1 minute 10.8 seconds. Models for other sets of records of course would yield a slower time. An 800 m runner who is closer to standard at 1000 m than at 600 m would probably want to give more attention to his speed.

It might be useful for an 800 m or 1500 m runner to compare his best performances with the profile of world records. He could have recorded performances from 100 m to 5000 m . If each of these is multiplied by the ratio of the world record 800 m (or 1500 m ) speed to his own 800 m (or 1500 m ) speed, and then plotted on the world record profile graph, then we would obtain some measure of his capabilities away from his specialist distance. His 800 m (or 1500 m ) speed, as adjusted by the above multiplication, would lie on the world record curve, but his adjusted performances either side would lie below the curve. The extent to which they fall below on either side will reveal his strengths and weaknesses. A possible example is given below in Figure 2.5. It is apparent that this runner's strength is his endurance and his weakness is his speed. Whether anything ought to be done about his weakness is another matter, but at least the decision can be made on the basis of sound knowledge. Such an analysis could reveal that the runner could be specialising in the wrong event, or at least the wrong event from a performance point of view.


Figure 2.5 Comparison of an athlete's range of performances with world record performances

## What is Middle Distance?

An inspection of the shape of the curve in Figure 2.3 reveals three distinct sections. The first is the part taking in the traditional sprints. It is fairly flat, indicating that speed is not really dependent on distance in this range. The third contains the traditional distance events, and for these too the curve is reasonably flat. But in the middle, the second section, there is a steep slope, as the speed rapidly falls off with distance. It is this middle section that we call middle distance, and it sits distinctly between two event groups that do not share its characterising feature, namely this savage effect of distance on speed. This is further illustrated by the effect on speed of distance doubling. Table 2.2 below shows the drop off in speed as we double the distance.

| Shorter dist. | Longer dist. | Speed ratio | Loss of speed(\%) |
| :--- | :--- | :--- | :--- |
| 100 | 200 | 1.019 | -1.9 |
| 200 | 400 | 0.893 | 10.7 |
| 400 | 800 | 0.856 | 14.6 |
| 800 | 1609.3 | 0.906 | 9.4 |
| 1000 | 2000 | 0.918 | 8.2 |
| 1500 | 3000 | 0.942 | 5.8 |
| 5000 | 10000 | 0.957 | 4.3 |

Table 2.2 Comparison of speeds for distance doubling

The immediately obvious aspects of the above table are at both the top and the bottom, and are what we saw in the graph in Figures 2.1, 2.2 and 2.3. There is no loss of speed from the 100 m to the 200 m , and less than $5 \%$ from 5000 m to 10000 m . From the pure sprints to the 400 m event there is a loss of speed of about $10 \%$, which indicates that the 400 m is a very different event. However 400 m speed is still much closer to sprinting speed than it is to 800 m speed, as can be seen from the $15 \%$ slow-down from 400 m to 800 m . So we are entitled to regard 400 m as a sprint, albeit a long one, and not pure at that.

The most significant change is from 400 m to 800 m - a $15 \%$ reduction in speed. This is by far the greatest reduction for any distance doubling. Furthermore the 800 m is about $24 \%$ slower than the 200 m . The 800 m therefore is clearly separated from the sprints, even from the 400 m . It is a very different event, with different forces coming into play.

We see that from 800 m to 2000 m , distance doubling leads to a loss of speed of 8$9 \%$. Beyond that the effect of distance starts to decline, and doubling from 1500 m to 3000 m results in a speed reduction of less than $6 \%$. By use of the model equation we see that if there were a 6000 m event, it would be a little more than $4 \%$ slower than the 3000 m . So from 3000 m onwards the events are distinctly different from the 800 m 2000 m range, in that their speed is not nearly so distance dependent.

The events in the range 800 m to 2000 m can be seen to be very different events from those on either side. Their speeds makes them well separated from the sprints, even the 400 m , and the fact that their speeds are so distance dependent distinguishes them from the longer events. We call them middle distance, and they are aptly named because they sit in the middle of the sprints and distance events. However their distinguishing feature, and what makes them really interesting, is not where they sit, but this ferocious effect distance has on speed. It is just so easy to get the pacing wrong in these races, and a fascinating challenge to get it right.

It is instructive to take a good look at the speed in the three event groups. Suppose we take the 1000 m to be representative of middle distance. It is a reasonable representation because its speed is about the average of the two common middle distances, the 800 m and the 1500 m . The 1000 m is ten times the distance of the 100 m , which can represent the sprints, and one tenth of the distance of the $10,000 \mathrm{~m}$, which can represent distance. The speed of the 1000 m is $25.5 \%$ slower than that of the sprint, but only $13.8 \%$ faster than that of the distance run. What does this tell us? It certainly tells us that in terms of speed, middle distance is much closer to distance running than to sprinting. It might also tell us that the practice of trying to make excellent middle distance runners out of good sprinters is unlikely to be successful. On the other hand it would appear to be more feasible to make a middle distance runner out of a distance runner by working on speed. Seb Coe is a very good example of this. In his mid teens he was a competent cross country runner but did not have much speed. His coach-father recognised this weakness and worked on it. His success is illustrated by Seb's second placing in the British 400m Championship in 1979. Of course if he had not been able to run this fast he would not have been comfortable with a sub 50 first lap. But the important thing here is that a promising distance runner was turned into a brilliant middle distance exponent.

It is interesting to notice the difference between running and swimming at the distances that are middle distance in running. The mile and 1500 m events in running are about $9 \%$ slower than the 800 m event. Yet in swimming an 800 m record has been set on the way to a 1500 m record. This is completely unknown in running. We have to go from 100 m to 400 m in swimming to experience a loss in speed that distance doubling causes in running. This suggests that in running terms, 100 m in swimming is a long sprint and the end of sprinting, and 200 m and 400 m are middle distance. 800 m and 1500 m are distance events.

This loss of speed with increased distance in middle distance running events tells us something about the nature of the events, which will become clear in a later chapter. The fact that a longer middle distance event is appreciably slower than a shorter one means that any attempt to maintain the pace beyond the finish of the shorter event is doomed to failure. Something is happening that causes loss of speed. It also suggests that correct pace distribution is all-important. (The same is true of the 400 m ; it could be categorised as middle distance but its speed separates it.) These are characterising features of middle distance racing, and the reasons behind them will become apparent in later chapters.

## CHAPTER THREE

## The Energy Systems

We saw in the previous chapter that what really characterises middle distance running is the dramatic way speed diminishes with the distance of the event. The reason for this is something that anyone who has tried running middle distance knows very well, namely the debilitating effect of lactic acid. When a runner has optimised his pace for best performance over say 800 m , he will find it impossible to maintain that pace for further than 800 m , and in fact any attempt to do so will result in a less than optimum performance over a longer distance. We get clogged up with something that we know to be lactic acid, and no amount of effort or courage will prevent us from slowing down dramatically. In fact this clogging up is well on the way before the 800 m has finished, and is an integral part of any middle distance event. But it is not all evil; it does go with being able to run at a certain speed, and without it the runner's speed would be less. That which produces the lactic acid also provides energy, and energy is what this chapter is about.

## Energy and Power

It is necessary at this stage to discuss a little physics, but it will be a simple approach that need not deter anyone. We need to understand the difference between energy and power, and in broad terms what they both mean. We need to do this so that energy systems make sense. If they do not make sense, how can we apply them properly?

When an athlete runs for a distance, any distance, he does work. In this respect he is no different from a motor vehicle - the vehicle does work in travelling a distance. In order to do that work he needs energy. Energy is the capacity to do work. In the case of the vehicle the energy is the chemical energy in the fuel. It is the same with the runner. The energy is chemical energy in his body. As with the vehicle, the chemical energy is converted into kinetic (movement) energy, which enables the runner to do work. For the vehicle the conversion is by means of combustion (hence the combustion engine). For the runner it is by means of one, two, or all of the three energy systems that his body possesses.

The runner can do a large amount of work, as in $10,000 \mathrm{~m}$, or a small amount, as in 100 m . He can do it fast, as in 100 m , or more slowly, as in 10000 m . This brings us to the concept of power, which is the rate of doing work. When an athlete races 100 m he does not use much energy, but his rate of doing work is high, so his power is great. On the other hand when an athlete races 10000 m he uses a considerable amount of energy, much more than the 100 m runner, but his power is much less than that of the sprinter. We can think of these quantities, in terms of a water reservoir with an outlet. The water in the reservoir is analogous to energy and the rate of flow through the outlet is analogous to power. The diagram in Figure 3.1 illustrates this analogy.


Figure 3.1. Water reservoirs illustrating concepts of energy and power

The reservoir on the left has only a small amount of water, but has a large outlet. So it represents a runner with not great energy stores, but the ability to expend the energy quickly, i.e. with great power. However the energy is soon depleted, and needs to be replaced before such an effort can be repeated. The reservoir on the right has plenty of water, but only a small outlet. It represents a runner with great energy stores, but only able to expend the energy at a moderate rate, i.e. with less power than the first runner. The energy will take some time to be depleted, meaning that the running can be continued for some time, but it too will then have to be replaced before the effort can be repeated.

## Strength and Endurance

It is desirable at this stage to get our terminology right about another matter. There is sometimes a tendency in athletic circles to use the word strength when we really mean endurance. It is important to use the terms correctly, which is the way they are used in science. Then all in the athletic community will mean the same thing when they use these terms, it will be what scientists mean, and athletics will be more open to scientific influence because there will be less confusion.

Endurance is the capacity to continue an activity without undue diminution in intensity. This is not strength, though that term is often used for the idea. Obviously endurance is related to energy, or rather the ability to convert it to work. A high level of endurance indicates a large amount of available energy.

Strength is the ability to apply or withstand a force. In running we are concerned with the ability to apply a force on the track, because this is what provides the forward propulsion of the runner's body. Strength is not about the ability to apply the force repeatedly for a length of time. That is endurance. The same strength is required to apply a particular quantity of force once or a thousand times.

Strength is related to power, though the two are not the same because power also depends on something else. Leaving aside refinements which are necessary to the scientist but not for our present discussion, work is the product of force and distance. We saw above that power is the rate of doing work, so it is the amount of work divided by the time taken. Consequently power is force times distance divided by time, and that comes down to force times speed. So power is more than strength; it is fast strength. A rugby forward must be strong, but he does not care how long it takes him to push the opposing scrum back, as long as he does it. That is not power. A 100 m runner on the other hand must apply force on the track in the shortest possible time in order to propel his body weight down the track as fast as possible. Looking at it another way the force must be
large in order to hurl the runner forward with a good stride length, and it must be applied quickly in order to give him a good stride rate. (Speed = stride length x stride rate) That is power. So too is the thrust of the shot putter as he pushes the shot out with the highest possible speed.

## The Cause of Running Motion

Paradoxically, although running is essentially a linear (in a straight line) motion, it is caused by rotational motions - the rotation of limbs about joints. The foot rotates about the toe joint and also about the ankle, the lower leg rotates about the knee, the thigh rotates about the hip, all in the act of propelling the body forward. It is instructive to go through each rotation in sequence in the running action, so that the action is properly understood and alterations to an individual's action, or remedial measures for it, can be made from a position of sound knowledge. However that is not the purpose of this book, so the exercise will be left to the interested reader. These rotations are brought about by systems of levers at each joint, but again it is not the purpose of this book to examine them. It is a useful study for someone really interested in the mechanics of running, but is not a prerequisite to understanding middle distance running.

It is muscular contraction that causes these rotations. For instance it is contraction of the hamstring muscles that causes the lower leg to fold back about the knee towards the upper leg. There are three types of muscular contraction. Concentric contraction is as described in the previous sentence, and occurs when contraction causes a decrease in the length of the muscle. Eccentric contraction occurs when the muscle contracts to retard or control an increase in the length of the muscle. The quadriceps muscles contract eccentrically when the runner's foot hits the ground, in order to control the knee sag that tends to occur under the action of gravity. Isometric contraction, whose name derives from two Greek words meaning same measure, is a contraction that prevents the muscle from lengthening or shortening, i.e. it prevents movement. Such contractions are necessary in the muscle groups in the pelvic region in order to obtain pelvic stability. This stability is necessary so that forces are transmitted onto the track, and are not wasted in moving the hips about.

Muscular contraction is caused by a substance in the muscle known as adenosine triphosphate, which is usually abbreviated to and known as ATP. This substance, a chemical compound, causes adjacent parallel filaments in the muscle to slide back on each other, in much the same way that an extension ladder behaves as it is wound down. It is this, happening right through the muscle, that is muscular contraction. If there is no ATP there is no contraction, and hence no movement. ATP gives energy to the muscle to enable it to contract, and this energy is present in the chemical bonding of ATP. Consequently, having delivered this energy, ATP loses its bonding and breaks down into component parts. It is no longer available to cause contractions, unless it can be reconstituted. The component parts are adenosine diphosphate, known as ADP, and the phosphate radical, which for the purpose of this discussion will be known as $\mathbf{P}$.

In a muscle at rest ATP will have been reconstituted by means of a process we will learn more about as we go on. The ATP will be ready for activity. However there is very little of it -only enough for about one second of contractions. So activity will very soon cease unless it can continue to be reconstituted.

Even though the ATP necessary for running is not present in sufficient quantity in the muscle, it can quickly be manufactured. This is brought about by the combination of the ADP and P that are in the muscle as the result of the previous breakdown of ATP. As the $d i$ in ADP implies, ADP contains two phosphate radicals, and this substance combines with the free phosphate to form the compound ATP, which as the tri suggests, contains three phosphate radicals. But we need not worry about the chemistry, except to be assured that it is sound, and hence our reasoning is solidly based. All we need be concerned with is that ATP can be manufactured in the muscle.

## Energy Systems

It is time to see where we are in this discussion. When an athlete runs he does work, and he uses kinetic (movement) energy to do that work. That energy is in the form of movement of his limbs, which in turn comes from muscular contractions. So the muscles expend energy in order to propel the runner forward. But where do the muscles obtain the energy? Leaving aside nuclear reactions, energy can neither be created nor destroyed. Energy must be given to the muscle in order that the muscle can expend it. We saw above that it is ATP that causes muscles to contract, and that ATP is available when ADP and P combine together to form it. So the question comes down to what causes $A D P$ and $P$ to combine? The answer is that an injection of energy does. Just as ATP gives up its bonding energy to the muscle when it breaks down, so energy must be given to ADP and P in order for them to bond. The energy must of course already reside within the runner, and it is there in the form of chemical energy. In much the same way chemical energy is stored in the motor vehicle, in the fuel in the tank, waiting to be demanded. In the vehicle it is combustion of the fuel that causes the transformation of chemical energy to kinetic energy. The runner's energy stores are his fuel, and, even though there are no flames inside him, it is consumption of this fuel that releases the energy causing ADP and P to combine. This happens when the brain sends signals to the muscles, telling them they have to run, and how fast.

The diagram below illustrates the cycle of ADP and P combining to form ATP, and then ATP breaking down again to leave ADP and P.


Figure 3.2 Formation and breakdown of ATP

There are three ways ADP and P can be caused to combine in the muscle. In other words there are three systems of stored energy utilisation (or fuel consumption, to continue the vehicle analogy) for bringing about the combination of ADP and P. We call these systems the energy systems, and, as we shall see, they correspond with the three running event groups - sprints, middle distance, and distance. This is not to say that each
event group uses one and only one system, but for each of them one particular system predominates.

We saw above that energy can be required at a high rate (for sprints) or at a lower rate (for distance), or for rates in between. We also saw that the amount of energy used varies from a relatively small amount in sprints to a large amount in distance running. As we shall see as we go on, the three energy systems deliver different amounts of energy, and at different rates, i.e. they have different capacities and different power levels. So it is not surprising that different systems predominate across the event groups.

The three energy systems, in ascending order of power and descending order of capacity, are the aerobic, the anaerobic lactic (or just lactic), and the anaerobic alactic. What these are, and why the above order of power and capacity prevails, will be discussed in this chapter.

## Fuel

Motor vehicles carry around petrol in their tank. Trains have diesel fuel or coal. Other vehicles might have oil. All of these fuels are compounds of carbon and hydrogen. They might also have other elements, but they always have those two. Hence they are known as hydrocarbons. It is compounds of these two elements that are perhaps the main source of energy on this earth, and certainly the most plentiful. The energy originally came from the sun, and it enabled plants to grow. In doing so this heat energy was transformed into chemical energy, which was stored in the plants in compounds of carbon and hydrogen. Millions of years of being buried changed the plants to coal or oil or gas, but the energy remained locked in the hydrocarbons, waiting to be released by combustion.

It is the same with us, although the process is fortunately more immediate. We eat plants, raw, cooked or processed, which have locked in them energy from the sun. In the case of edible plants and their processed derivatives, the compounds of carbon and hydrogen that they contain are known as carbohydrates. These carbohydrates are stored in the muscles as a substance known as glycogen, and this is the fuel for running. There are other possible fuels - fat and protein. The first is utilised when there is no more glycogen, which happens after about an hour of continuous solid running, or in low-level exercise like walking. Protein is utilised when neither glycogen nor fat is available, and its use can be dangerous. So for the purposes of this book the fuel is glycogen.

We will discuss diet in Chapter 8, but for completeness of the present discussion it needs to be emphasised that what does not go in cannot come out. Energy cannot be created out of nothing. Energy in running comes from glycogen and glycogen comes from eating carbohydrates. There has to be enough carbohydrate input to enable the training and racing to be done. If there is not, performances will be sub-optimal, and particularly racing performances, since they come at the end. For completeness also it needs to be stated at this stage that even though energy comes from plant matter, other foods are valuable and even essential.

## The Aerobic Energy System

This system, as its name suggests, relies on air, or more precisely, the oxygen in the air. The glycogen in the muscle combines with oxygen, in much the same way as a
hydrocarbon fuel burns in the presence of oxygen. They combine to form carbon dioxide and water, and in the process yield the energy that had been locked in the plant material. This energy bonds ADP and P together to form ATP in the muscle. ATP meets the demand for motion by causing muscular contraction. It does so by releasing its bonding energy as kinetic energy, which causes the muscle fibres to ratchet upon each other. This is muscular contraction. The substances from the combination of glycogen and oxygencarbon dioxide and water- are harmless expired gas and perspiration. The diagram below illustrates the reactions.


Figure 3.3 Reactions of the Aerobic Energy System
The oxygen is transported to the muscle from the lungs by blood. The fact that oxygen is not immediately available in the muscle but must come there via air/blood transfer, blood flow and blood/muscle transfer, makes this system the slowest manufacturer of ATP of the three energy systems. It is therefore the least powerful. But it has a very large capacity, by far the largest of the three systems. There is no limit to the amount of oxygen available, and the system is limited only by the amount of fuel available. There is enough glycogen for about one hour of running. As mentioned above, other fuels are available after that, but one is weaker and the other is dangerous, so we will not concern ourselves with them. In any case they are not relevant to middle distance running.

Since the lungs and heart can supply oxygen to the muscles at a steady maximum rate, the aerobic system allows for steady state running. It can enable the athlete to run at a constant reasonable pace for a long time. So it is utilised by distance runners, and is by far their predominant energy system. Its power at the elite level is indicated by the average speed in the world 10000 m record -6.32 metres per second. It is the most efficient of the energy systems. Obviously the greater the capacity to take in and consume oxygen the faster will be the steady state speed.

Every runner has an aerobic system, but as performances indicate, the aerobic systems are not all equally good. The worth of the system is measured in terms of its energy and power. The energy is determined by the amount of glycogen stored in the muscles. The greater the amount of stored glycogen the further the athlete can run at a reasonable steady pace. (The utilisation of fat is also an issue, but only for marathon runners, so we will ignore it here.) However having a large store of glycogen will not enable the athlete to run faster. This is a matter of power, and power is determined by the
rate at which glycogen is consumed. This in turn depends on the rate at which oxygenated blood can be pumped into the muscles.

That brings us to a sad observation- it is possible to increase the above rate by a practice that can only be described as cheating. The concentration of red blood cells can be increased by pharmaceutical means, and this enables the blood to carry oxygen at a greater rate to the muscles. However this improvement has nothing to do with the athlete and he has no right to benefit from it.

If a runner wants to run faster than the supply of oxygenated blood to his muscles will allow, he calls into action his next energy system.

## The Anaerobic Lactic System

As the name suggests, this system operates without oxygen. Glycogen is consumed anaerobically, i.e. without oxygen, to release energy. However the resulting chemical compounds are not the harmless carbon dioxide and water that can be breathed and perspired out, as in the aerobic process. Rather there is formed in the muscle an acid, known as lactic acid, and every runner knows its unpleasant effects. The diagram below illustrates the chemical reactions of the system.


Figure 3.4 Reactions of the Anaerobic Lactic System
The name "anaerobic lactic system" is quite a mouthful and is not necessary in order to distinguish it from the other energy systems. From now on we will usually refer to the system as the lactic system.

Here we have a system that does not rely on resources outside the muscle for its operation, so it can generate ATP faster than the aerobic system. However in the effort it produces an acid in the muscle that inhibits the muscle's operation. These are the good and the bad aspects of the lactic system, and they are expressible in terms of energy and power. Since it generates ATP faster, it is more powerful than the aerobic system, enabling the athlete to run faster. Therefore it is called upon when the athlete wants to run faster than his supply of oxygen to the muscles will allow. However the muscle soon becomes clogged up with debilitating lactic acid, which limits the capacity of the lactic system, i.e. the amount of energy it can deliver. Its capacity is well below that of the aerobic system. The acid is eventually flushed out of the muscle, but this happens in a considerably longer time frame than that of middle distance running. The rate of buildup of lactic acid in the muscle depends on running speed, but an effort that predominantly
uses this system will only last 1 to 2 minutes, after which the accumulation of acid in the muscle is so high that worthwhile functioning of the muscle is impossible.

It takes about 30 minutes to one hour for the lactic acid to be removed from the muscles. This is really a process of taking the acid to places where its hydrogen ions can combine with oxygen to form harmless water. We talk about oxygen debt after a hard effort, and this is an apt description of the situation. A lactic effort, being anaerobic, produces energy without oxygen. But this is really only a borrowing, and it leaves a debt that must be repaid with oxygen. So the energy production has not really been without oxygen; the supply of oxygen has just been delayed. The gulping for air, the panting, the hard breathing for some minutes, as the runner struggles to repay the debt, are a measure of the energy that has been expended.

The important thing about the lactic system, and the aspect which characterises it, is that its power output is not constant, but diminishes with time. In this it differs significantly from the aerobic system, which is steady state. The reason for this is the accumulation of lactic acid in the muscles. At first the system can be at full power output from the anaerobic breakdown of glycogen, but immediately lactic acid begins to be formed in the muscle. The acid cannot be disposed of in the time frame of the vigorous operation of this system ( 1 to 2 minutes), and its level builds up. It seriously inhibits the operation of the muscle, so there is an inexorable decline in the power output, as exhibited by the runner's deceleration. There are two reasons for this deterioration of muscular performance. The first is the effect on the muscles themselves, and every runner knows the feeling of those rubbery legs! The second is that the acid inhibits the action of the enzymes that enable the anaerobic breakdown of glycogen. So the lactic system is in a sense self defeating; it works against itself and eventually turns itself off. The process of course is progressive; as the acid accumulates the production of ATP by the system falls off. When the amount of acid in the muscle reaches a certain level the speed is down to what can be sustained with the aerobic system and the lactic system turns off. The power is down to the level of the aerobic system after 1 to 2 minutes, and continues to fall until the acidity of the muscle is substantially reduced. Indeed it is only the aerobic system that enables activity to continue.

It is important to realise that as long as the runner's speed is above his maximum steady state speed, i.e. what he can sustain by means of his aerobic system, he will generate lactic acid. The acid will continue to accumulate, unless it can be disposed of. As we saw above, the disposal is a matter of some minutes - up to an hour for a heavy accumulation. The greater the margin above his maximum steady speed the greater the rate of production of lactic acid, and the sooner his speed will fall down into the aerobic range. It follows that the greater the speed the greater the deceleration and the shorter the time for which the lactic system operates. Despite the short duration the accumulation of lactic acid is enormous, and it will take up to an hour to dispose of it. There will be virtually no disposal during the operation of the system. However if the speed is just above steady speed the rate of production of acid is low, and there is some chance for disposal to militate against accumulation. Deceleration will be much less and operation of the lactic system will last longer. But in this case the predominant system is the aerobic.

The deceleration aspect of the lactic system has two implications. The first is that a run that is heavily lactic will be a deceleration run - the pace will decrease as the run
progresses. The second is that if a runner wants to run further, he must reduce his pace. Otherwise he will accumulate lactic acid to the point of slow running and switch-off of his lactic system well before the finish, and his performance will be sub-optimal. It is logical that if the lactic system is more powerful than the aerobic, the athlete would want it to last as much of the run as possible. The way he accomplishes this is to reduce his pace so that it will. This is why, as we saw in Chapter 2, the speed of middle distance world records is so distance dependent. Middle distance events make great use of the lactic system, and in fact it is the key system for middle distance runners.

Although the aerobic system can operate alone, the same is not true of the lactic system in middle distance running. It is true that for a short while the lactic system could work alone, but it would be only for a matter of seconds, and in any case would be something the runner would find unhelpful. The lactic system provides the energy over and above that provided by the aerobic system, so that a greater speed is possible than the aerobic system alone would allow.

If an athlete wants to run faster than the lactic system and aerobic system will allow, he calls on a still more powerful system.

## The Anaerobic Alactic System

As the name indicates, this system operates without air and without production of lactic acid. It is the most powerful of the energy systems and provides the least amount of energy, for reasons that will become clear as we go on.

We saw above that there is very little ATP in the muscle, enough for only about a second of strenuous activity, unless it can be reconstituted. Fortunately there also is in the muscle another substance that can very rapidly enable ATP to be reconstituted. It is creatine phosphate, which is known as CP. At times of high-energy demand, so high that it cannot be satisfied by the other two systems, CP can readily donate its phosphate radical ( P ) to ADP. This is because CP is an unstable compound, due to the high energy associated with its phosphate radical, and it is looking for an opportunity to off-load the P. The opportunity is provided by the need for ATP, and in fact this need is the only thing that does enable CP to shed its P . The P is shed together with its energy, and this becomes the bonding energy enabling the P to combine with ADP. This method of obtaining ATP is the anaerobic alactic system. The first word is because it operates without air and the second is to distinguish it from the lactic system, which also operates without air.

In simple terms, this method of manufacture of ATP is quicker than the aerobic and the lactic because it is more direct. The demand for ATP immediately causes CP to give its P to ADP, without the need for any energy-producing event beforehand. That makes this system the most powerful. Obviously it is the predominant energy system for sprinters.

Unfortunately there is little CP in the muscle, and in high demand the stocks are depleted in at most 20 seconds. In fact maximum demand will deplete them sooner, in as little as 5 seconds. When the CP has been used up the system stops operating. So despite the high power output there is very little energy in the anaerobic alactic system. There is less than in the lactic system, which has considerably less than the aerobic system.

Fortunately the CP can be replenished, so that it can facilitate another burst of energy output. However this can only happen when the energy demand on the muscle is
low, which is not of much use during running. When demand is low, and ATP is not needed for much else, ATP breaks down and provides its energy to enable creatine and the phosphate radical to combine and form CP again.

The replenishment process is as follows. After a short burst of powerful activity that required the breakdown of creatine phosphate, what we have in the muscle is some free creatine (C), some ADP and some free phosphate radical (P). The natural state is to have CP rather than free C and P in the muscle, but CP is a substance bonded with high energy, so an injection of energy is necessary to bond the C and P . This energy comes from the operation of the aerobic system. As with the lactic system, operation of the anaerobic alactic system incurs an oxygen debt, albeit not nearly as great. Gulped-in oxygen combines with the glycogen in the muscle to produce the energy necessary to form ATP. Then the ATP breaks down, yielding the energy to bond C and P together to form CP. This process of manufacture and breakdown of ATP continues until all of the CP has been reconstituted. We can see why it can only happen during rest; any demand for muscular contraction would take the energy from the breakdown of ATP, depriving C and P of bonding energy. This process of reconstitution takes only about 2 to 3 minutes, which is why many repeats of maximum bursts of a few seconds are possible with only a few minutes recovery between them.

CP has something of a symbiotic relationship with ATP - they need each other. It is only to ATP that CP can give energy, and CP can only receive energy from ATP. CP acts as a short-term extension of the energy store of ATP. It is as though the muscle had some seconds supply of ATP rather than less than a second, but it avoids some undesirable side effects that would ensue if actually did have that much ATP.

The diagram below illustrates the chemical reactions and energy transfers in the operation and restoration of the anaerobic alactic system.


HIGH DEMAND ON MUSCLE


LOW DEMAND ON MUSCLE
Figure 3.5 Reactions of the operation and restoration of the Anaerobic Alactic System

We remarked above that the lactic system does not operate in isolation, but on top of the aerobic system. The anaerobic alactic system on the other hand can operate by itself. In
a short sprint it does not matter whether you breathe or not. Even if you breathe the aerobic system will not get underway to any significant extent until the anaerobic alactic system has expended most of its energy. An indication that the lactic system is also relatively slow at kicking in, though not as slow as the aerobic system, is the fact that there is little lactic effect from repeated short bursts of maximum effort. If the lactic system were operating to any extent, there would be significant build-up of lactic acid, since the time frame for removal of the acid is about half an hour.

Although the anaerobic alactic system is primarily a sprinting system, for completeness it has to be said that this system is the energy provider at the beginning of any activity, because it is the only immediate system.

Again in the interests of ease of expression we avoid using the mouthful "anaerobic alactic system" over and over, and will use a simpler but clear name. We will usually refer to the system as the CP system.

## Energy Systems in action

The fact that there are three distinct energy systems, and that each is suited to a particular event group, could cause us to think that only one is in use when we run a particular distance. This is only true for very short distances, up to say 50 m , when only the CP system has time to come into operation. Beyond that all three will come into play, to a greater or less extent depending on distance and speed.

The efficiency of the human body dictates that energy will be provided by the least powerful system available and adequate for the speed required. More powerful systems will be reserved for higher speed demand, and not squandered on a gentler pace. As we saw above, at the beginning of activity the CP system is the only one available, and it will provide the energy even though one of the other systems might have been adequate. If the speed demand is high the CP system will continue until its stock of available CP is exhausted. Within a few seconds the lactic system is effective, and it will contribute as much energy as is needed to achieve the pace required. If the speed demand is high it will supplement the failing CP system. If the demand is low it will take over from the more powerful system. After about half a minute the aerobic system has become fully operational, and being the least powerful it is now prime provider of energy. If it can sustain the running speed required the other two systems cease operation. If it cannot, the lactic system remains in service, and if necessary on top of that the rapidly failing CP system.

After at most 20 seconds the CP system has ceased, either through depletion of CP or lack of need. If the pace is slow enough, the lactic system is also redundant, and the run continues relying solely on the aerobic system for energy. If the pace is above the capability of the aerobic system the lactic system provides the additional required energy. However as we saw above it too has limited capacity, and after progressive decline it will cease operation. Eventually the aerobic system will be the sole energy provider, but provided the other systems have not been depleted they will be available for an increase in speed if required.

## CHAPTER FOUR

## The Race and its Energy Implications


(photo from New York Road Runners - www.mensracing.com)

In Chapter Two we saw where middle distance is located in the spectrum of running events, and what its overall speed requirements are. Chapter Three introduced
the energy systems that are used in running. This chapter focuses on the energy systems used in middle distance, and the extent that they are used, by examining the pace structure of middle distance races. This knowledge of the energy systems used, and the extent to which they are used, will provide strong guidelines as to the training required to be a successful middle distance runner. We begin with a theoretical discussion of the use of the energy systems in middle distance races, and then look to top quality middle distance performances for confirmation of the theory.

## Overview of a run

We talk of different energy systems being required for different distances, and indeed that is what this chapter is about. But it is an oversimplification, used to emphasise the main applications of the three systems. In fact it can cause us to miss the important point that a run over any distance will use all the energy systems, and in the same way. What changes with the duration and intensity of the effort is the extent to which each system is used.

As we saw in the last chapter, at the beginning of any physical effort the CP system is the most accessible and it will provide the bulk of the energy in the first second or so, regardless of the rate at which it is required. This is the acceleration system, and it serves at this stage to propel the runner from rest to motion. If the effort is one seeking maximum speed the CP system will continue to supply it, up through maximum speed and down again, and the system will rapidly be depleted. Most of the energy will have been supplied by the CP system. But even for such an effort the other two systems come into play, albeit not as rapidly or to the same extent. The lactic system is important even in sprints, because its performance is a determining factor in the amount of deceleration after top speed. The input from the aerobic system is certainly much less, because it takes about half a minute before lungs and heart are fully operational. It would even appear that the aerobic system is unused in a short sprint, because it matters little whether or not the athlete breathes. However that ignores the oxygen already in the body, and the body is going to grab all it can to produce maximum speed, even if the amount is little and late.

At the other end of the scale, in an easy long run the CP system is only necessary for that initial acceleration from rest. This does not deplete it, and it is available for any further sudden exertion required. It is replaced by the less powerful but higher capacity systems, both of which are slower to power up, but when they do, are able to meet the speed demand of the runner. The lactic system is quicker to power up, and it takes over initially, with increasing assistance from the aerobic system as the latter comes on line. Within about half a minute the aerobic system is able to supply the requisite power and the lactic system switches off. The latter is by no means exhausted and it too waits in readiness for any further demands that the aerobic system cannot supply. The rest of the run is powered by the weaker but more efficient and higher capacity aerobic system.

In between is a run that is too fast to be sustained by the aerobic system but is not a short duration maximum quest for speed. This run too begins with the power from the CP system for acceleration from rest. The speed requirement is greater than for the easy run, so more acceleration or acceleration for longer is required, and more of the CP stores are depleted. Some may still be left for later acceleration. While the CP system has been in action the lactic system has been powering up, and so too, though at a slower build up,
has been the aerobic system. When they together can supply the required speed they take over from the CP system. Initially the main source of energy is the lactic system, but the aerobic system continues to build up, and it supplies as much power as it can. As the pace is too much for the aerobic system, power must continue to be supplied by the lactic system on top of it. The faster the pace the more power that must come from the lactic system, while the aerobic system supplies all that it can.

The pattern in each run is the same. The run is launched with the powerful acceleration system and the other two systems begin their build up. The lactic system predominantly takes over when it can supply the requisite speed, while the aerobic system continues to build up. If the run lasts long enough the aerobic system takes over and supplies the speed, or it powers up to maximum and is topped up with the lactic system to provide the speed required. If the lactic system continues to operate, at a high level in a short duration effort or a low level in a long duration effort, eventually it chokes itself off, and all that is left is the aerobic system to sustain the run. For any run the body seeks to use the most efficient means of supplying energy at every stage. Whenever and to whatever extent it can, it uses the aerobic system.

## Overview of Energy Systems in Middle Distance

So in essence the middle distance race uses the CP system to get up to pace, and then the lactic system, increasingly supported by the aerobic system, in an attempt to sustain the pace. It differs from the races either side only in emphasis. The 400 m uses the CP system to a greater extent to generate a faster pace, and in fact its exponents are those who can get more out of that system. It then relies mainly on the lactic system to keep the pace up as much as possible. The deceleration during the operation of the lactic system can be quite severe. The 5000 m also uses the CP system to accelerate up to speed, but as the speed is lower than middle distance the use of the system is less. The reservoir of CP is also less, but there is likely to be some left for very short exertion later. The lactic system takes over from the CP system, but soon the aerobic system reaches maximum output and provides most of the energy for the rest of the race. The aerobic system does not have enough power to sustain the speed required and the lactic system tops it up.

That is enough about the similarity between the middle distance races and the races on either side. If that was all there was to it there would not be much difference between a 400 m run and a middle distance run, or between a 5000 m run and a middle distance run. But the difference in emphasis in the use of the systems is important, and does differentiate middle distance from the events either side of it. Otherwise the same runner would be proficient at everything from sprints to distance.

The key to the middle distance run is the use of the lactic system. There is some debate over whether the lactic or the aerobic system provides more energy, and some of the technical literature purports to show that the aerobic system does. Even if this were so, it is the lactic system that provides the link between the accelerating and the enduring systems, and proper use of it is necessary in order to optimise the total performance.

## Operation of the Lactic System

In order to organise proper use of the lactic system we need to understand how it works. We saw above that at speeds above steady state speed (which can be sustained
with the aerobic system), the lactic system tops up the aerobic system. The extent of the top up depends on the speed required. Distance events are faster than can be sustained with the aerobic system, but not excessively, so only a small top up is required. However it could not be any more than small, because small for a long time adds up. Middle distance events require substantial top up, and so the duration is much shorter. The very finite capacity of the lactic system, and the reason for this, are the key to determining the right pace distribution in middle distance.

As we saw in Chapter Three, the lactic system is self-defeating. It is unable to produce energy without producing lactic acid, and this acid eventually shuts the system down. But before this the acid progressively restricts the lactic system in the following manner. The system produces energy by means of the breakdown of glycogen in the absence of oxygen. Enzymes in the muscle enable this breakdown to take place, but unfortunately the lactic acid, which is produced as a by-product, then proceeds to inhibit the action of the enzymes. So the more acid produced the less enzymes are available to enable the system to work, and the less energy further able to be produced. When none of the enzymes are inhibited the system is unaffected and able to produce maximum lactic speed. As the system continues to operate, more and more acid is produced, and more and more enzymes are inhibited. The result is that the maximum power available from the system, and so the maximum speed it can produce, continues to fall. This is not to say that the speed necessarily falls; it is the maximum speed available that falls, and if the running speed is below that then constant speed and even acceleration is possible. As long as the running speed is above maximum steady state aerobic speed the lactic system is in operation, producing lactic acid that continues to lower the maximum speed possible. So during the operation of the lactic system there is continual inexorable loss of maximum available speed, save for the momentary exertion possible if the CP system has not been depleted earlier.

The rate at which maximum available lactic speed is lost obviously depends on the rate at which the enzymes have been inhibited. This in turn depends on the rate of production of lactic acid, which is determined by running speed. The faster the pace the more rapidly does the maximum available speed fall. Also the faster the pace the sooner all the enzymes are inhibited and the sooner the lactic system becomes inoperative.

The operation of the lactic system is described by the following word equations. They are mathematical equations expressed in words. Even in words rather than symbols they might be still to complicated for the non-mathematical mind. If so they can be skipped over without affecting the sense of the rest of the chapter.

- max speed available = max speed - speed potential lost
- speed potential lost is proportional to number of enzymes inhibited
- number inhibited $=$ sum of consecutive products of time increment and rate of enzyme inhibition during the time increment
- rate of enzyme inhibition is proportional to the difference between actual speed and max aerobic speed
Only the third equation has any complexity, and in fact it has more than shown here. It is properly expressed in integral calculus terms. Only if the rate of enzyme inhibition is constant does the equation become simple, and then the right hand side of the equation simplifies to the rate multiplied by the time for which the lactic system has been
operating. These equations are expressed mathematically in Appendix 2, and from them is developed a mathematical model of the lactic system. This model will enable the performance of the system to be predicted and optimum use of it to be determined.

We now consider how a runner should use the lactic system. Obviously he can play safe and keep well below the maximum possible lactic speed, so that speed can be increased if he desires. Indeed he will do so in a distance race. However such caution is no way to race well in middle distance. How fast then should a middle distance athlete run? Should he run at the maximum lactic speed possible? The answer to this lies in a piece of advanced mathematics that has no place in this chapter. It is reproduced in Appendix 2 so that it can be seen that the answer has a solid basis. The answer is that running at maximum lactic speed is suicidal, because the result is an exponential decline in that maximum speed. Deceleration is severe and the lactic system operation does not last long. If the maximum possible speed can be avoided, then it still falls off, but not as dramatically. The trick is to keep running speed as close as possible to maximum possible speed, without hitting it until the finish. The mathematics tells us what every runner knows, though imprecisely - when the bear jumps on your back there is nothing you can do to prevent a savage deceleration.

There is an analogy that describes this effect. The lactic system is like a room with an adjustable ceiling, and the runner has to get from one side to the other. As the system operates, the lactic acid it produces is pumped above the ceiling, which forces the ceiling down. The more acid that has been produced the lower the ceiling becomes. When the ceiling comes down to head height the runner is obviously in trouble; his speed suffers dramatically. The trick is for him to run at such a speed distribution that the ceiling reaches his head when he reaches the other side of the room.

This still does not tell us what is the optimum strategy for use of the lactic system in middle distance running. Broadly speaking, there are two possible strategies, though of course variations on these are possible. The first is for a constant speed during the operation of the lactic system and the second is for gradual deceleration. It turns out from the mathematics of Appendix 2 that deceleration is the best strategy for any event requiring use of the lactic system, though the difference is only significant for 400 m and 800 m . The difference in the results from the two strategies is still there at 1500 m , and theoretically it can be said that deceleration is the best strategy, but the accuracy of some of the assumptions used and the practicalities of racing 1500 m possibly swamp the difference.

## Operation of the CP System

We now know what the optimum strategy is once the lactic system is underway. But before the lactic comes the CP system, and we must determine what the optimum use of this system is. Firstly we can say that if the stores of CP are not depleted in the race then the effort has not been optimum. The CP system is the most powerful, and if it is not fully exploited the maximum available energy is not utilised. The CP can be used all in one go, or some of it can be retained for later acceleration. The problem with the latter option is that it can leave a runner hung up on a pace that is beyond his ability to sustain with the lactic system, and he can go into premature dramatic loss of speed. The better option, at least for shorter middle distance, is to deplete the stores of CP by gentle acceleration and then slide from a maximum speed, to a speed from which the gradual
deceleration under the lactic system can take place. For longer middle distance, where the pace during the operation of the lactic system is not sailing so close to the maximum lactic speed available, there can be some point in retaining some CP for tactical moves later on.

The second point to be made is that the less the reliance on the CP system for a good performance, the greater has to be the reliance on the lactic system. Not only is the lactic less powerful, as discussed above, but it also chokes itself. This is less of an issue for 1500 m because the proportion of energy contributed by the CP system is much less, but it is important in 800 m .

We need to determine what should be the peak speed from the CP system and how long the system should be caused to operate. The two questions are of course interrelated. The 100 m runner depletes his available CP in 6 to 7 seconds and from then on he is in deceleration. There is plenty of evidence that the CP system is available for much longer than this with more judicious use. Typically a 400 m runner's second 100 is faster than his first (unlike the 200m runner), so he is probably using the CP system into the second 100 , and well into the second 10 seconds of his effort. That there is not much of the lactic system in this is shown by the repeatability of such 200 m efforts. It is likely that there is more CP available for these gentler efforts than for the much more extravagant 100 m demand, because there is less waste. Therefore ideally in middle distance the CP effort continues for much of the first 200 m , after which time the lactic system is in full operation.

## Ideal Race Pace Distribution

THE 800M
What speed should the CP system take the runner up to? In other words, what should be the speed of the first 200 m ? The speed of the first 200 m will be faster than the average speed for the whole distance and slower than the speed possible for a flat out 200 m . In between these two extremes will be the speed for the first 200 m of a 400 m and the speed for the first 200 m of an 800 m . The 400 m and the 800 m are both deceleration events, and the 800 m can be considered a long 400 m , so there is advantage in considering both together. The important consideration in the first 200 m of both is the speed from which the runner wants to decelerate for the remainder of the run. In other words the CP effort must be considered in the light of the optimum lactic effort. A reasonable first approximation, in terms of the average goal pace for the 800 m , would be for the speed of the first 200 m to be $103 \%$. To put it another way, the speed of the first 200 m would be $103 \%$ of the average speed for the whole race. Then the deceleration could be at the rate of $2 \%$ per 200 m , giving the necessary average of $100 \%$ for the whole distance. This pattern fits in with the above criteria and avoids high and low extremes of speed at either end. It would give a race pace distribution, with respect to average goal pace for the distance, as follows:

| $1^{\text {st }} 200$ | $103 \%$ |
| :--- | :--- |
| $2^{\text {nd }} 200$ | $101 \%$ |
| $3^{\text {rd }} 200$ | $99 \%$ |
| $4^{\text {th }} 200$ | $97 \%$ |

It is instructive to see what the distribution is in terms of best 200 m effort. This is given below:

| $1^{\text {st }} 200$ | $89 \%$ |
| :--- | :---: |
| $2^{\text {nd }} 200$ | $87 \%$ |
| $3^{\text {rd }} 200$ | $85 \%$ |
| $4^{\text {th }} 200$ | $83 \%$ |

The implied assumption is that an 800 m runner's average speed over 800 m is about $86 \%$ of his average speed over 200 m . (The ratio of world records over the two distances is $76.4 \%$, which reflects the fact that an 800 m specialist is much better at 800 m than 200m.)

The above model is, as was stated above, a first approximation, but it does have a manageable first 200 m and a realistic deceleration pattern. However as we shall see when we look at actual performances, it needs some adjusting.

## THE 1500M AND MILE

The longer middle distances are a different story. As we saw above, Appendix 2 established that in theory deceleration is the optimum strategy for the lactic stage over any distance, but the advantage of this over steady pace is insignificant for 1500 m and beyond. There are further reasons why deceleration is not a wise model for 1500 m and mile races. If there is any advantage in this strategy, it depends on a deceleration so gradual as to be unattainable by all but those with very fine pace judgement. To err on one side is to be very close to even pace, which we know to be about as good. However to err on the other side is to invite disaster, because the early pace in the lactic stage is too fast and the runner suffers premature choking of the lactic system. The even pace strategy during the lactic stage is good because it is easier to judge, and the effect of getting it slightly wrong by gradually decelerating from a slightly faster pace is just as good. So the theoretical model for pace distribution in 1500 m and mile races contains an even pace during the lactic stage.

Because the optimum strategy during the lactic stage is an even pace, we are not looking for an opening pace from which to decelerate throughout the race. However the first 200 m should not be at the same speed as the rest of the run, for two reasons. Firstly, if it were that slow, there would be little use of the CP system, and some energy would not be utilised. The performance would be sub-optimum. Secondly, since the steady pace is significantly below the maximum possible, there is plenty of scope for a brief burst to obtain a favourable position. It is unlikely that the first 200 m will deplete the CP stores, and there should be enough left for a tactical burst towards the end of the run. This has to be judiciously used, because if employed too vigorously and too far out from the finish it could leave the runner hung up on a pace his lactic system cannot sustain, and he could go into exponential loss of speed.

So a model 1500 m or mile would have a pace distribution, relative to average goal pace, something like this:

| $1^{\text {st }} 200 \mathrm{~m}$ | $103 \%$ |
| :--- | :--- |
| $2^{\text {nd }}$ | 99 |
| $3^{\text {rd }}$ | 99 |
| $4^{\text {th }}$ | 99 |
| $5^{\text {th }}$ | 99 |
| $6^{\text {th }}$ | 99 |
| $7^{\text {th }}$ | $99 \quad\left(13^{\text {th }} 100 \mathrm{~m}\right.$ for 1500 m$)$ |

## Confirmation and Adjustment of the Models

There is good correlation between the mathematically derived models of pace distribution for 800 m and 1500 m , and the evidence provided by top class runs. Furthermore this evidence bears out the difference between 800 m and 1500 m races when it comes to pace distribution. However the historical evidence in the 800 m does suggest a more complex model with more emphasis on the CP-driven first 200 m .

Figure 4.1 below shows the speed of the first and second 400 m , as a percentage of average speed of the performance, for twenty-two 800 m performances ranging from $1: 41.73$ to $1: 43.50$. They were not selected for any other reason than that they were the quality performances available to the author, for which splits were given. They obviously represent comprehensive sample of quality performances.

## 800M PERFORMANCES



Figure 4.1 First and second 400 m speeds of top 800 m performances.
As can be seen from the figure, there is only one in which the first lap is slower than the second. This was a remarkable run by a man who was not really an 800 m runner, but rather a 1500 m and mile exponent. It was Steve Cram, and the occasion was the Commonwealth Games in 1986. He ran it more like the distance he was used to, and of course he was good enough to win. It is significant that he has two faster runs, both of which are recorded in Figure 4.1, and in both his first lap was the quicker. There are nine runners represented in the above performances and they all have their best performance, which it is reasonable to regard as their best possible effort at the distance. The average first lap speed for these performances is $101.7 \%$ of their 800 m average speed, which provides reasonable correlation with the first approximation model derived above (103\%
and $101 \%$ of average speed for the first and second 200 m gives a first lap having a speed $102 \%$ of the 800 m average). If we leave out Cram's performance, on the ground that his was not a typical 800 m run, the first lap speed rises to $101.8 \%$.

Of the performances that are recorded in Figure 4.1, the 200 m splits are known to the author for four. There are two of Coe ( $1: 41.73$ and $1: 42.32$ ), one of Cruz ( $1: 41.77$ ), and one of Gray ( $1: 42.80$ ). The speed of these 200 m splits, as a percentage of the average speed for the 800 m , is illustrated in Figure 4.2 below.

Split Times for Four Great 800 m Performances


Figure 4.2200 m splits with respect to 800 m average - four great runs
If the three runners had a single ideal pace distribution for their performances, it seems reasonable to suggest, on the basis of the above figure, that it was one of deceleration from first 200 m to last. This is some confirmation of the above model, though more than four performances would be necessary to be definite based on historical evidence.

The historical evidence does suggest that a faster first 200 m and greater deceleration to the second 200 m would be more effective than the pattern in the first approximation model. The model suggested by the above four performances is $105 \%$ of average 800 m pace for the first 200 m , followed by a relative rest in the second 200 m , with the pace falling by about $5 \%$. Then there is increased effort in the third 200 m to avoid further deceleration, and finally the inevitable catch-up deceleration with a $4 \%$ loss of speed in the final 200 m .

The reason for the discrepancy between historical evidence and the first approximation model is that the latter is conservative in its assumption about the basic speed of 800 m runners. It is likely that the three athletes in the historic data had more highly developed CP systems, relative to their overall ability, than the average middle distance runner, so they could manage a fast first 200 m on their stores of CP , without getting significantly into their lactic system. Indeed Coe was on one occasion second in the AAA (British) 400 m Championship race. Gray has run $1: 12.81$ for 600 m after passing through 400 m in 47.1 , and has a relay leg of 45.0 to his credit.

After the first 200 m , not wishing to be hung up on too high a speed at the beginning of operation of their lactic system, they eased off for 200 m . Had they not done so, they would have reached the point when their maximum possible lactic speed descended to their running speed well before the finish, and their running speed would have gone into exponential decline.

These four performances draw attention to the first 200 m of the race. It is different from the other three parts in that it relies so heavily on the CP system and not on the lactic system. In order to obtain the best 800 m performance it is necessary to run the first 200 m correctly. This section of the race is the opportunity to maximise the use of the most powerful energy system without incurring excessive early lactic acid build up. Proper use of a well-developed CP system will gain valuable time without setting the runner up for early lactic speed collapse. In terms of the lactic system, the second or so gained in the first 200 m is free. A key element is the speed at the end of the section, because this is basically the speed at the beginning of the lactic part of the race. It cannot be too high, yet if it is too low the 200 m has not been fast enough. The speed at the 200 m mark is an important parameter in determining the pace distribution in the first 200m.

It is all right for athletes with highly developed CP systems to run at $105 \%$ or more of their goal average speed for the first 200 m , but for slower athletes it is courting disaster. There is a classic example of this in the 1988 Olympic 800 m final. Figure 4.3 below has the details.

Joacim Cruz ran 23.5 seconds for the first 200 m . If he was aiming to run to his best form this would have represented $108 \%$ of goal pace, which was slightly ambitious. It might have cost him the gold medal because his speed at the finish was way below that of the winner, Paul Ereng. However Cruz was following Nixon Kiprotich, and if Cruz's pace was optimistic, Kiprotich's was presumptuous. The latter went through the first 200 m in 23.5 seconds and kept going. He passed the 300 m mark in 36.5 seconds and the bell in 49.7 seconds. His best 800 m time coming into the Games was almost 3 seconds slower than Cruz's, and he does not seem to have had a background of 400 m running as did Ereng, so he had no reason to believe that he could run the first 200 m in 23.5 seconds and survive to contest the finish. He was probably well into his lactic system operation by the 200 mark, and continued to pile on the lactic acid over the next 400 m as he tried to hold up the pace. The result was the inevitable exponential loss of speed well before the finish, and this is well illustrated in Figure 4.3. Contrast this with the much more sensible pace distribution of the winner, Paul Ereng - a manageable first 200 m of about 25 seconds, $103.5 \%$ of his average speed for the race, followed by an overall slight deceleration for the rest of the race. And Ereng had a background in 400 m running, so was better equipped than Kiprotich for a fast first 200m. The gold medalist had learnt his
lesson well from the Kenyan trials, where he had passed the bell in 49.0 seconds and the 600 m mark in $1: 14$ before he suffered his inevitable nose-dive. His last 200 m took 31 seconds, as he was passed by one, and then another runner, and just held on for third and a chance at the Olympics.

Best \& Worst Pace Distribution


Figure 4.3 1988 Olympic 800 m - the best and the worst of pace distribution.

## IDEAL PACE DISTRIBUTION FOR 800M

Putting together the pace distribution suggested by the theoretical model and the information from actual performances, it would seem that the ideal pace distribution for achieving the fastest time would be within the framework shown in Figure 4.4 below. The variation having the fast first 200 m , followed by a big deceleration to the next and then gradual decelerations from then on, is in between the two lines, and is discussed below.


Figure 4.4 Two views of pace distribution for 800 m
The pace distribution represented by the broken line would be more suited to a runner having a reasonable 400 m background. In fact it is more likely to be optimum for him because it allows him to fully exploit one of his strengths, namely his CP energy system. On the other hand a runner with more of a 1500 m than a 400 m background would find the pace distribution given by the unbroken line more suitable.

The fast first 200 m needs some attention. It is $105 \%$ of average race pace, or $89-$ $90 \%$ of average 200 m best pace. In order to finish the 200 m at a speed gentle enough to allow use of the lactic system for the next 600 m , and yet achieve the required $89-90 \%$ of best 200 m performance, the runner must have a very good middle section of the 200 m . He must be able to comfortably hold $100 \%$ of average 200 m pace for about the middle 100 m .

We need to look more closely at the last 600 m of the above four performances. The flat section of the second and third 200m came about because of one athlete- Seb Coe. In both his 1979 and 1981 world records he sped up in the third 200 m relative to the second. It is unlikely that this was deliberate because such changes of pace are debilitating, and likely to leave a runner hung up on too fast a pace for the lactic system to sustain. His might have happened to Coe to a minor extent, and his 1981 world record could even have been better, because his last 200 m took 26.7 seconds, compared with his third of 25.1 seconds. The fast third 200 m occurred because he became impatient with the pacemaker who was slowing down. A gradual slide off the second 200 m pace would have enabled him to finish more strongly in the last 200 m , with a split in the low 26 second range.

It does not seem advisable to devise a model based on one athlete's third 200 m effort, particularly when that effort lacks reasonable explanation. It is better to look at the overall pattern of the last 600 m in all four performances. It is one of a slight deceleration from a second 200 m that is about $5 \%$ slower than the first. The rate of deceleration for the last 600 m in the pattern is about $1 \%$ per 200 m . Such a model is shown below, also in terms of average speed for the whole of the 800 m .

First 200m
104.5\%

| Second 200m | $99.5 \%$ |
| :--- | :--- |
| Third 200 m | $98.5 \%$ |
| Fourth 200 m | $97.5 \%$ |

Let us look at what the above means in concrete cases. Take first the case of a woman who wants to run 2 minutes. We will consider both the conservative approach and the approach that might be taken by an athlete who also runs 400 m . We begin by noting that the average speed for a $2-$ minute 800 m is 30 seconds per 200 m .

In the conservative approach the athlete would start with a 29.1 second 200 m and follow it with 29.7 seconds, for a first lap of 58.8 seconds. The third 200 m would be covered in 30.3 seconds, taking the athlete to the 600 m mark in 1:29.1 seconds. The final 200 m would be run in 30.9 seconds, enabling the athlete to reach the finish in 2 minutes.

An athlete wishing to exploit a strong CP system would start with a 28.7 second first 200, and follow it with 200s of 30.2 seconds, 30.4 seconds and 30.7 seconds. This would give a first lap of 58.9 seconds, a 600 m of $1: 29.3$ and the full distance in 2 minutes.

A male athlete trying to run 1 minute 46 seconds would be working around an average speed of 26.5 seconds per 200 m . His 200 m splits for the two strategies are given in the table below.

200
400
600
800

| Conservative <br> $\mathbf{2 0 0}$ |  |
| :--- | :--- |
| $\underline{25.7}$ | $\frac{\text { elapsed }}{25.7}$ |
| 26.2 | 51.9 |
| 26.8 | $1: 18.7$ |
| 27.3 | $1: 46.0$ |


| CP |  |
| :--- | :--- |
| $\underline{\text { 200 }}$ |  |
| $\underline{25}$ | elaphasis <br> 25.3 |
| 26.6 | 51.9 |
| 26.9 | $1: 18.8$ |
| 27.2 | $1: 46.0$ |

Of course life is not as perfect as depicted in the above analysis, and variations brought on by reality will be discussed later.

## MILE AND 1500M PERFORMANCES

The historical data shows that there is a distinct difference in Mile/1500m performances, compared with 800 m performances, when they are analysed on a first half/second half basis. Whereas the first half of the 800 m is invariably faster than the second, Figure 4.5 below shows that there is no such pattern for the Mile.

Figure 4.6 is for 1500 m , and it shows the same pattern as Figure 4.5, though it plots first 800 m and last 700 m , which explains why the lines do not all intersect at the same point. In twelve top performances in the Mile, and twelve top performances in the 1500 m , chosen for no other reason than their splits were available to the author, there are as many with faster first halves as faster second halves. This suggests strongly that the optimum strategy is even pace. In fact nine of the twelve mile performances and eight of the twelve 1500 m performances had both halves within $1 \%$ of average speed for the distance. Even more strongly, all eight of the 1500 m performances in which the halves were within $1 \%$ of average, actually had their halves within $0.5 \%$. It would seem that there is an ideal behind all of these elite performances- equal first and second halves. This corresponds with the theoretical model.


Figure 4.5 Relative speeds of first and second halves of 12 top miles.


Figure 4.6 Relative speeds of first and second halves of 12 top 1500 m runs.
Much more is known of further breakdown of splits for the Mile and 1500 m than for the 800 m . Quarter mile splits are available for all of the twelve Mile performances and 400 m times are available for the 1500 m performances. These are shown in Figures 4.7 and 4.8 below.

There is a very obvious pattern in both the above figures, but particularly in the Mile. The first lap is faster than the average pace for the mile ( 1500 m ), the second and third laps are about the same pace and slightly below average, and the last lap is faster than average. This is in agreement with the strategy suggested above in the section on operation of the CP system.

Much more is known of further breakdown of splits for the Mile and 1500 m than for the 800 m . Quarter mile splits are available for all of the twelve Mile performances and 400 m times are available for the 1500 m performances. These are shown in Figures 4.7 and 4.8 below.


Figure 4.7 Pace distribution by quarters for 12 top mile runs


Figure 4.8 Pace distribution by 400 s for 12 top 1500 m runs
If all these elite athletes had a particular ideal pace distribution in mind, and it seems likely that they did, then it would be something like this:

## Mile

| Q1 | $102 \%$ |
| :--- | :--- |
| Q2 | $98.5 \%$ |
| Q3 | $98.5 \%$ |
| Q4 | $101 \%$ |

1500 m

| $1^{\text {st }} 400$ | $103 \%$ |
| :--- | :--- |
| $2^{\text {nd }} 400$ | $98 \%$ |
| $3^{\text {rd }} 400$ | $98 \%$ |
| last 300 | $102 \%$ |

The above distribution is something like the mathematical model of pace distribution arrived at earlier. However the higher speed at the start and finish lasts longer and the speed in the middle is less. There is no apparent reason for the difference between the two events, since there is less than $7 \%$ difference in distance. There would not be a difference in strategy because of that. Perhaps it is because the 1500 m is a much more common race, and hence athletes have more aggression in their quest for a faster time than their previous performance, or a faster time than that of another athlete. In any case it seems reasonable to assign the same strategy to both events. Doing so, the model would be like this:

| Q1 or $1^{\text {st }} 400 \mathrm{~m}$ | $102.5 \%$ |
| :--- | :--- |
| Q2 or $2^{\text {nd }} 400 \mathrm{~m}$ | $97.5 \%$ |
| Q3 or $3^{\text {rd }} 400 \mathrm{~m}$ | $97.5 \%$ |
| Q4 or last 300 m | $102.5 \%$ |

There is some smoothing in this; variations about the theme are possible and indeed can be seen from the historical evidence. However this represents a model from which the variations can take place. There is a little inherent inaccuracy in the model with respect to 1500 m because the sections are not even, the last one being 300 m rather than 400 m .

For a woman wishing to run 4 minutes 10 seconds for 1500 m the average speed would be 66.7 seconds per 400 m . Therefore the model would give splits as follows:

$$
\begin{array}{lc}
1^{\text {st }} 400 \mathrm{~m} & 65.1 \\
2^{\text {nd }} 400 \mathrm{~m} & 68.4 \\
3^{\text {rd }} 400 \mathrm{~m} & 68.4 \\
\text { last } 300 \mathrm{~m} & 48.8
\end{array}
$$

The total of the above is 4 minutes 10.7 seconds, and the additional 0.7 seconds comes about because the faster pace at the end is only applied for 300 m . However other real life variations are likely to swamp that minor discrepancy.

For a male athlete wanting to run 3 minutes 35 seconds the average speed would be 57.3 seconds per 400 m . So the model would give splits as follows:

| $1^{\text {st }} 400 \mathrm{~m}$ | 55.9 |
| :--- | :---: |
| $2^{\text {nd }} 400 \mathrm{~m}$ | 58.8 |
| $3^{\text {rd }} 400 \mathrm{~m}$ | 58.8 |
| last 300 m | 41.9 |

Similar to the woman's run, the total of the above is slightly above the goal ( 3 minutes 35.4 seconds instead of 3 minutes 35 seconds), but the discrepancy is minor compared to other variations possible.

As remarked above for 800 m , the model exists in an ideal world, and real life situations will force variations on the ideal splits.

## The Real World

Obviously in a race not everyone can, nor would everyone want to, run to the model pace distribution. Many other factors have a bearing on how an athlete will distribute his pace. He might want to obtain a good position or avoid being boxed in. It often happens that an athlete has a choice between going with the pace of the race and trying to run the pace he thinks to be right for him. A potential problem with the latter choice is that he might get isolated and then have difficulty even running the pace he wants by himself. If he is in danger of being isolated and has trouble maintaining a pace by himself, going with the pack might be a better option. All of this means that it is sometimes necessary to run faster than the ideal pace in the early stages of a race.

There is another reason for running faster early than the pace considered to be ideal. It is that if improvement is going to come it will probably come from running faster early and then finding the endurance to avoid steep deceleration. An athlete who does this every time is being presumptuous. There has to be some indication, perhaps in training, that improvement is possible. But to enable the improvement to happen the athlete must be prepared to run faster than ideal pace early. It needs to be noted that the ideal pace is related to and derived from the goal time for the race. So if improvement has been already built into the goal time it would be supremely optimistic to expect further improvement on that.

Similarly, often in 1500s though rarely in 800s, the athlete has the choice between dawdling with the pack and waiting for the charge for home, or running the ideal pace by himself out in front. The sensible and courageous course is to run the right pace, but again it does require the ability to do it alone. The athlete will sometimes want to take the fast finish option.

What this means in terms of variations from the ideal pace distribution is discussed below.

## THE REAL WORLD OF THE 800M

It is sometimes desirable to run the last part of an 800 m faster than ideal pace, but this is rather rare. This is particularly so because the time will be slow, and most athletes do not want slow times. Furthermore the race becomes more uncertain and dangerous for the better runners if the early pace is slow. There is increased possibility of the race going to a slower runner. The 800 m in the 2000 Olympics was a classic example of this. So negative splitting is rather rare. The most common variation is the faster early pace. What pace faster than ideal will not be suicidal?

An indication of the answer to the above question can be obtained by looking at the performances of the greats. Some of those have run faster early than the ideal pace and have come out of it with a high quality performance. It would be presumptuous of lesser mortals to run comparatively faster in the early part of the race than they did.

A look at Figure 4.2 shows that just under $107 \%$ is the upper limit for the first 200 m . Let us call it $107 \%$. What this is saying is that to be a complete 800 m runner, capable of handling any race situation, one thing the runner must be able to do is run the first 200 m at $107 \%$ of average race pace on his CP system. He must not be heading into lactic build up by doing so. For a male runner hoping to do $1: 46$, this means he must be able to do the first 200 m in 24.8 seconds easily. A woman hoping to run 2 minutes must be able to do the first 200 m in 28.0 seconds easily. The emphasis is on easily. The 200 at that speed must come from a conservative, extended use of the CP system, and must not result in any significant build up of lactic acid by use of the lactic system.

Sometimes it is desirable to continue a faster than ideal pace for the entire first lap. This could be to avoid being isolated, or because of a judgement that the runners behind will give up. Whatever the reason, Figure 4.2 tells us that about $103.5 \%$ of race pace is the upper limit for a good performance. The complete 1:46 runner must be able to do the first lap in 51.2 seconds, and the complete 2-minute runner must be able to do 58.0 seconds. We can no longer ask that this effort be without the lactic system. That is impossible. So it will be at some cost in terms of lactic acid build up. However it must not be at great cost, otherwise the lactic system will become choked and the second lap will be very slow.

Because the fast first lap will result in the runner carrying more lactic acid than usual at that stage of the race, it is also necessary for him to have a well developed tolerance to lactic acid, so that lactic speed collapse (the exponential fall) will not rob him of all he has gained in the first lap, and more.

Very occasionally the second lap is faster than the first, or the same speed as it, but this is so rare that it is not worth considering as part of the 800 m runner's armoury.

## THE REAL WORLD OF THE 1500M AND MILE

As has become obvious, the 1500 m is a very different race to the 800 m , and much more variety is possible in pace distribution. A fast early pace is not uncommon, and in championship races a slow early pace followed by a furious finish is even more common. A complete 1500 m runner has to be able to cope with both extremes.

It takes a courageous runner to set off at a fast pace and then control the deceleration to a minimum. Perhaps the best example among the elite performances was Steve Ovett's near world record mile run of 3 minutes 49.66 seconds in July 1981. Anyone expecting to run comparatively faster in the early part of the race than the aggressive Ovett and survive is a supreme optimist. His quarters were successively $106.7 \%, 99.2 \%, 97.8 \%$ and $96.8 \%$ of average race pace. So, broadly speaking, the fastest an athlete should expect to run in the first part of a 1500 m is about $106.5 \%$ of goal pace for the first lap and $103 \%$ for the first two laps. An athlete aiming for 3 minutes 37.5 seconds should be able, if it is necessary or desirable, to run 54.5 for the first lap and 1 minute 52.6 seconds for the first 800 m . This is tough, and not necessarily the best way to run 1500 m , but the complete runner 1500 m runner will be able to do it. A woman aiming for 4 minutes should be able to run 60 seconds for the first lap and 2 minutes 4.3 seconds for the first 800 m .

More common, particularly in championship races, is the slow early pace and the charge home. It does not produce fast times, but athletes hoping to win major championships must have this ability in their armoury. Perhaps the best example of this is the 1980 Olympic 1500m final, which Seb Coe won in 3 minutes 38.40 seconds. That performance seems reasonably respectable, but its magnitude becomes apparent when it is realised that his time at the 800 m mark was a pedestrian 2 minutes 5 seconds. So his last 700 m took 1 minute 33.4 seconds, or 1 minute 46.7 seconds pace for 800 m . And he was getting progressively faster; the third lap was 54.2 seconds and the last 300 m was in 39.3 seconds, or 52.4 second lap pace. Even more amazing, his last 100 m took only 12.1 seconds.

Goal pace does not have any meaning in a race like this, so we relate the pace to the pace the runner is capable of. In the above case Coe was a 3 minutes 30 runner, or 56 seconds per lap. His last 700 m was $104.9 \%$ of the 56 second pace. His last 300 was $106.9 \%$ of the 56 second pace. To look at it another way, at that stage Coe held the world record for 800 m , at 1 minute 41.73 seconds. So his last 700 m was at $95.3 \%$ of his best 800 m pace, and this after an 800 m in 2 minutes 5 seconds. As before, this performance represents something of an upper limit on what a complete runner should be able to do. He should be able to run the last couple of laps at $95 \%$ of his best 800 m pace after the first couple of laps at about $90 \%$ of his best 1500 m pace. Furthermore he should be capable of winding up the pace over those last couple of laps, in order to fight off challenges that will inevitably come because of that slow early pace. What does this mean in practical terms? A runner capable of 3 minutes 37.5 seconds and 1 minute 46 seconds should be able to run the last 700 m at under 1 minute 50 second 800 m pace after a first 800 m of 2 minutes 9 seconds. This would give a 1500 m time of about 3 minutes 45 seconds.

## Energy System Requirements for Middle Distance

Now that we know what speed is required at various stages of middle distance races, and for how long, we can decide which energy systems are needed and to what
extent. This of course is a prelude to determining the training sessions required, which we will come to in the next chapter. By looking at it in terms of energy systems we have the fundamentals on which training can be based. The 800 m is sufficiently different from the 1500 m to be treated separately.

## ENERGY SYSTEM REQUIREMENTS FOR 800 METRES

As we saw above, an 800 m runner should be capable of a first 200 m at $107 \%$ of 800 m goal pace, without incurring lactic build up to any extent. This will be in the range $91-93 \%$ of maximum 200 m speed for an 800 m runner, and it must be relatively easy. This is a CP effort and it obviously requires a well developed CP energy system- not as well developed as a 400 m runner would require of course, but considerably more than the overall pace of the 800 m would suggest. The capacity of the system is more important than the power. Without some emphasis on developing the CP system the pace will be a struggle and will land the runner into the lactic zone too early. Furthermore the beginning of the race, the setting up of the effort, will never be improved.

The runner should also be capable of a first lap at a pace that is $103.5 \%$ of average goal pace, while still having enough left to avoid getting rubbery legs in the second lap. That is in the range $93-95 \%$ of best 400 m pace, so training for it is not much different to some of the training the runner would do if preparing for 400 s . The effort obviously has a large CP content, and, since it continues beyond 200 m , it is well into the lactic phase. In order to be able to run the 400 m and still have plenty left, a well-developed CP energy system is necessary, and also a reasonably powerful lactic energy system with a large capacity. The power is necessary so that a reasonable pace can be maintained after the cessation of the CP system, and the capacity is necessary so the first lap does not deplete the system too much.

As we move into the second lap it is the capacity of the lactic system that matters. Also the aerobic system now becomes important. It takes a little time to power up, but in the second lap it is well underway, and it becomes increasingly important as the lap progresses, because it has to support a dying lactic system. What we want is an aerobic system which is trained to power up quickly, and which has a reasonable level of power output, so that the runner is less dependent on the dying lactic system. Looking at it another way, the difference $\mathbf{v}-\mathbf{v}_{\mathbf{a}}$ is very important, where $\mathbf{v}$ is running speed and $\mathbf{v}_{\mathbf{a}}$ is maximum aerobic speed. This difference determines the amount of lactic acid produced, and the higher is $\mathbf{v}_{\mathbf{a}}$ the higher can be the running speed for the same amount of lactic acid. This is why a powerful aerobic system is helpful for an 800 m runner. The capacity of the aerobic system is not an issue.

The above covers the extreme for 800 m running- the faster than ideal early pace. If a runner is equipped for this, is he also equipped for running at the ideal pace distribution? In the ideal case there is less emphasis on the CP system and more on the lactic. As long as the runner has not neglected his lactic system in his quest for a good CP system, it is likely that he is equipped for the ideal pace distribution.

So there we have it. An 800 m runner needs a reasonably powerful CP energy system with good capacity, a powerful lactic system with good capacity, and an aerobic system that kicks in early and is reasonably powerful.

## ENERGY SYSTEM REQUIREMENTS FOR 1500 METRES

The fast first half variety of 1500 m racing requires the ability to run the first 400 m at $106.5 \%$ of 1500 m goal pace. This is not an easy first lap for most 1500 m runners, and the only way it can be made easy enough to allow another 3 quality laps is by training for it. There is a CP component in such a lap, with the emphasis on CP capacity. There is more emphasis on the lactic system operation, again particularly on capacity. So a combination of CP and lactic energy systems, both of good capacity, is necessary if a runner is to be able to run a fast first lap and continue on successfully. The story is much the same if the fast pace continues for 2 laps. A high capacity lactic system becomes even more important. For the remainder of the race, $1 \frac{1 / 2}{}$ to 2 minutes of running, the aerobic energy system becomes very important, because this is too long a time to rely on the lactic system continuing to provide a significant part of the energy. A well developed aerobic system, not as well developed as for a distance runner but still powerful, is necessary to provide most of the energy, and to prop up the lactic system until the end so that it too can continue to contribute. The remark above in the 800 m section about the necessity of a fast maximum aerobic pace in order to limit the build-up of lactic acid applies even more to 1500 m running, because the build-up must continue for much longer.

The fast second half requires different attributes. The slow early pace must be mainly aerobic, otherwise the lactic energy system will also be required, and the lactic build up carried into the second half will prevent a fast pace being maintained. So a welldeveloped aerobic system is required. That some use of the lactic system is inevitable can be seen from the 1988 Olympic 1500m run of Peter Elliott. At that stage Elliott had run 1:43.41 for 800 m , yet off a gentle (for him) pace of 2 minutes for 800 m he could only manage the last 700 m in $1: 50$ pace for 800 m . But we do not want any significant use of the lactic system in those slow first two laps, which means that the aerobic system must be powerful enough to provide almost all of the speed. Then the fast second half requires a lactic system with great capacity, as well of course as the aerobic system.

What of the ideal pace distribution, which lies in between the above two extremes- two halves of about the same overall pace, with a start and a finish faster than the average pace? It is clear that a runner who is equipped for both of the extremes is indeed ready for the ideal, because the two halves of the race are both less stressful than the halves for which he is equipped.

So the energy system requirements, if a runner is to be completely equipped for a 1500 m race, are similar to those for an 800 m , but not the same. The difference lies at the two ends of the energy spectrum. The 1500 does not require as much emphasis on the CP system as the 800 m , and it requires more emphasis on the aerobic system. Regarding the key system for middle distance, namely the lactic system, again the difference is in emphasis. Lactic power, the ability to produce a large amount of lactic energy quickly, is more important for an 800 m runner than for a 1500 m runner, and lactic capacity, the ability to produce and tolerate a large total amount, is more important to the 1500 m than the 800 m exponent.

## CHAPTER FIVE

## Training the Energy Systems

Anyone seeking an simple event to train for should put this book down and forget about middle distance. A distance runner predominantly uses the aerobic energy system, and most of his training will be to develop that. A sprinter predominantly uses the creatine phosphate energy system, and he would be wasting his time if he devoted too much attention to developing the others. So their training regimes are relatively simple. The middle distance runner on the other hand has to have well developed aerobic, lactic and CP energy systems, which means all have to be trained. A problem will be to fit everything in. But that is the subject of a later chapter. This chapter is about the various training sessions that are used to train the different energy systems. Some of the sessions are quite specific, and only train one energy system, while some train two systems. A race of course trains all three, but an athlete does not race often enough for this to constitute a large part of training.

## Types of Sessions

We should first of all look at the various types of training sessions there are, before we talk about training the energy systems. There is considerable confusion in the terminology used, and a purpose of this section is to avoid the confusion. There is no confusion about the first type of session, whether it is on the track, on the road, or crosscountry; it is the continuous run. This session consists of a run that constitutes the whole session, and it is something like 20 minutes to one-hour duration. Then there are sessions, usually on the track, in which a run of a certain duration is repeated a number of times. That leads us to call these runs repetitions. Some of these are sometimes called "intervals", but we avoid that term because of the confusion surrounding it. The first confusion is what sessions are interval sessions and what are repetition sessions. The second confusion is just what "interval" means. Some people use the term to refer to the effort, while others insist it means the rest or the interval between two efforts.

There are two types of repetition session, and they are distinguished by the nature of the recovery. In the first type the duration of the recoveries is long enough to allow repeat runs that are at or near $100 \%$ effort for the distance. For repeat bursts of 40 or 60 m the recoveries can be just a few minutes, but for maximum efforts of hundreds of metres the recoveries will need to be many minutes. In the second type the duration of the recoveries is deliberately not long enough to allow repeats that are near $100 \%$ effort for the distance. Repeat runs of 100 s of metres, which in the first type necessitated recoveries of many minutes, might only be allowed recoveries of a few minutes or even less in the second type. So the duration of the recovery is not the distinguishing feature. Rather it is the extent of the recovery. We refer to the two types of repetitions as being with full recovery and without full recovery.

There are two variations on the above. The first is a combination of the two types of repetitions. The repetitions without full recovery are done in sets of a few runs, and there is a recovery period between the sets of sufficient duration to allow the level of
effort in the sets to be maintained. In other words the sets are done with full recovery. The second variation, which is just mentioned for completeness, and will not be used in this book, is the use of a number of runs of different length in a session.

It is appropriate at this stage to make a general comment about the above types of session. The continuous run is always considerably longer than any middle distance race. Therefore it is not specific to middle distance. That does not negate its usefulness, and that will be explained in the next section, but it does mean that it cannot be the mainstream of middle distance training. Although recoveries between runs of less than race distance are also not specific, but these sessions can be more specific than continuous runs because the pace can be closer to race pace. In fact a reason for having repetition sessions is to obtain sufficient volume of work at a pace somewhere in the vicinity of race pace. All of this is by way of saying that we should bear in mind that the athlete is training to run a certain distance at a certain speed. We will talk more about this in the chapter on principles of training (Chapter Seven).

## Training the Aerobic Energy System

As we saw in Chapter Three, the aerobic system, like the other systems, has power and energy. The amount of energy it can produce is its capacity, which is way beyond the requirement of a middle distance runner. So we need not concern ourselves any further on developing this attribute of the aerobic system. The attribute we need to develop is the power of the system.

The power of the aerobic system is determined by the rate of consumption of oxygen. Of course it is also determined by the efficiency of the system, and that is a matter of running properly. Good style applies to all the energy systems, and will be discussed at the end of this chapter. But for a given level of efficiency, the greater the rate of oxygen uptake the greater the power of the aerobic system. It is the same as any engine that consumes oxygen. How do we develop the ability to consume oxygen faster? We will consider in detail the general question of how we train anything in Chapter Seven. For the present the answer is: by running in such a way that breathing is as hard as possible for as far as possible. In other words, we want maximum oxygen uptake for as far as possible. This does not mean the fastest pace, for beyond a certain pace the uptake does not increase. So fortunately it is not necessary to run flat out, or anything like it. On the other hand it is not possible to run forever, because the pace that demands maximum oxygen uptake is well into the lactic region. It turns out that a maximum effort of about 8 minutes duration is optimum (Martin and Coe, 1991). Any further and the pace would not be fast enough to demand maximum oxygen uptake. Any shorter run, while the pace might be faster, will not require any greater oxygen uptake, and the maximum uptake is simply being practiced for a shorter time.

A single run of 8 minutes would not normally be sufficient for a session, and the session would probably consist of two or three of these. The runs would not be so stressful as to require inactivity for recovery, and a slow easy run for a recovery would be appropriate. The lactic accumulation would not be high, and a slow run of about five minutes would be sufficient for recovery, but it would not matter if it was 8 minutes because the exercise is purely in the maximum runs. The session is in the nature of a continuous run, even though the effort is not uniform. The session can sometimes take
the form of fartlek- a Swedish word meaning speed play- in which there are maximum bursts of some minutes, interspersed with minutes of easy running.

Another aspect of aerobic running that needs attention is the border between aerobic and lactic effort. This border is also the subject of some confusion in terminology; some speak of aerobic threshold, others of anaerobic threshold, and some speak of both. What matters is that at a certain speed for a runner at a particular stage of development, the ability to manage on aerobic effort ceases, and greater speed requires contribution from the lactic energy system. Obviously the faster the speed at which the lactic system kicks in the better, because there will be less reliance on the lactic system to produce a given speed, and that speed can be sustained for longer. This aerobic ceiling can be lifted by running at or just above the speed at which lactic contribution starts. Since there is some lactic contribution in a $10,000 \mathrm{~m}$ race, if the athlete were to run a $10,000 \mathrm{~m}$ race, we are talking about a pace slower than that. Marathon pace is an appropriate description. It is a pace that, with maximum effort, could be sustained for an hour or more. That is not to say the training run should continue for an hour or more. For a middle distance runner, particularly an 800 m runner, such a run could be too debilitating and adversely effect other training over the next few days. Typically the run would be about 45 minutes, but a longer run from time to time, followed by adequate recovery (measured in days, not hours) would be advantageous.

Long easy runs (half to one hour) are also aerobic, and they have some value. They are sometimes described as conversational runs, because the pace is such as to permit conversation. Provided the terrain is even, they provide an opportunity for the runner to concentrate on style, on not wasting energy, an opportunity that perhaps is lacking in more stressful runs. However if the runner is still able to concentrate on style in harder runs, then this rationale for easy runs is lacking. Another reason for long easy runs is to prepare the body for more demanding work. It is light exercise for the muscles, and conditions the heart, and blood flow paths to the muscles. If an athlete was just beginning after a long break such runs would be beneficial, but it is difficult to see that much conditioning is required after normal breaks at the end of a season. A further reason given for these runs is to facilitate recuperation after strenuous efforts the previous day. They can take away stiffness that comes from tight muscles, and they can make the athlete generally feel better. However if no run at all has the same effect then we have to wonder about the recuperative benefit of the run. It is all a matter of what works, what best enables the athlete to be ready for another good training session that does not lead into a downward spiral of soreness and tiredness. It is not an article of faith that athletes should go for a recuperative run. They should do it if it helps recuperation but leave it if it does not. We have to remember that all running causes wear and tear, and the aim should be to get the desired results with minimum wear and tear, so that the results will keep coming for longer. All of this is by way of saying that easy long runs have their uses, but are not essential in the way that the other aerobic runs are.

As we saw in Chapter 4, the aerobic energy system is relatively slow to become completely operative. That can create a problem as the lactic system is fading and the CP system is long gone. It is only the aerobic system that can hold the speed up, and if that is slow in kicking in then the athlete is in trouble and the speed will fall rapidly. If there is some way the pick-up of the aerobic system can be encouraged to be earlier and faster, that would be well worthwhile. There is as yet no established way this can be done, but
logic can suggest an approach. This is to challenge the aerobic start-up in training by creating an early need for it. Unfortunately this can only be done by running fast for about a minute, so that the CP system is exhausted, the lactic system is being run down, and the level of lactic acid is becoming uncomfortably high. In this situation the systems in the body will do all they can to adapt, so that the situation is not so stressful. One way this can happen is for the aerobic system to pick up earlier and faster, and the training will be encouraging this to happen. This type of training is a variation of lactic capacity training, which will be discussed in the next section.

## Training the Lactic Energy System

Like the aerobic system, there are two aspects to the lactic system, namely power and capacity. Both are important for middle distance running. Power determines how fast a runner can go with the lactic system and capacity determines how far, or for how long. Some sessions will train both power and energy. Firstly we consider power.

Because the CP energy system is going to supply most of the energy in the early part of a run, a run to develop the power of the lactic system must last longer than 20 seconds. A fast CP effort will set up a pace that demands a powerful lactic effort to sustain it. (Actually the effort cannot sustain the pace, but it strives to.) Too long a run will not be powerful enough. 30 to 45 seconds is the optimum range of run to develop the power of the lactic system. The effort is intense enough to be near maximum power, and long enough to provide sufficient exercise. Typically this would be a 300 m run. The effort must be near maximum. The more this is done, the more the power of the system will be developed, so the athlete does repetitions. However the runs have to be high quality in order to train the system properly, otherwise something else is being trained, which might not be beneficial. So the recoveries have to be long, and the number of repetitions has to be limited to that which enables the quality to be maintained. The number of repetitions and the length of the recoveries are determined by the ability and maturity of the athlete. The recoveries will probably range from 8 to 12 minutes, and the number will range from 3 to 6 .

The capacity of the lactic system is determined by lactic tolerance. The operation of the system is going to produce lactic acid, and a good system will of necessity produce plenty. A lactic system could be very powerful, producing lactic acid at a great rate, but the muscles could have a low tolerance to lactic acid, in which case the system would not operate for long. This would be the case if the large number of enzymes, which are necessary to enable the breakdown of glycogen in the absence of oxygen at a great rate, have a low resistance to lactic acid. So the training for a high capacity lactic system should increase that resistance. It does this by challenging the ability of the enzymes to tolerate lactic acid. We need not worry about how this happens. It could be by means of the body producing a buffer to the lactic acid, or it could be by some other method. What matters is that the body does not like lactic acid, particularly when it still has some work to do, and it will find a way to adapt so that a certain level of lactic acid is not as stressful as in the previous experience. This is what conditioning is all about. So the body is trained to tolerate lactic acid by calling on it to continue working when the acid level is already high. Of course this is done gradually. And as the muscles develop the ability to tolerate higher levels of lactic acid, the capacity of the lactic system is improving.

As remarked above it is better if the tolerance is trained gradually, and this begins with training that is really a combination of aerobic and lactic, which will be discussed later. The true lactic tolerance training is much more demanding and stressful. It consists of attempting to hang onto a pace when that pace has already produced a high level of lactic acid. The most effective though also the most stressful session that achieves this is a maximum run of 60 to 90 seconds, the first half of which produces a high level of acid, and the second is an attempt to hang onto the pace despite the high and increasing acid level. It will not be possible to maintain the pace, but the deceleration must be slight. The reason the duration of the run is not longer is that beyond this the aerobic system becomes much more predominant, and the training of the lactic system is not as pure and thorough.

A problem with the above lactic capacity session is that it is so stressful the volume of training is somewhat limited. An alternative is sets of repetitions of shorter duration. Within a set the repetitions are run at a pace that will produce high levels of lactic acid, and they are repeated before the level has subsided much. Ideally they are repeated also before the store of CP has replenished, so that the lactic system is denied this assistance. As we saw in Chapter 3, CP stores are substantially replenished in about 3 minutes of inactivity, so the rests between repetitions within a set have to be considerably less than 3 minutes. A typical session would consist of sets of 3 or 4 repetitions of 30 to 45 seconds, with rests between repetitions of a minute or so. Progress could be by means of reduction in rest duration. This phase of training could commence with a certain goal pace, say race pace, and rests of 2 minutes, and then proceed by holding that pace and winding down the duration of rest over a number of weeks. It would be possible to do 3 or 4 such sets in a session, thus achieving twice the volume as in the sessions of longer runs described above.

The variation of lactic sessions that challenges the aerobic system to come in earlier and faster (referred to in the previous section), is to run for about a minute, but slightly faster for as far as possible. In this way the lactic acid level will go higher, thereby reducing the output of the lactic system earlier, and the need for the aerobic system will be high earlier. There is no need to prolong the run because the only aim is to cause the aerobic system to become effective earlier.

## Training the CP Energy System

As with the other two energy systems, there are two aspects- power and capacity. Power of course is more important for pure sprinting, but capacity is more important for middle distance running. Nevertheless it is not possible to have excellent capacity without a reasonably powerful system, because both depend on the level of CP stores. Another way of saying this is that it is not possible to have a fast sub-maximum pace unless the maximum pace is very fast.

We can take as an example an athlete aiming, without being presumptuous, to run $1: 46$ for the 800 m . We saw in the previous chapter that the athlete should have in his armoury the ability to run the first 200 m in $107 \%$ of the average speed of whole race, which would be 24.8 seconds. Furthermore this has to be comfortable. That is not possible unless the athlete's top speed is considerably faster. For a 400 m runner the first 200 m is about $95 \%$ of maximum 200 m speed, so it is reasonable to expect the first 200 m for an 800 m to be at about $90 \%$, which would indicate a top speed of 22.3 seconds. It
could be slightly slower because this first 200 m of the 800 m would be unusually fast. Nevertheless since the first 200 m must be comfortable, and even more comfortable than the first 200 m of a 400 m , the athlete must be capable of substantially less than 23 seconds. This requires power, and power training is called for.

The best training to develop CP power is multiple repetitions of short maximum sprints. 40 m or less is too short, because in these the emphasis is on acceleration. On the other hand 100 m is too long, because deceleration is underway towards the end. That is not something that needs training, and besides the energy in the deceleration portion could be more usefully utilised in doing an increased number of shorter runs. All this makes 60 m the ideal length for the repetitions. They do not use up much energy so many are possible. As we saw in Chapter 3, it takes about 3 minutes for replenishment of CP stores, so we need about 3 minutes between runs. They must be smooth, in order to be repeatable and so form a basis for improvement. One fast ragged run, of which only the raggedness is repeatable, is not the basis for developing speed. Up to 15 repetitions should be possible. There is value in total volume, because what we want to train are smooth fast movements, and the more repetitions the more natural these movements will become, and the easier it will be to speed them up a little more. The 60 m sprints can have rolling starts, because this takes the emphasis off explosive acceleration, which is not necessary in middle distance.

Having said that explosive acceleration is not necessary in middle distance, it is worth mentioning here that this is no reason to give away a valuable tenth or two of a second by means of a bad start. Yet most middle distance runners, even some international 800 m runners, do precisely this. It is quite common to see runners, at the sound of the gun, pick up their front foot and put it down again, before getting their back foot off the ground. Runners would do well to remember that the start is like a crouch start. The back foot must move first if there is to be forward motion, and a way to ensure this is by a forward thrust of the opposite arm as an immediate reaction to the gun. That will encourage movement of the back foot first. It is certainly worth practising.

If the stores of CP are high, which the above power training will achieve, the middle distance runner is then concerned about gradual rather than the explosive exploitation of those stores, so that the CP system will last for much of the first 200 m of an 800 m or 1500 m . This can be achieved by gradually lengthening the sprint, while decreasing the acceleration so that deceleration does not set in significantly before the sprint is finished. The 60 s become 100 s , and then 150 s , and finally 200 s . The number of course decreases, say from $15 \times 60$, to $10 \times 100$, to $8 \times 150$, to $6 \times 200$. In all of them the emphasis is on speed, but smooth, repeatable speed. By the time the athlete gets to the 200s the speed should be so ingrained and extended that it is comfortable over the full 200 m , and so comfortable that the sixth is as fast and no more trouble than the first. The speed at this stage needs to be faster than $107 \%$ of 800 m goal average speed. For the 1500 m runner, who needs to be able to run the first lap in $106.5 \%$ of goal average speed, the story is much the same. He also needs to be able to churn out 200s that are comfortable and yet faster than $107 \%$ of his 800 m goal pace.

## Training Combinations of Energy Systems

In middle distance at most stages of the race more than one energy system is in operation. While it is important to do training that emphasises only one system at a time, so it can be properly developed, it is also important to train systems in combination,
because they need to be able to work effectively together. To some extent the above sessions accomplish this, though by no means sufficiently. All runs of necessity start with the CP system, so all of the above sessions include some CP training. But only the CP sessions really tax the CP system, so only they qualify as proper CP training. At the other end, in the lactic capacity training the aerobic system is coming into play at the end of an effort. In fact this can be a deliberate aim when the training is also designed to encourage earlier significant contribution from the aerobic system. Nevertheless the effort is predominantly lactic, and this is the focus of the training.

The sessions discussed below are different in that they deliberately work the combination of systems.

## Training the Aerobic and Lactic Systems

Sprints aside, any run that is faster than maximum steady state pace uses the lactic energy system, and incurs a build up of lactic acid. If the pace is too fast the build up is considerable, and the effort soon comes to an end without any significant aerobic training. So the pace has to be between steady state and maximum 90 second pace. (The latter is about the maximum duration of lactic production and lactic tolerance.) As for the duration, anything approaching 10 minutes is too close to the aerobic power run. Anything less than 30 seconds does not stress either system to any great extent. Therefore the runs are of duration between 30 seconds and about 5 minutes. This means that they will be performed in repetitions, in order to develop sufficient volume.

It is important to structure the sessions in order to get the most out of them. The duration of each run, the pace, and the rest are all interrelated. In order to begin to develop some idea of the structure of these sessions, it is necessary to have some idea of the pace of maximum lactic effort and maximum aerobic effort. Obviously athletes differ, and so it is not possible to be precise, but we can obtain a sufficiently accurate idea of the two speeds to enable us to design the lactic/aerobic sessions. Using 800 m pace as a basis, the pace for a maximum lactic production and tolerance effort would be about $105 \%$. At the other end an athlete could probably manage a $10,000 \mathrm{~m}$ at about $70 \%$ of 800 m pace.(This would mean a $1: 42$ runner being able to run 30 minutes.) We can assume that the athlete would lose about another $4 \%$ of speed in going to a maximum one hour run, which would be close enough to aerobic maximum. Thus maximum aerobic speed is about $67.5 \%$ of 800 m speed. A pace half way between aerobic speed and lactic speed is $86 \%$ of 800 m speed, which is reasonably close to 3000 m pace. We need not quibble about whether a $1: 42$ athlete would run a $10,000 \mathrm{~m}$ in 30 minutes. It is close enough for the purpose of establishing a framework for these lactic/aerobic sessions. We should note that 3000 m speed is about the pace for the aerobic power sessions discussed above. The repetitions should not be any slower than this, because we are then into aerobic predominance, and the sessions would be more suitable to a distance than a middle distance runner. This is not to say they are not useful to a middle distance runner. They are, but there is a limit to the number of sessions an athlete can do in a certain period, and the aerobic power and aerobic ceiling sessions are probably more valuable than the slower mixed sessions because they are more specific.

So 3000 m pace is to be the slowest speed of the repetitions. What should be the length or duration of each repetition at this speed? We suggested above that it should be no greater than 5 minutes, in order to make it a sufficiently different session from the
aerobic power one. Even 5 minutes at 3000 m pace might be too taxing to be repeatable in a package that warrants the name repetitions. One kilometre runs are definitely manageable and repeatable, and a package of 6 to 8 is also manageable. What should the recoveries be in order that the session sufficiently stresses both the aerobic and lactic systems? That is largely a matter of lactic tolerance, which is the aspect of the lactic system we are trying to train. Too little recovery will cause excessive lactic acid build up, and the pace of the later repetitions will drop below the required 3000 m pace. Too much and the runs become somewhat separate exercises, and the level of lactic acid falls to the extent that lactic tolerance is not being sufficiently trained.

In order to find out what the rests should be for these 6 to $8 x 1 \mathrm{~km}$ runs at 3000 m pace we need to compare their lactic performance to a 3000 m run. A good 3000 m run will produce the maximum amount of lactic acid without going into lactic speed collapse. It will be a steady pace that accumulates lactic acid at such a rate that at the end the maximum speed possible falls to the steady pace. The maximum reasonable amount of acid will have been accumulated. (We can regard an amount that causes lactic speed collapse as unreasonable.) We know from Chapter 3 that this amount of lactic acid will take about 30 minutes to dissipate. The dissipation in the rests in the $6-8 \mathrm{x} 1 \mathrm{~km}$ repetitions is going to allow the 3000 m pace to be continued for $6000-8000 \mathrm{~m}$. All the while the level of lactic is building up, albeit more slowly than in a 3000 m run, and the body is being trained to cope with this build-up. Each 1 km repetition at 3000 m pace is going to accumulate $33 \%$ of the maximum acid level. Six repetitions would accumulate $200 \%$. The rests have to dissipate $100 \%$, so that at the end of the session the lactic level is the same as after a good 3000 m run. At first glance that would indicate that the 5 rests should be 6 minutes each, because the total rest time would then be the 30 minutes required for dissipation of $100 \%$ acid level. However anyone who has ever done repetitions knows that the first seconds of a rest get rid of a disproportionate amount of acid. The dissipation is not linear with time. When we know that an amount is too high (or too low), but do not know by how much, a reasonable first estimate is to halve it (or double it), and see how it fits. Using this device we arrive at 3 -minute rests, which experience shows is reasonably manageable. That gives a ratio of duration of effort to rest of about $1: 1$, which provides a good rhythm to the session.

What we have finished up with for the most aerobic of the mixed lactic/aerobic sessions is $6-8 \mathrm{x} 1 \mathrm{~km}$ with 3 minute rests. It has to be appreciated that the data on which it is based is a bit rubbery. 30 minutes for dissipation of lactic acid is a nice round number, and is really not much more than indicative. The rate of dissipation in the first minute or so is certainly greater than the overall rate, but may not be twice as great. But none of this matters because everything is in the right direction and it gives us a framework which will work. The aim is to run at a pace that is half way between aerobic and lactic, and this is roughly 3000 m pace. The framework allows the athlete to do twice the work of a 3000 m run, but in a rhythmic fashion that is not too stressful. The 3 minute rests might be too little or too great, but will not be out by much. They can be varied slightly to hold a specific pace if desired. Other variations are possible if a pack of runners, not all the same standard, is doing the session. The better runners can go a bit further than 1 km and also have a shorter rest than 3 minutes, and the slower runners can run go less than 1 km and have a longer rest. The essentials of the session are the right pace and rhythmic running.

We move on now to other lactic/aerobic sessions, moving towards the lactic end. A faster pace means shorter runs, if we are to keep the session contained as a package that stresses lactic tolerance. The key then to designing the session for its express purpose is the duration of the rests. Having decided that 3 minutes, or thereabouts, is the required rest duration for the session of 1 km runs at 3000 m pace, it is possible to work out from that what the rests should be for the other sessions. This is done by adjusting the rests so that the dissipation of lactic acid is the same as for the 1 km session. Appendix 3 contains the reasoning and the calculations, and the rests are stated below.

The pace of the next session to consider is 2000 m pace, which is about $40 \%$ of the way between lactic and aerobic. At this pace 600 to 800 m runs would be appropriate, and we choose the shorter distance to make the package sufficiently different from the 1 km session. 6 to 8 repetitions again gives about twice the volume of a single 2000 m run. Appendix 3 shows that the faster pace coupled with the shorter distance and the same number of repetitions, produce about the same amount of lactic acid as does the longer session, so the rests can be the same. This would give us sessions of $6-8 \times 600 \mathrm{~m}$ with 3-minute rests.

Moving further towards the lactic end we reach 1500 m pace, which is about $30 \%$ of the way between lactic and aerobic. There are a few combinations that will give a reasonable package, one of which is $10 \times 300 \mathrm{~m}$, again twice the distance indicated by the pace. Appendix 3 shows that the rests for this session should be slightly more than one minute, and one minute could well be used. However 45 seconds has some appeal, because it gives us the one to one ratio of effort and rest, and this allows a good rhythm to be developed.

1000 m pace is about $20 \%$ of the way between lactic and aerobic, and is the basis of the next session. Anything further than 300 m at this pace will require rests that are too long to maintain a rhythm, and anything much shorter will be insufficiently lactic, so the runs will be 300 m . Eight of them will give a total distance of 2400 m , a little more than twice the 1000 m on which the session is based. The additional pace compared with the $10 \times 300 \mathrm{~m}$ session above will produce considerably more lactic acid, and the rests will need to be extended. Appendix 3 shows that the rests need to be about 100seconds, but again we adjust downwards slightly. 90 seconds duration fits nicely into the pattern of the other rests, being half the rest of the longer sessions and twice that of the shorter session. Furthermore it gives a rest to effort ratio of about $2: 1$, which is still sufficiently rhythmic.

There is nothing hard and fast about the above sessions. They form a coherent whole, in that they are based on specific speeds- $1000 \mathrm{~m}, 1500 \mathrm{~m}, 2000 \mathrm{~m}$ and 3000 m - that are $20 \%, 30 \%, 40 \%$ and $50 \%$ along the way between lactic speed and aerobic speed. So they give a good coverage for a middle distance runner of a lactic/aerobic mix. The distance covered in a session is roughly twice the distance the athlete could run at the pace without rests, and the rests enable the greater volume of training by reducing the intensity. The rests are related nicely to the duration of effort and so provide a good rhythm of training, and they are nicely related to each other, being 1,2 and 4 times 45 seconds. The sessions form a compact, ordered set, in which speed progression is possible if desired. Nevertheless they form but one of a number of possible sets of mixed lactic/aerobic sessions, and coaches and athletes will doubtless devise others. The
important thing in designing a session is to focus on what you are trying to achieve in the session- the speed, and, given the speed, the volume and the lactic tolerance training.

A progression through a range of lactic/aerobic sessions, from most aerobic to most lactic, has certain advantages. One of these is that in the slower sessions the lactic acid builds up slowly, allowing the body to adapt to rather than be overwrought by the acid build up.

The set of sessions described above is given in table form below.

| LACTIC/AEROBIC | PACE | DISTANCE | RESTS |
| :---: | :---: | :---: | :---: |
| $50 / 50$ | 3000 m | $6-8 \times 1000 \mathrm{~m}$ | 3 min |
| $60 / 40$ | 2000 m | $6-8 \times 600 \mathrm{~m}$ | 3 min |
| $70 / 30$ | 1500 m | $10 \times 300 \mathrm{~m}$ | 45 sec |
| $80 / 20$ | 1000 m | $8 \times 300 \mathrm{~m}$ | 90 sec |

Figure 5.1. Table of mixed lactic/aerobic training sessions.
There might be some scepticism about the percentages quoted above. However all that is implied is that if maximum 600 m pace represents lactic speed, and $5 \%$ slower than $10,000 \mathrm{~m}$ pace represents aerobic speed, then above percentages applied to those two speeds roughly gives the paces stated.

## Training the Running Style

If the energy systems are the fuels that power the running machine, the running style represents the tuning of that machine. We can have high quality fuels, but to some extent they are wasted unless the engine is properly tuned. Similarly we can have high quality energy systems, but some of the energy is wasted if the runner does not have an efficient style. This chapter is mainly about training the energy systems, but an energy system cannot exist in a vacuum and it requires a muscular system to which it can supply energy. So it is appropriate in this chapter to also talk about training the operation of the muscular system or, in other words, training the running style. That is what this section is about.

There is a prejudice about, particularly in other sports, that running is just something you do in other sports. It is not a skill in itself, it is just something you do in exercising other sporting skills. Everyone can run, it is just that some people can run faster than others. Unfortunately some of this attitude rubs off on athletics as well, and runners train very hard to get the most out of themselves without learning to run properly first. The result is that some of their training is wasted because some of the energy expended goes to extraneous movements, and indeed facilitates the training and embedding of those movements. They become so ingrained that, with the best will in the world, they cannot be eradicated in a race, and the performance is less than it might have been. So neither the training nor the racing is efficient. A problem with inefficiency is that you have to do more than you need for the same result. Running causes wear and tear, and the more you do the more the wear and tear. So inefficient running is more likely to lead to injury.

We know of almost perfect stylists like Carl Lewis and Wilson Kipketer, and it would be nice if everyone could be like them. However this is not possible, because
many people, even good runners, have some aspect of asymmetry about them. This might be something like one leg slightly shorter than the other. Such asymmetry would prevent a symmetrical running action, and any attempt to obtain one by style alteration is doomed to failure. So before we spend an inordinate amount of time and frustration trying to correct an asymmetric style, we should find out whether a symmetrical style is possible. That will probably involve a visit to a good sports doctor or physiopherapist, and this would be the strategy if a month or so of trying was unable to effect a correction.

Before we talk about training for style it is important to realise just what constitutes running. Although running is a linear motion, it is brought about by a series of rotational motions of limbs around joints. Thigh rotates around hip, lower leg rotates around knee, foot rotates around ankle, and toes rotate around the metatarsophalangeal joints. All of these joints are extended in order to pull or push on the ground, and it is this pull or push that thrusts the body in the intended direction of travel. If the rotations do not take place in the plane of the direction of travel then extraneous movements are set up, which have a double deleterious effect. The first is that they waste energy. The second is that, if the running direction is not to be effected, opposing motions have to be set up, which waste more energy.

It is the legs that produce the forces that cause running. The motion of the arms is to balance the torques set up by the legs. The legs operate either side of centre line, and unopposed would twist the body. The action of the arms is to oppose the torques set up by the legs and to stop the body from twisting. The rotations of forearm around elbow and upper arm around shoulder should also be in the plane of travel, but with a qualification. This is the fastest way to provide opposing torques to the legs, and is used in sprinting. However it is energy sapping and cannot be continued for too long. For longer, slower running a slight oscillation of the trunk around the vertical centre line is combined with a gentler arm action to counter the torques caused by the legs. This is slower, and so not suitable for sprinting, but it is less energy demanding and so can be continued for longer. It is important to realise that any irregularity in leg movement must be balanced by an irregularity in arm movement, so if the leg irregularity is natural, it is useless trying to eradicate the opposing irregularity in the arms.

In order for the runner and coach to know whether the runner is conforming to the ideal, it is probably necessary to view the running in slow motion and from a number of angles. This requires a video camera, and if neither runner nor coach possess one it should be possible to borrow. It is well worthwhile because a runner has no idea what he looks like, and so does not have a feel for what he is trying to correct. Most coaches do not have a good enough eye to pick up what can be seen by playing a short piece of action over and over again in slow motion.

When it is known that a runner is symmetrical, or has been made as symmetrical as possible, he can then work on efficiency. This means, as much as possible, all movements working to project the body in the desired direction of travel. It means, as much as possible, no movements competing against other movements, and no energy wasting movements which are extraneous to projection in the desired direction of travel. It means foot placement so that muscles are working in the line of travel, and indeed that the right muscles are working. This is vital because travel only comes from forces applied on the ground though the foot. It is not unusual, even in good runners, to see foot placement at an angle to direction of travel. Some might say that the success of those
runners demonstrates that it does not matter. However that flies in the face of logic. If the foot is not in the line of travel the muscles of the leg used for propulsion cannot be used optimally. This fault is sometimes the result of some muscles not working properly, and they can be taught to work properly. Again this will probably involve a visit to a good sports doctor or physiotherapist, who will prescribe some exercises to teach the muscles to work properly. It usually is something an athlete cannot correct simply by trying, so some professional help is required.

One of the reasons most athletes need a coach is because they cannot see themselves, and have little idea how they are running. This is all right when their style is almost perfect, but most are not like that, and if they are, do not stay like that. Bad habits creep in and good habits have to be developed. Most athletes need to be constantly supervised, in order that problems can be eliminated before they become habit, and so that bad habits can gradually be eradicated. This is something a coach looks for all the time, and he will, without discouraging the athlete with constant criticism, correct as necessary. It will help if the athlete has a vivid mental picture of a good running style. He might gain this by frequently watching a video of a champion with a good economical style.

As well as the coach always being on the lookout for faults, and the athlete always being conscious of running properly, it is a good idea to have sessions that are devoted mainly to style. These will not be strenuous, so the athlete can give full concentration to running properly. Such sessions could be once a week if there is a fault to eradicate, or once a month for maintenance.

## Summary of Training Sessions

Below is a table that sets out all of the above training sessions, from fastest through to slowest. They form a consistent group, covering the whole range of sessions, but they are by no means the only possible group.

| No. | Pace | Distance | Repetitions | Recovery | Training Effect |
| :---: | :---: | :--- | :---: | :--- | :---: |
| 1 | $100 \%$ | 60 | $10-15$ | Full | CP power |
| 2 | $97.5 \%$ | 100 | $10-12$ | Full | CP capacity |
| 3 | $95 \%$ | 150 | $6-8$ | Full | CP capacity |
| 4 | $95 \%$ | 200 | $5-6$ | Full | CP capacity |
| 5 | 400 m | 300 | $5-6$ | $8-12 \mathrm{~min}$ | Lactic power |
| 6 | $800 \mathrm{~m}+500$ | 3 | $12-15 \mathrm{~min}$ | Lactic capacity |  |
| 7 | 800 m | 600 | 2 | $15-20 \mathrm{~min}$ | Lactic capacity |
| 8 | 800 m | 300 | 2 sets of 3 | 2 min reducing. <br> Lactic capacity | L-12min* |


| 9 | 1000 m | 300 | 8 | 90 sec | Lact/Aerob.(80/20) |
| :--- | :--- | :--- | :---: | :---: | :---: |
| 10 | 1500 m | 300 | 10 | 45 sec | Lact/Aerob.(70/30) |
| 11 | 2000 m | 600 | $6-8$ | 3 min | Lact/Aerob.(60/40) |
| 12 | 3000 m | 1000 | $6-8$ | 3 min | Lact/Aerob.(50/50) |
| 13 | 5000 | 3000 | $2-3$ | $5-10 \mathrm{~min}$ | Aerobic power |
| 14 | max ss\# | 45 min | 1 |  | Aerobic ceiling |
| 15 | 800 m | 100 | many | Full | Style |
| *...2min between reps., reducing over a number of sessions, <br> 8-12min between sets |  |  |  |  |  |
| \#... maximum steady state |  |  |  |  |  |

## CHAPTER SIX

## Non Specific Training and Other Issues

The training sessions described in the previous chapter all involve running, and indeed running normally. The speed is fast or slow, and the distance is short or long, but it is still normal running, the type of running that would be used in a race. However we need to consider more than normal running in the development of the middle distance runner. In fact we need to be mindful of much more than simply physical activity. All of this is important as we go on in a later chapter to put together training sessions in a training program.

The athlete is a complex human being, and is much more than just a person who can run. We ignore this at our peril. This chapter is a discussion of some of the many facets of a middle distance runner's life which impact upon his running, and which are impacted on by his running. Some of them are more important than his running, and this book is not the vehicle for considering them in their own right. However if something is more important than running, and affects and is affected by running, we have to give it some consideration in the development of the runner.

## The Life of a Middle Distance Runner

Most runners who take their running seriously aspire to be among the best, even among the best in the world. That is as it should be. Unless they have that sort of a vision they will not achieve the reality. However it is a mistake for an athlete to have this as his only vision. There are more important things in his life, such as obtaining a career that is interesting enough to be enjoyable for a long time and will provide the necessities of life, and having good relationships with other people, particularly family. Regarding the first, young athletes sometimes have ambitions of building a career around running, and making enough money out of the sport to facilitate this. A few athletes do manage this, but it is not something you would rely on with any degree of certainty. So many things can go wrong, which will prevent the athlete being as good as he expected to be, and then there is little money and no career. Of course the same is true of other careers as well; the person might not turn out to be as good as he expected to be. But he will still have a career, and it can still be a satisfying and able to provide the necessities of life. So an aspiring middle distance runner should have a career or the ambition of gaining one.

Even athletes who are good enough to make a good living out of athletics for a few years of their life would be well advised at least to have their eyes on a career after athletics. They have many, many years of life left, many more than they have devoted to athletics, and it would be a tragedy if they have only memories ahead of them. So all middle distance runners, whether they have aspirations of being professional athletes or not, should be aiming for a career. When they are younger this means study, and when they are older it could mean more study. From when they start to become serious about athletics, study and career should be a more important focus than running.

Even more important than study and career are personal relationships. These are more likely to determine whether the athlete is happy. It barely needs to be said that being happy is the most important thing in life, and the athlete has every right to make this his first priority. It must also be the first priority for the coach and anyone else advising him on athletics. So relationships must be a higher priority than athletics. The running program should not be such as to take the athlete away from the family when he is needed there, or deprive him of the time and opportunity to have close relationships with other people. This would create tensions that could in the end make the athlete unhappy. It would also interfere with his development as a person.

The above restrictions on an athlete's dedication to his sport might seem to reduce his chances of success. However history gives us plenty of examples to the contrary. Roger Bannister, John Landy, Herb Elliott and Seb Coe spring to mind, and there are plenty more. As this book is trying to say, middle distance attracts intelligent people, and they are well able to handle the triple priorities of people, study or career, and running. In fact there is plenty of evidence that they complement each other well. People who are well organised so that they can fit their running in, are able to carry that organisation over into their studies, so that they study more effectively. They are less likely to waste time. Similarly they can carry over into running the thinking ability they develop in study, and this will eventually make them better runners.

There is something else to be said for having the above triple priorities. Sometime something will go wrong with one, and if that was all there was to the person's life, he would not be happy. However with the three-pronged approach to life, a temporary setback in one is not a disaster. It can lead to greater concentration on the others for a while, which would take his mind off the setback, as well as perhaps providing rewards in the other two priorities.

Any book that purports to be for the guidance of those passionate about middle distance running must not be only for those right at the top of the heap. The others are no less important, and it should not even need saying that first is meaningless unless you have second, and so on. They all matter in the sport. This book is for all who love middle distance running, not just for those who are good enough or wealthy enough to be full time professionals. Therefore it recognises that there is much more to an athlete than his running, and sees running within a whole framework for the development of a person, a framework that will enable the person to reach his potential on a wide front. There is much to be said for the old Latin motto: Mens sana in corpore sano- a healthy mind in a healthy body.

When we come, in a later chapter, to putting training sessions together to form a training program, we will be mindful of the above.

## The Female Middle Distance Runner

This book is now about to break with the convention of the use of the masculine pronoun to mean either male or female, because this section is only about females. Women have quite rightly won the right to contest every event a man can contest, though it has taken many years, and required the breaking down of many myths and prejudices. As far as event programming is concerned, women should be treated exactly the same as men. However they should not be treated the same as men in their training and
competition programs, by themselves or whoever is guiding them, because there is a fundamental difference. Men do not have menstrual cycles.

It is a fact that regular training, particularly long runs, can delay the onset of puberty, and can cause established menstrual cycles to stop. Both of these conditions can be causes for some concern. It is abnormal for a girl in her late teens or a mature woman not to have reasonably regular cycles and this lack needs to be checked with a medical practitioner. It might be quite safe but it would seem unwise to continue with the condition for a length of time without having it checked. Long periods of time without menstruation can give rise to loss of bone density, and this can lead to problems of osteoporosis in later life. Checking with a sympathetic sports doctor is easy and well worthwhile.

## Nutrition and Diet

In the author's opinion, there is much nonsense spoken on this subject. All that is needed is the good sense most athletes grow up with in a family environment. In general no fancy eating is required. In particular cases some special food intake could be necessary. Most athletes can save themselves considerable money and trouble by sticking with the eating with which they have been brought up. Their parents have been concerned to make them healthy, and no one will do much better than that for them.

It is said that we are what we eat. In a limited sense that is true, but certainly what we eat determines how we run. As we saw earlier, running requires energy, and that energy is stored as chemical energy in the body. It does not just appear there, it has to be put there, and we put it there by eating. Like many forms of energy we encounter in life, the chemical energy for running is a hydrocarbon, and its source is plants. We acquire the energy by eating things that grow in or from the ground. The obvious source is vegetables and fruit. The runner needs plenty, and the more he runs the more he needs. A good mixture of vegetables is desirable, so that the full range of vitamins and minerals is obtained. The vitamins and minerals do not provide the energy, but they enable the body to perform all the functions it should. So vegetables ideally should include each day leafy vegetables, root vegetables, greens and colour vegetables.

So much for the source of energy. However a plentiful supply of energy will be useless without a good engine in which to use it. This engine for the runner is his muscular system and bone structure. Muscles are built from protein, which comes from meat, fish, dairy products and some vegetables. Unless there is a reason for avoiding meat and fish, it is probably better not to rely solely on vegetables for protein, because one has to know which vegetables contain protein. In any case meat is a richer source of protein. However it cannot be denied that some vegetarians eat very well and obtain all the muscle they need. Bones need calcium, and this is obtained from dairy foods and some vegetables.

So a good balanced diet, made up of meat, fish, dairy products, vegetables and fruit will provide the athlete with the engine and the fuel for quality running.

Is anything else, or anything less, necessary for success? Firstly there are a few qualifications. The greater training distance an athlete covers the more carbohydrate he needs to eat in order to obtain the necessary fuel. Secondly after an illness an athlete might have a vitamin or mineral deficiency, for which a doctor could advise a course of vitamins. Thirdly athletes who cover great distances, particularly female runners,
sometimes suffer an iron deficiency, and a doctor could advise an iron-rich diet for a while or a course of iron medication. The first is common sense. The second and third involve some health problem and diagnosis and treatment is the province of a doctor.

With those qualifications, there is no evidence that anything more or less will lead to any more success. Various food supplements are available and promoted as building muscle, making stronger, etc., but there is no hard evidence that they result in better performances. Athletes who use them are relying on faith rather than science. Whatever the supplements have in them that is purported to be advantageous is available in sufficient quantities in a good balanced diet. As for diets that have less in them, such as low fat diets, similarly the author is unaware of any evidence that, in normal circumstances, they produce better results. Of course if an athlete is carrying excess fat for some reason, a low fat diet might be desirable for a while. But very, very few athletes in training are in this category, and most likely if they are it is because of injury. It is tempting to believe that since excess fat is bad then any fat is bad, but that is a fallacy. Some fat is necessary in food intake. Low-level exercise for example is fuelled from fat, and there is plenty of such exercise during the day, so some input is necessary. Of course an athlete should eat lean meat and avoid fast foods, which tend to be high in fat, but in the absence of special circumstances this should be sufficient caution.

In the absence of reliable indicators a normal balanced diet, as described above, is all that is necessary. The reliable indicators are performance and weight. Weight gain together with falling performance would indicate that the athlete's diet needs looking at. Similarly weight loss and falling performance signals that the diet should be examined. Athletes should be encouraged to keep a daily check on their weight, at the same time every day, so that trends can be detected early. As well a coach should enquire from time to time about the athlete's eating habits. Generally speaking the body will adapt to the stresses put on it by training; it will shed unnecessary weight and it will signal what and how much food is required. The athlete should be encouraged to listen carefully to his own body, and to heed the signals it is sending. Thus it is not sufficient for an athlete to realise he is hungry and to satisfy that hunger; he should sense what food his body needs and satisfy it specifically.

## Training Other Than Normal Running

Having covered the non-athletic issues that impact largely on a runner's career, we move on to some training considerations that are outside the realm of normal running. These are intended to supplement running and are part of training. They include weight training, plyometrics, and resistance running.

## Weight Training

Just as the energy systems are analogous to the fuel in a motorised device, so the muscular system can be likened to the engine itself. The previous chapter was devoted to training the energy systems, or improving the quality and quantity of the fuel; this section is about training the muscular system, or improving the engine. Of course we must realise that it is not possible to train the energy systems in a vacuum. We can only train them by using the muscular system, and this also trains the muscular system. But perhaps we can build a more powerful muscular system, which enables us to run faster or
further, by means of specialised training of the muscles. This is the goal of weight training.

Weight training is not specific to running, but the theory is that by making muscles strong enough to move a greater mass, they will be able to move body or limb mass faster. There is no evidence to show that this is a universal truth. Weight training is fairly common among sprinters, though it is not even universal for them. Obviously most sprinters believe it is beneficial, or they would not be doing it. The practice is less common among middle distance runners, though many do use it. It is probable that it has helped some, perhaps only at some stage, and that it is detrimental to the performance of others. Why should this be so, when the theory says that a weight-trained muscle will be a stronger muscle, and a stronger muscle will move the limb faster? There are a few possible reasons. The weight training could give rise to additional mass that must be moved, and the extra strength might not be sufficient to move it any faster. Or the additional strength might come at the cost of reduced mobility, which impedes speed of limb. It is possible that weight training, while increasing the strength of the relevant muscle, inadvertently sets up some behaviour in another muscle that is undesirable for running speed. Or it could simply be that weight training for some athletes is not particularly specific. They learn to move a particular weight faster, but the muscle has developed so as to do just that, and there is no translation to the movement of body or limb mass. Yet another is that weight training leaves some runners so tired that they are unable to do quality running sessions.

An indication that weight training for runners is not an exact science is the disagreement between experts about what weight should be used. If weight training is to be employed, it is power that must be trained. The athlete could start with weight training that will improve muscular strength, i.e. the force that the muscle can apply, but it is speed of movement that matters and eventually muscular power must be trained. Some experts hold that weights approaching 1 repetition maximum should be used, and moved as fast as possible. Others say that only about $30 \%$ of 1 repetition maximum should be used for the development of power. This is a wide discrepancy, which does not induce much confidence in the training.

Despite all of the above, most of which is negative, weight training is something that should be considered for a middle distance runner. There are plenty of examples of very successful athletes having used weight training, and they and their coaches saying that weight training was a factor in their success. Perhaps a prime example is Seb Coe, and he might be typical of the type of runner who could benefit. He started his athletic career in his early teens as a slightly built cross-country runner without much speed. His father-coach actively sought speed for him, and one method employed was weight training. It is likely the reason he did not have much speed when he was young was his lack of muscle, and it is possible that some of the very effective muscle he did gain was due to weight training.

If weight training is employed, it is essential that the coach and/or athlete know why it is employed, and then ensure it is effective. If the reason is speed, as it probably would be, then speed should increase, otherwise why do weights? If speed is not improving then something is not working, and something should be discontinued. It is likely that this "something" is weights, for one or more of the reasons mentioned above. If an increase in speed follows the inclusion of weights in the training program, it is
reasonable to suggest that weight training is the reason, and of course the training would be continued. A question to ponder is whether there is any time delay between the gaining of additional strength and the expected increased speed. Beyond the normal adaptation to increased load, which might take a few weeks, there seems no reason to postulate any time delay. That being the case, signs of increase in speed should be apparent after a month or so. If they are not apparent, there would seem to be no reason to persist with weight training, because there are plenty of useful things a middle distance runner can be doing, and limited time to do them in.

## Weight Training Exercises

Before we embark on a weight training program we need to consider what muscles are used in running and how. Many exercises are available and they will develop better muscle, but if it is not muscle used in running then the exercise is not for running. The runner could develop the best chest in the nation, but if this does not help him to run faster then it is useless as running training. In order to decide on what exercises might be beneficial some thought about the use of muscles in running is required.

Almost all propulsion in running is the result of the leg muscles causing the foot to push or pull on the track, or causing the leg to pull the hip forward. This is simple but fundamental. The upper body plays only a secondary role in running. The propulsion is initiated when the foot grabs the track as a result of the leg being accelerated in the backward direction. The foot is fixed when it hits the ground, and thereafter the pivoting leg propels the hip forward. The acceleration of the leg is achieved by the contraction of the hamstring muscles, and in fact begins with an eccentric contraction that reverses the direction of motion of the leg. The faster the runner the more important this action is. It certainly is the most important for a sprinter, but probably also is for the middle distance runner. An exercise that works the muscles in something like the required fashion, and with the extra loading, is a step-up onto a platform with a barbell across the shoulders. The exercise is performed with a sharp pull-back of the lead foot, followed by a quick straightening of the knee. One reason for the step-up (another will be discussed shortly) is that it gives a greater range of rotation about the hip than would be obtained by a simple step forward.

Another exercise that works the hamstrings, though not as specifically, is the hamstring curl. In this the knees are flexed against a resistance that is applied at about the bottom of the calf. The hamstring muscles are used to bend the knee, whereas in running their main function is to cause rotation of the thigh about the hip. Nevertheless the exercise does strengthen the hamstring. Also the hamstrings do have a minor function of flexing the knee slightly just before ground contact. This rotation, added to the more powerful rotation of the thigh about the hip, increases the backward speed of the foot on ground contact. In addition the hamstrings come into play again to flex the knee immediately after the foot completes its drive and leaves the ground.

When the foot hits the ground the body is descending under the action of gravity. In the absence of any restraining force the knee would buckle. This would cost time and additional energy would also be required to lift the body again. So it is necessary to prevent the knee from buckling. This is achieved by the action of strong quadriceps
muscles. An exercise that achieves this is the above weighted step-up. Another is the half squat, and this has another purpose as well, which will be discussed below.

The next part of the stride is the continued contraction of the hamstrings, and also the gluteal muscles, in rotating the thigh around the hip and thereby thrusting the hip forward. An exercise that strengthens the hamstrings and gluteals, as well as other muscle groups, is the half squat. Another is the split squat. A third exercise requires a machine that exists in most gyms. It applies a force by means of pulleys behind the athlete's knee, and the leg is rotated around the hip against the force.

The final part of the pull/push action on the ground is the extension of the knee and ankle in order to give drive off the track. The knee extension requires strong quadriceps and we already have an exercise for that. Another is the knee extension exercise, which is often performed on the same apparatus as the hamstring curl. The ankle extension is achieved by the contraction of the calf muscles. An exercise to develop these muscles is heel raises. The athlete rises up on his toes against a gravity force applied on his shoulders.

While one foot has been on the ground the opposite leg has been swinging forward and up. This is a very necessary action because it pulls the opposite hip forward in unison with the one being propelled forward as described above. If this did not happen we would have rotation of the hips about the vertical axis. The forward swing of the free leg requires strong hip flexor muscles, and an exercise to develop these is to swing the flexed leg forward against a resistance, or with the leg weighted. Again most gyms would have an apparatus in which a resistance is applied to the thigh as it is swung forward. A simple alternative is to rapidly swing a straight leg from about 30 degrees behind the body to horizontal in front. This is not the running action of course, because the leg should be flexed so that it will swing through faster (a shorter pendulum). However for this reason it is harder to swing the leg in the straight position, so it is equivalent to loading the flexed leg.

That completes the leg action, which as remarked above is what running is mainly about. However the upper body does have a secondary role to play. The action of the legs on the hips is to drive or pull them forward, but this does not happen equally to both hips at every instant. The result would be an oscillation of the body about the vertical axis if there was not a counter movement set up at the top of the body. This counter action is achieved by backward and forward oscillations of the arms or the shoulders. Sprinters use their arms exclusively to achieve this balancing because that action can be fast. However it is also somewhat exhausting, and runners wishing to go for longer than about a minute will introduce an oscillation of the torso about the vertical axis as well. This is more efficient, less tiring, but slower. Another effect of the arm swing is to provide some lift to the torso, which will take some weight off the hips as they are being propelled forward. For a middle distance runner the predominant action is of the arms, and the muscles that drive the action are the deltoids and the biceps. The deltoids drive the upper arm forward and back, and the biceps flex the arm as it is coming forward. A simple exercise that develops both is a running action with the arms while holding dumbbells. It is also reasonably specific.

There is a need for pelvic stability when an athlete is running. Without it forces are absorbed in the pelvic region as the hips slosh about, and those forces are lost to propulsion. Furthermore the superfluous action can give rise to injuries. One way of
obtaining this stability is to ensure that there is no superfluous or ill-directed motion of the hips while weights exercises are being performed. This will require isometric contraction of the muscles controlling the pelvis. Another exercise is a variation of the one described above for the deltoids. It consists of fixing the legs on an inclined bench and then, leaning back to the straight position with the back unsupported, swinging dumbbells in a running action.

There remains the question of what size weights to use, how many repetitions in a set and how many sets. The answers lie in what we are trying to achieve. It will probably be speed, but could be muscular endurance. If a runner finds that his limitation is tired muscles, then he would want to improve muscular endurance. The duration and the recoveries have to be such as to stress the limits of endurance. Given that the running action of a middle distance runner involves about two movements per second of each limb, and that movement with weights will be slower, something like 50 repetitions would be reasonable. The weight would have to be low, in the order of $20 \%$ of the maximum for one effort or 1RM as it is sometimes called. The recovery between sets could be a minute, and the number of sets two to four. The recovery can be adjusted up or down in order to maintain a reasonable speed of movement and an adequate endurance load.

If the use of weights is to increase speed, greater strength is called for. This will necessitate heavier weights, fewer repetitions and longer recoveries. Even so the weights should not be so heavy that they cannot be moved quickly. Opinions differ on how heavy the weights should be. Some advocate up near 1RM while others claim they should be as low as $30 \%$ of 1 RM. It is difficult to see how with the heavier weights the limbs could be moved at anything like running speed, and so the lighter end of opinion would appear to be more appropriate. However there is a way of combining both opinions. Early in the program heavier weights could be used, and this would certainly develop muscular strength. Then later in the program the size of the weights could be reduced and the speed of movement picked up. It is possible that under this regime the extra strength gained would be directed into greater power, i.e. the lighter weights would be moved faster than if heavier weights had not been used. The number of repetitions for the weights in the region $30-50 \%$ of 1 RM would be $8-12$. If the weights are in the region of $80-90 \%$ of 1 RM the number of repetitions would be $3-5$.

Progression in a weights program is by means of increasing repetitions and increasing weights. The athlete would start with a manageable weight with the lowest number of repetitions- say 8 . When these can be moved fast the number of repetitions can be increased by 1 or 2 , and when these can be performed with no diminution of speed the number can be increased again. When the maximum number- say $12-$ can be performed at least as fast as the minimum number were performed, the size of the weights can be increased by $5 \%$ and the number of repetitions reduced to minimum again. Then the process starts again.

How often should a middle distance runner do weights? There is no precise answer to this, but there are perhaps some guidelines. Because success is uncertain, because weights can be stressful and therefore effect other training, because it is simple to build up, less is better than more. Also the more weights training the less running, and there are so many different types of sessions for a middle distance runner to do. All of
this means that initially, and perhaps always, one session of weights per cycle (normally one week) is sufficient.

All of the above is saying that use of weights is a complex matter, and that there is no simple answer to what is best. What suits one athlete might not suit another, and what suits an athlete at a particular time might not suit the same athlete at a different time. Monitoring is essential to ensure that the program is delivering what it should be delivering.

A word of caution is necessary. Weights can be dangerous if used without proper technique. Of necessity these are heavy and therefore somewhat difficult to control. Injuries can easily occur if weights get out of control. Therefore it is necessary to learn proper technique and proper procedures, and these should be taught by an expert. Gyms often have such experts, but failing that the athlete should have a weights instructor teach him. It could even be that his coach is an expert, but the coach should not pretend to be. If his instructor is a weights expert, that person's role should be limited to instruction on technique and procedures. It is unlikely he would be an expert on weights work for middle distance runners, and so any advice from him on which exercises, how heavy the weights, and how many repetitions, should not be followed unless cleared by the running coach.

The table below lists a possible set of weights exercises.

| Exercise | Start Wt | No. of Reps | No. of Sets | Purpose |
| :---: | :---: | :---: | :---: | :---: |
| Wt'ed Step up | $30 \% 1$ RM | $8-12$ | $2-3$ | hamstrings |
| Half Squats | $40 \% 1$ RM | $8-12$ | $2-3$ | hams, quads |
| Thigh Pull-back | $40 \% 1$ RM | $8-12$ | $2-3$ | hams, gluteals |
| Hamstring Curl | $30 \% 1$ RM | $8-12$ | $2-3$ | hamstrings |
| Knee Extension | $30 \% 1$ RM | $8-12$ | $2-3$ | quadriceps |
| Heel raise | $30 \% 1$ RM | $15-20$ | $2-3$ | calfs |
| Thigh Thrust | $40 \% 1$ RM | $8-12$ | $2-3$ | hip flexors |
| Dumbbell Run | $30 \% 1$ RM | $15-20$ | $2-3$ | deltoids, biceps |

Table 6.1 A Set of Possible Weights Exercises for a Middle Distance Runner

## Plyometrics

A physicist will tell us that impulse equals change in momentum. That might sound like a bit of learned nonsense for a runner but it is very relevant. In broad terms impulse is the force applied on a body multiplied by the time for which it is applied. (For the purist we have to acknowledge that the force might not be constant and so impulse will be the integral of force with respect to time. However the broad definition conveys the principle.) Momentum is the mass of the body multiplied by its velocity, and for our purposes we can say speed instead of velocity. A simple example of impulse and change of momentum is the golf club striking the golf ball. The club applies a large force for a small amount of time to the ball, and the result is that the momentum of the ball is changed from zero (since the speed was zero) to a considerable amount (the mass of the ball multiplied by its considerable speed when it leaves the club).

It is the same with a runner. The ground applies a force on the body via the planted foot, in reaction to the force that the runner applies on the ground. That force
applied over the time the foot is in contact with the ground constitutes the impulse. The impulse has to be applied every stride to make up for the speed lost while airborne.

If we want to run faster we have to increase the impulse. However in running faster the foot is on the ground for less time. Remembering that impulse is force multiplied by time, we realise that if time is reduced then the force must be increased by a greater proportion than that by which the time is reduced. Running faster therefore is about applying a greater force for less time. Plyometrics is an activity designed to train the runner to do just that. The word comes from two Greek words meaning "more" and "measure".

Plyometrics is about applying a force greater than running force on the ground, and consciously minimising the time of application of the force. It is not specific of course, but it is more specific than weights. There are dangers to be avoided- the ground is being hit harder than in normal running, so it is more likely to cause injury than running. It is an activity that must be started at a low level, and any soreness of joints is a sign to back off. The normal repertoire of drills includes jumping from heights, but the author is wary about this exercise and would not advise it. Some typical drills are described below.

Firstly there are the series of vertical jumps, which exercise the quadriceps and to a lesser extent the hamstrings. Initially these are done on two feet, in order to halve the load on each leg. Examples are:

- rocket jumps- in which the runner explodes upwards from a squat position, lands, and repeats
- squat jump- in which the runner explodes upwards from the half squat position, lands, and repeats
- split squat jumps- in which the runner explodes upwards from a split squat position, lands with same foot forward, and repeats
- tuck jumps- in which the runner explodes upwards from a half squat position, grabs knees to chest, lands, and repeats
A later stage, when the above can be handled easily, has the runner operating with only one leg, perhaps using the other for balance and control. This of course doubles the loading on the leg.

There are a series of horizontal travel drills, which as the name suggests involve forward movement. Where appropriate these can be done on two feet initially, in order to halve the load on the legs. Then when they are managed satisfactorily the runner can advance to single foot landing. Examples are:

- ankle bounce- in which the runner advances forward by means of a jump upward and forward using only the ankles, and on landing immediately rebounds; this obviously is an exercise for the calf muscles
- hopping (double and single leg)- jumping high and cycling leg(s), bringing feet under buttocks at the top of the jump; rebounding and repeat on landing
- barrier jumps- in which the runner bounces over a line of low barriers
- bounds- in which the runner jumps forwards and high, driving knee high, and then lands under the centre of gravity to explode off again
- straight leg bounds- in which the runner explodes forwards off a straight leg pull back, kicks the other leg out and retracts it vigorously to then explode forward off it

It is important in all of the drills to emphasise the necessity of explosive take-off and the striving for minimum ground contact time. Also it must be remembered that these are about increasing speed. Therefore it does not make sense to perform a large number of repetitions. That would be an endurance exercise.

Typically a runner would start with about 8 exercises, most of them relatively gentle, which can be accomplished by having most of them double leg exercises. The number of repetitions would be about 8 , which could be increased to 12 over a few weeks. There would be 2 sets of each initially, increasing to 3 of each over a few weeks. When the runner is easily able to manage these without any lingering soreness, the number of single leg exercises can be increased in place of some double leg exercises.

## Resistance Running

This differs from plyometrics in that the runner does not apply additional force at ground impact, and the emphasis is not on minimising ground contact time. Rather the environment provides additional loading, which causes a greater force to be applied in order to overcome a resistance. Whereas plyometrics puts the emphasis on high initial force, in resistance running the force has to be built up throughout ground contact in order to overcome the external resistance. This training is particularly useful for sprinting because of its emphasis on force throughout contact time. It is difficult to develop high power when running fast, which causes speed to drop off quickly, but if force can be maintained while the foot is on the ground this limitation is reduced. Resistance running also has relevance to longer running than sprints. The training in repeated application of additional force over longer effort conditions the runner to remain powerful in endurance runs on the flat.

The most common form of resistance running is hill running. The resistance comes from having to raise the body as well as propel it horizontally. It is important that the gradient of the hill is enough to be challenging yet not so great as to significantly effect the running action. A gradient of 1 in 10 is about the maximum. In hill running the foot strikes the ground early, limiting the impact on ground contact. Consequently the runner must work hard at developing driving force. The range of rotational motion about the hip is greater than in normal running, which ensures that force can be exerted over the full range of motion in normal running. Arm action has to be vigorous. Sprinting power is developed by bursts of 20-40 metres. As in development of CP power, the rests between repetitions need to be about 3 minutes. Speed endurance is developed by efforts of 60-150 metres, with recoveries of 3-5 minutes. Power endurance, the ability to continue developing power over a minute or more, is trained by runs of 200500 metres. The latter can be with an emphasis on power, in which case the runs are at the shorter end and with longer recoveries, or with an emphasis on endurance, when they will be at the longer end and the recoveries can be simply walk-back.

Another method of resistance running is sand hill running. The resistance here is in the yielding nature of the sand, which reduces the reaction force exerted by the ground. This causes the runner to apply greater force in order to progress. Of necessity this takes more time, and runners with good natural leg speed will attempt to compensate by sacrificing some force for a higher stride rate. It does not matter which approach the runner takes; either the quest for additional force or for higher stride rate is good training. Another beneficial effect of sand hill running comes from the hill together with
the sand. The sand tends to anchor the runner to the ground when he wants to climb the hill. He tries to overcome this effect by vigorous use of his upper body. This trains him to use his upper body, particularly his arm action, to help lift himself off the track. Sand hill running of course was made famous by Herb Elliott and his coach Percy Cerruty in the 1950s.

One of the advantages of sand hill running is that it takes athletes away from their track or trail environment and gives them a change from the normal routine. Even though it is tough training most athletes find it fun. They can put in more effort than they would on the track and still thoroughly enjoy it. However it should not be done too often because it is not sufficiently specific, and runners could develop habits that are not helpful for middle distance track running.

## Water Running

This is often a very useful activity when an athlete is unable to run. Of course it cannot be used when it requires use of a muscle that is injured. For instance a hamstring injury would rule out water running because this is the main muscle used in the activity. However injuries to the lower leg and impact injuries are unaffected by the activity, and it provides an excellent way to do reasonably specific work. With significant qualifications, many running sessions can be simulated in the pool.

Water running consists of emulating the running action as much as possible in the pool. The runner usually wears a buoyancy vest in order to remain upright and afloat. The predominant action is the pull back of the legs through the water, using the hamstrings and gluteals. That part of the action is quite specific and so very useful. So too is the swing forward of the flexed leg against water resistance. The arms work in a running action against water resistance to balance the action of the legs. It is important to concentrate on having an action as much like running action as possible. The leg should be quickly flexed at the back and swung forward and up, and then it should be opened out and pulled back.

There is a part of water running that is not specific, and that is the speed of limb movement. The water resistance slows this down to about half the rotational speed of the limbs when running. So although the forces exerted by the hamstrings and gluteals are greater than in running, and the activity is useful on that account, the limbs get used to moving more slowly than they should. A way of countering this tendency is to do some limb rotational work out of the water. This can be done by having the legs in the air, feet uppermost, body supported on shoulders and upper arms, and then cycling the legs. Without any resistance except air, it should be possible to achieve a limb speed of about twice that in running. This will compensate for the slower limb speed in the water.

With the qualification covered in the previous paragraph, it is possible to simulate a number of track sessions in the pool. For instance 6 repetitions of 3minutes on, 3 minutes off, will simulate the $6 x 1 \mathrm{~km}$ session. 10 repetitions of 45 seconds on, 45 seconds off, will simulate the $10 \times 300 \mathrm{~m}$ session with 45 second recoveries. Sprint sessions can be simulated by flat out bursts of 6 to 20 seconds, with plenty of recovery. If the sessions have to be continued for a number of weeks, progress can be measured by the number of strides in a certain time.

## Rest

Rest is an essential part of training. The reason for this will be covered in the chapter on principles of training. There are two types of rest. The first is the part of the regular cycle of training and the second is irregular enforced rest. The first will be dealt with in the next two chapters, and we will only concern ourselves here with the irregular variety. This is made necessary by injury or illness, and there is a great temptation for the athlete to avoid or shorten it. But this is never successful; it only prolongs the recovery to quality running. An athlete needs a healthy body in order to run, and his health recovery mechanisms want no competition in order to function effectively. So if an athlete trains with a defective body two things happen- he practises running poorly because that is all he is capable of doing, and he diverts effort from his recovery mechanisms, making recovery slower. The situation is even worse if the injury or illness is running induced. Then running will exacerbate the problem, undoing some of the recovery that has already taken place.

If the problem is an injury it is sometimes possible for the athlete to do some training that does not use the injured limb. An example is the water running described above. However he must be careful that this training does not develop inappropriate habits, and that the injury stays protected.

As a general rule the athlete should not be able to feel the injury when walking before he start jogging again, and should not be able to feel it jogging before he starts slow running. Slow running must be free of problems before the speed is increased. A clear day at each of these steps is advisable. It is unwise to believe in miracle cures. Injuries take their own time to repair, and little can be done to accelerate the process. Patience is very important in the quest for long term success.

## Psychology

It seems a truism to say that an athlete must know what he wants, but there is more to the statement than meets the eye. There is a wide gap between wish and want. Wish is light as a feather and blown away in the slightest buff of wind. Want is deep and hard, and survives the severest buffeting. Want knows the price as well as the prize, and accepts the first as fully as it values the second. It is not possible to want success without being prepared to do what is necessary to obtain it. It is a contradiction for an athlete to want success yet be unwilling to complete a training session honestly that is designed to take him to that success. It is a matter of will. Success in any field does not go to the talented, it goes to those that have the will to succeed. Will survives disappointments, failures, obstacles, discomfort, injuries, injustices, every setback; pure talent can only handle success.

No one can give an athlete this will. It must be within him. A coach or advisor can provide leadership, which gives the athlete a vision of what is possible for him and how. But he cannot give the athlete motivation. That depends on the want.

It is essential for the athlete to believe in himself. The sport is hard enough anyway, and any self doubt can make the price seem higher and weaken the will. This is where a coach or advisor can be invaluable. It is natural for the most tough-minded athlete to suffer doubts when there is a sequence of things going wrong. It is then the coach's job to help him see the big picture, that this is just a temporary slump and that the overall trend is good. All that is needed at this stage is to eliminate any problem such as
health or injury and then begin a steady climb back to form. Temporary setbacks must not stop him believing in himself.

The athlete must realise that there are three steps towards success. They arethorough preparation, belief in oneself, and determination, and they are in sequence. If a runner is thoroughly prepared he can believe in himself. Then if he believes in himself he is able to be determined to do what is necessary in a race.

## Immoral Assistance

It is a sad commentary on the state of athletics that there needs to be a mention of this topic in a book on the sport. There is not much to be said but it is absolutely fundamental. Middle distance has a proud history of great athletes striving to beat each other and to raise standards, but using nothing but their hearts and minds and bodies to do it. It was a contest between individuals, and that is the way it should continue. The use of drugs, or any other external performance enhancing aid that might become available, changes the contest. It becomes, at least to some extent, a contest between pharmaceutical companies or other scientific enterprises, and not a true contest between individuals. That is not what sport is about. Perhaps it is entertainment but it is not sport. It is not a matter of what is legal, because there will always be new performance enhancing aids which are legal before they are illegal. That will not stop the rot. The moral dimension is the only measure that can ensure fair contests. Athletes must want not to cheat. There is no difference between use of drugs and taking a short cut in a race if that could be undetected. It is obvious that the latter is wrong. So is drug-taking. It is cheating and it is immoral. There has to be a culture in the athletic community such that people who behave immorally are not welcome; there has to be an expectation that people will not cheat. How can that come about? By people from the grass roots of the sport applying pressure on their associations to clean up their sport. The athletic communities own athletics, and it is up to them to ensure that their sport is not contaminated. They should expect the same standard of behaviour of their elite athletes as they do of their interclub athletes.

## CHAPTER SEVEN

## The Principles of Training

What we have determined in Chapters 5 and 6 are the training elements, the individual training sessions, which the athlete needs in his training program. However this does not tell us how the elements fit together to make up a training program. In order to determine this we need to know something of the principles of training. These principles are about how training works. They are about how, in general, a person can be trained to perform at a certain level at a certain time. Indeed some of it is general because it applies to any pursuit of human endeavour. That is reassuring because it is unlikely that the attainment of improvement in running is different in essence from the attainment of improvement in any other human endeavour.

The principles concern what causes improvement. That is a very simple question. Some of the answers are also simple, and obvious; others are not so obvious and consequently not simple. The application of the answers of course is more complex, but we will come to that in the next chapter. As with any other human endeavour improvement comes with practice, and it is normal to practise that which is to be perfected. So the training has to be specific, though as we will learn it cannot be completely so. It should not need saying that training must have a purpose, but many traditional training programs had little more purpose than folklore. It also makes sense for training to be progressive; the human body does not like sudden large changes, and has trouble adapting to them. We need to know how the body adapts to a stimulus, how long it takes to have an effect and how long the effect lasts after the stimulus is removed. We will see that recovery is very important and we need to know how much and how often. Finally if the training is to be predictably successful (rather than a fluke) it must have controls on it. Training is like a vehicular journey, and there needs to be a driver who monitors progress, assesses the environment and makes necessary changes to the original journey plan. It goes without saying that there should be such a plan. All of these matters are discussed in the following sections.

## Specificity

A pianist practises for piano recitals mainly by playing the piano, and furthermore he practices the pieces he intends to play in recital and tries to play them the way he wants to play them in recital. Similarly a mathematics student will practise problems he expects to face in the examination, so that increased proficiency leads to quickness and certitude. It is the same in running. The runner wants to develop the ability to move his limbs with the optimum amplitude and frequency for a certain duration, so as to cover a certain distance in minimum time. As with the pianist and the student, this will require many hours of practice, and if he is to follow their example, the practice will mainly be running. It seems unlikely that any other training will be as effective; he has to learn certain movements, develop the required cadence, and learn to perform these in the face of oncoming fatigue. Any other activities he engages in which are not running should be
those which will make his running training better, or which are in place of running when this activity is not possible.

Just as the pianist would practise what he must play in recital, it would appear that the middle distance runner should spend considerable time practising his performance over race distance. There is some truth in this, which is reflected in the expression "racing is the best training". It is the best because it is entirely specific, provided the race effort is honest and controlled. It is obvious that a bad effort or an ill-disciplined performance is not good training for anything. However if a runner relied on honest performances over race distance for his training he would not do very much. Such performances are not very repeatable because they require so much effort. More than one a week could not be sustained for very long, before the athlete descended into a downward spiral of performances because of insufficient recovery. So reliance on completely specific training alone would result in not much training. Even so, it is the best of training sessions. Only in such sessions is everything practised together in correct combination.

Given that training cannot consist just of racing, what must a runner do to make it as specific as possible? It first of all has to be acknowledged that there must be a considerable amount of training that is not specific, but it lays the foundation for more specific work. When that should fit into the training program will be the subject of discussion later in this chapter. At the extremities there are the long runs and the sprints. Neither is specific in terms of distance or pace, but both are vital in raising the level of competence in essential ingredients of middle distance running. Their value is not in themselves; it does not matter if a middle distance runner is not a great sprinter or distance runner. Rather what matters is that this work lays the foundation for greater competence at more specific work. So although not particularly specific to middle distance running, it is vital in preparing for specific work.

To return to the question of what a runner must do to make his training as specific as possible, we need to consider what constitutes a specific session. As we saw above, nothing is more specific than a race over the regulation distance, and there should be plenty of that over a competitive season. But this will only constitute a small part of a year's training. What we can vary from the race are distance and pace. If we increase the distance the pace of course becomes slower, whereas we can reduce the distance and maintain race pace. Less than race distance at race pace is more specific because the runner is practicing the cadence he needs for the race. The question is how much less. The shorter the distance the greater the total volume that can be achieved, but the less specific it is. A middle distance runner can easily run 100 m at race pace, and could do many of them. But the effort involved in sustaining race pace for 100 m is so small as not to bring about a significant training effect. The runner will become very used to the pace, but not to coping with build up of lactic acid. Probably half race distance or above is necessary in order to train most of the processes the runner will use in a middle distance race. Three quarters race distance is probably as far as it is possible to go at race pace in training. These are repeatable-three quarter distance probably only once- so a greater volume of specific work can be managed than if race distance was run.

Another way to be reasonably specific, while recognizing that full distance at race pace is not repeatable enough to bring about an optimum training effect, is to package the race distance in a set of shorter than race distance repetitions with short recoveries. This
preserves race distance and race pace but reduces the intensity of the effort by introducing a few short spells in the package. Examples are $4 \times 200 \mathrm{~m}, 3 \times 300 \mathrm{~m}$ and $2 \times 400 \mathrm{~m}$ for 800 m runners, and $5 \times 300 \mathrm{~m}, 4 \times 400 \mathrm{~m}$ and $3 \times 500 \mathrm{~m}$ for 1500 m runners. The recoveries are what can be managed while retaining the required pace. There is no race that has a series of spells within it, so the specificity of this type of session is a little limited. There has been many an athlete who could do repetitions at the required pace, but was then surprised when he was unable to run that fast when the spells were removed. This is not an argument for not doing them, but rather for not relying on them. Obviously the shorter the recoveries the more specific the set is, and also the less repeatable. As in most things, there is a trade off between quality and quantity. Quality is about being specific and quantity is about doing enough to have maximum training effect.

The message from this section is that if middle distance running is like other human endeavours, and there is no reason to believe it is not, then the best training is that which is most like the race, i.e. it is specific to the event. However due to the intensity of this training there is a very real limit to how much can be done. When it should fit in to a training program will be discussed in the next chapter. Since the amount of specific work is limited, there will be plenty of training that is less than specific. The aim of all of this training, whatever it might be, is to enable higher quality specific training.

## Needs Based Training

It seems almost unnecessary to say that training must be based on need. The runner trains because he has a desire for success; success will fulfil a personal need. However as soon as we start talking about training programs we are usually talking about traditional ones, or standard one, or programs of someone else, and we are not talking about the need of the athlete in question. It is essential that training be based on the needs of the individual athlete.

We begin with what the athlete wants to achieve. This is the high level need, into which all other needs must slot. Most athletes, when they are young, aspire to be national champions and Olympians. Very few of course will make it, and it will take them years of preparation. But training must be such as to enable the athlete to eventually satisfy this need, if at all possible. The next chapter deals with planning, including long term planning, and all we need to say at this stage is that all of training, from the start of his career to the finish, must take account of his needs, long term, medium term and short term. Of course not all the athlete's needs will be athletic. Some will be social and some will be academic or career related. It is essential that training take account of these other needs as well. It could mean for instance that training sessions at some times of the year have to be shorter or easier than the ideal.

At the more immediate level, training must be based on needs, and this means the needs of the individual athlete. Needs of athletes, even within the middle distance group, vary considerably. Some athletes lack endurance, and training programs should seek to address this weakness. It does not mean that they neglect the development of their strengths, but they obviously need more attention to endurance work than other middle distance runners. Similarly a runner who lacks speed will need to pay more attention to speed development than one to whom speed is natural, and his training program will
structured accordingly. It is important here to realise that we all have our limitations, and excess emphasis on some aspect of performance will not have commensurate rewards. While the wasted training has been going on the runner has neglected the opportunity to develop his strengths. Nevertheless there must be some attempt in training to minimise weaknesses, and these weaknesses are individual.

Above we have talked about basing career planning and annual programming on the needs of the athlete. The planning and the programming must have specific purposes, which are closely related to needs. It is the same at the level of everyday training. Every training session should have a purpose, and that purpose is to address a particular need. The athlete must know what the purpose of the training session is, and he must be able to say at the end of it whether that purpose has been met, and why. The session might be to improve aerobic power, which will enable the middle distance runner to maintain speed in the latter stages of a race. The athlete must know that this is the aim of the session, have a feel for it, and be able to say whether the session has been successful. The success will be gauged by the way the athlete feels, how he has been able to handle the work, and progression in performance, though the latter does not mean being a slave to the watch. Being able to say that the session has not been successful is as important as being able to say that it has. That it has not worked is saying something, and the athlete needs to listen to it. It could be that the training is wrong, and needs to be altered. It could mean that too much is being sought too quickly. It could even be that the athlete is attempting the impossible, and should be concentrating on another distance. Whatever, unless the athlete knows the purpose of the training session, unless he knows what he is trying to achieve and why, he cannot know whether the training has been useful and is worth repeating.

## Progressive Loading

Sustained speed is unnatural. There is a high degree of discomfort and even pain. The human body does not like it and will avoid it if at all possible. The mind of the middle distance runner will not allow the body to avoid the effort and the body then has two recourses. Either it can adapt upwards to take the stress or it can adapt downwards so that it cannot make as much effort. The former is successful training and the latter is fatigue. Obviously we want the former and not the latter.

The quest for comfort, or rather the absence of discomfort, is the key to training. When the athlete does a session that has a degree of difficulty, and therefore causes some discomfort, all the relevant systems in the body- muscular, circulatory, respiratory, etcwill try to adapt to that level of stress, so that next time the body does not experience discomfort. This is the body's response to having to perform an effort it does not like- it tries to change so that it can handle that level of effort without discomfort. But it does not stop there; the body is not allowed to remain in the new comfort zone. Once the new level of effort is tolerable the level is raised so that it is uncomfortable once again. Again all the systems have to adapt, so that this increased level of effort can be handled without discomfort. And so it goes on- increased effort with corresponding discomfort, the body's adaptation to tolerate without discomfort, increased effort again, etc. All the while the mind is in control of the body, causing it to adapt to increasingly greater levels
of stress, brought about by increasingly greater physical efforts, without commensurate increases in discomfort.

Looking at it from a mechanical point of view, we can regard the amount of training in terms of duration, distance, intensity, etc as the body's external loading, and the amount and degree of fatigue the athlete feels as a result of training as the internal loading. Progress occurs as a result of the ability of the athlete to take a greater external loading without incurring an increase in internal loading. Progress is successful training.

It would be nice to think that this process could be continued ad infinitum, that the mind could maintain its control over the body indefinitely so that there is no end to the increase in external load, without an intolerable and inhibiting increase in internal loading. But life is not like that; the ability of the human body to adapt is limited. There will come a time in a phase of training, or in a season, or in a year, when no more adaptation is possible. It is important to realise this, to recognise it when it happens, and to accept it. Not to do so, but rather to push on expecting more improvement, will invite fatigue and a reversal of the adaptation process.

An important, indeed critical, aspect of the adaptation process is the period of adaptation. At first it seems somewhat surprising that adaptation takes place when the load is off, when the athlete is resting from the activity causing the stress. So the improvement is coming while the athlete is a rest. However it is not so surprising when we realise that the adaptation is going to come from physiological changes- more muscle fibre, more capillaries, more red blood cells, etc- and these cannot be gained when the body is doing all it can to maintain the effort. Rather they come when the body can manufacture them, which is away from running. They come during rest, when food is converted into organisms that are necessary to sustain the additional effort without distress. This means that food and sleep are important ingredients in the training process.

Throughout a training session the athlete becomes increasingly stressed, and his ability to sustain the effort decreases. If at the end of the session he attempted to repeat the session he would not be able to, and the performance he could produce would be considerably below the level he had just managed. That situation would remain for some time, but eventually he recovers. After a period he would be able to repeat the session with the same level of performance. However because the body is adapting itself to be able to do that comfortably, he has only to wait a while longer and he will be able to repeat the session at a higher level of performance, and with no more discomfort than the previous session. So we see that the keys to progress are a level of discomfort, to which the body adapts so that the same effort is comfortable, and sufficient recovery before a repeat session, so that the body can adapt to handle the same session without discomfort. Of course what the mind does then is compel the body to rise to a higher level of performance, inducing the same level of discomfort.

There are two essential ingredients of this progression. The first is that each session must be manageable even though a little uncomfortable, and the second is that the period between similar sessions must be long enough to allow adaptation but not so long as to lose the adaptation. It is no good trying to do a session at too high a level of performance. Either the session will not be managed, which is not a good basis for progression, or it will be so fatiguing that adaptation will take too long and not enough training can be done. If there is insufficient time between similar sessions then the repeat session will be attempted before the body's systems have built up to their new comfort
level, and the level of performance will not be as high as it could be. If the time between sessions is really insufficient the body will not have even recovered enough to handle a repeat of the previous performance, and if this scheduling is continued the athlete will be in a downward spiral of training performances, which is exactly the opposite of the purpose of training. The following diagram shows capability versus time for optimum training, and for periods between similar sessions that are too short.

## Training Regimes



Figure 7.1 Progressive loading- effective and ineffective regimes
It will be seen that the key to progressive loading is gradual loading. Big steps might sometimes be possible, but they should not be taken too seriously because they might not be repeatable. Such a step could come from the top end of what an athlete is capable of, and infrequently at that. An attempt to build on that, or even to emulate it, is likely to be unsuccessful and disappointing. Small steps are manageable, repeatable, and a basis for sure advancement.

It is worth saying again that there can only be progress if adaptation has been possible after the previous session, and this requires time between similar sessions. How much time depends on the individual athlete, and will be the subject of a later section of this chapter.

## Training Effects- How Long Does An Effect Take To Train

There are two important questions we need to consider about an effect brought about by training. The first is the question of how long an effect takes to train. The second is the question of how long a training effect lasts. This section considers the first.

We know that improvement cannot go on forever. If for instance we are trying to improve speed it will probably improve for some weeks, even perhaps for a few months, but it will not improve week after week, month after month, year after year, even if there are no injuries. How long should we continue to seek a particular training effect?

The first thing we can say is that, like anything else, it depends upon the athlete. Some athletes will improve a certain attribute quickly and then plateau, and beyond that time efforts to continue the improvement are likely to be frustrating and counterproductive. Others will take longer to reach that point. Obviously this is very difficult to know beforehand, and we must learn from experience.

Having said that, there are a few guidelines that will provide us with a framework within which we can make individual modifications. The first is that aerobic fitness takes much longer to train than speed fitness. This is probably because development is much more a whole of body exercise than speed development. In the former we need to develop not only the muscles but also the heart, lungs, blood paths, capillaries, etc. If there is more to train it is reasonable to expect that the training input will be much greater. Furthermore aerobic training involves covering considerable distances, and it takes some weeks to build up to the quantity that will have a significant training effect. It takes on average about 10 weeks before a runner, starting from a rest period, can adapt to long runs to the extent of being able to attack them. Aerobic fitness can improve, given proper progression strategy, for another 10 to 15 weeks, and might be still on the upward trend beyond then. However a middle distance runner would then be seeking to place the emphasis elsewhere and improvement in aerobic fitness training would become less important than improvement in other facets of training.

Nevertheless if this training continued at the same rate, as it would to a significant extent for a distance runner, improvement could continue for much of a year. What would bring it to an end would be fatigue caused by intensive racing, which of course was the purpose of the training. In the absence of racing it would be likely to terminate anyway within a year. Then a rest period would be necessary before settling in and improvement could start again.

As indicated above, speed does not take as long to develop, and improvement is seen in a matter of weeks. Improvement will plateau much earlier than in aerobic training. It will vary from athlete to athlete, but on average we could expect improvement to peter out in about six weeks. Speed training is stressful on the muscles and they probably have had all they can take for a while by then. It will be necessary to desist in the intensity of this work for a while before launching into another block of similar work. While some maintenance work will be beneficial there is a danger in continuing to seek improvement that is not there. Psychologically it can cause frustration
and loss of confidence, and physically it is possible that that the leg muscles are telling the runner something about their condition that should not be ignored.

In between aerobic fitness and speed fitness there is lactic fitness, of which there are two components- the fitness to produce lactic acid and the fitness to tolerate it. The fitness to tolerate lactic acid can be developed slowly, beginning with a low rate of lactic build up, which comes from a running speed that is just above steady state. Initially there is very little lactic acid to tolerate, but as the speed builds up over a number of weeks the amount of lactic acid in the muscles increases, and the muscles learn to tolerate it. This process can continue over the winter period, before the onset of the competitive season. When the time comes for the muscles to be able to tolerate a rush of lactic acid, as will be necessary when furious lactic efforts are called for, they will be prepared to move to this next step.

Fitness to produce lactic acid takes a little longer to develop than speed, but not as long as aerobic fitness. This could be because the process of CP donating its high energy $P$ for the formation of ATP is simpler than the process by which the anaerobic breakdown of glycogen leads to the formation of ATP. On average improvement in the ability to produce lactic acid will come to an end in about eight weeks.

Fitness to tolerate the surge of lactic acid that is an unavoidable part of middle distance running is aided by the gradual build up of tolerance as described above. However more than this is needed, and can only be obtained by subjecting the body to the surges. It is savage work and cannot be continued for too long. On average about four to six weeks is as long as improvement can be expected.

It must be stressed that none of the above durations are at all accurate and there will be great variations from athlete to athlete. They are guidelines only. But in the end this will not matter too much because there are other limitations on how long a particular phase of training should be continued, such as the need to fit all the various phases together in a training year.

## How Long Does a Training Effect Last?

We need to know the answer to this because it is not possible to continue training every attribute of middle distance individually right up to major competition. It is not possible to fit everything in, and even if it were, the training program would be too crowded. If the runner stops training speed, or aerobic fitness, how long will the training effect last before it is necessary to top it up? We also need to know in case of injury or other enforced interruption to training. What attribute might have deteriorated significantly in that time, requiring special attention to it before resuming the scheduled training program?

Although there is no simple, sure answer to the question, there are some guidelines that are useful. The first is a phenomenon of human nature. The longer a characteristic or habit takes to develop the longer it is likely to last. Thus a student finds that something he has learnt gradually and regularly over a period of time will remain with him much longer than material he has crammed the night before an examination.

The best illustration of the above phenomenon is that aerobic fitness hangs on for a considerable time after aerobic training ceases. After a month there is barely any discernible loss of aerobic fitness. After a couple of months there will be noticeable falloff and after three months the runner will perhaps be one month behind the level of fitness at the beginning of the layoff. This means that it is not necessary to continue extensive aerobic training into the competition season, provided that aerobic fitness has been well developed up to then.

On the other hand speed does not last long if it is not used. "Use it or lose it" applies to any human activity, but it applies strongly to speed. It is a habit that is quickly gained, if it can be gained, and similarly quickly lost. Hence speed training cannot be neglected in the competition season. A couple of weeks of layoff from speed training will see a diminution of speed.

Lactic power will not fall off with disuse as much as speed, but the diminution will be greater than for aerobic fitness. Probably a month will see significant deterioration. The falloff in lactic tolerance with disuse might be more mental than physical in the first few weeks, because there is considerable mental effort in handling lactic tolerance work, and absence from it can weaken the resolve. Physically also there will be a deterioration, as the mechanisms which provide a buffer to the effects of lactic acid return to more normal and less onerous duties. More than a month layoff from lactic tolerance work will result in a significant deterioration in lactic acid tolerance.

Of course the athlete is not going to ignore any aspect of development completely unless he has to. And barring injury he does not have to, even in the competition season. Without the extensive work that is necessary to develop the required attributes, it is still possible to do maintenance work that will hold the level of competence of each of the attributes at high levels. This might consist of returning to a solid aerobic session once every four to six weeks to ensure the competence is still there, doing a lactic power/lactic tolerance session every two to four weeks, and keeping in touch with speed every one to two weeks. If the revisit to the session reveals significant deterioration then the session can be repeated for a week or two in order to restore the competence.

## Recovery

There are two types of recovery. The first is abstaining from one form of exercise, e.g. speed, while indulging in another form, e.g. aerobic. This is what an athlete does in a normal part of a training program. It is the only way the athlete can get enough training done, and keep the training advancing on all fronts. The second type is complete rest from training.

In the first type the theory is that following a session in which one particular attribute is stressed, the athlete only has to rest from that stress for adaptation to take place. This adaptation, as we saw previously, will allow the athlete to cope with a greater level of external loading. However the rest has to be sufficient, and this can be a problem while other training is going on. In theory the different types of training can be considered separately because there is no overlap, but this is only an approximation. Aerobic training is speed training to some extent, and will not allow complete rest from
speed training. It is similar with other training. The extent to which this matters depends on the individual athlete. Furthermore an exhausting session of any type will inhibit training the next day, even if it is very different training. So although the training program is based around training one aspect of middle distance running while resting the others, this has to be tempered with the consideration of allowing effective rest after stressful sessions. This can be handled by such strategies as following hard sessions with easy sessions, or having a sequence like- hard, easy, medium, easy, hard.

We need to consider how much active rest, i.e. rest that involves doing different sessions, is necessary between similar sessions. As a general guideline, a week is a reasonable gap between hard sessions of the same type. The sessions can be repeated within the week, but only if the repeat is easy. It needs to be emphasised that adaptation cannot take place under stress- it only happens when the stress is removed.

The second type of recovery is complete rest from training. Some dedicated or addicted runners do not like this, but it is very beneficial provided it is properly timed. It can be forced or planned, and the more there is of the latter the less will be necessary of the former. The forced variety is when an athlete's performances are deteriorating, and training only seems to make them worse. In this situation more training is unlikely to turn matters around, and rest from training is the best strategy. The situation is probably the result of insufficient recovery from some sessions, and it matters little that another athlete is able to handle the same workload. All athletes are different, with their own strengths and weaknesses. How long should the rest be? As a guide it should take in at least two cycles of training, so that two of each session are missed. Then it will really feel like a rest. A longer rest might be necessary. Again as a general guide the rest can be as long as the period of deterioration of performances.

The planned variety of rest is preferable because it allows proper progression, with a minimum of fallbacks in performance. It also recognises rest as an important part of training. The rests can be short, medium and long. The short rest- one day- would occur at the end of a training cycle, which would typically be at the end of a training week. This puts a rest in the training cycle. After a few cycles the stress levels mount, and this cannot be continued indefinitely without injurious effects. Therefore another rest is required, and this is a medium length rest. It is an easy week, which must be very easy and could even have almost no running. Typically this would be something like every fourth week. Thus a phase of training, which consists of a number of cycles, contains one or two rest cycles. Finally at the end of a training year the runner is in need of a long rest in order to become refreshed and ready for another training year. This rest needs to cover the period of a cycle of cycles, i.e. to encompass what would have been two easy weeks and the cycles in between them. Then the athlete is away from training for long enough for lack of training to become the norm, to be glad he does not have to train, and then to look forward to resuming. That is a proper rest.

The important thing about all the rests above is that they aid the adaptation process. The weekly rest tries to ensure that there has been sufficient rest throughout the cycle to allow adaptation to the stress level of each of the different sessions of training. The easy week at the end of three or four cycles recognises that there has not been sufficient rest over preceding cycles to allow full adaptation, and that a longer rest or a more restful week is required. Finally the four to six weeks rest at the end of the training
year allows all of the positive effects of the year's training to be absorbed. There is adaptation to the yearlong demands on the athlete's person while those demands are off, and as a result he is ready for greater stress levels in the new training year.

## Sequence of Training

There are many different training sessions a middle distance runner must do, and they cannot all be done concurrently. The training cycle would have to be a month or more long to fit in all of the sessions. Therefore it is necessary to sequence the sessions so that some sessions are done in advance of others. But what sessions should be done first, what should be done closer to important competition, and what should be done in between?

There are a few keys to answering the above question. The first is that, as we saw in an earlier section of this chapter, aerobic condition lasts longer than other fitnesses. Therefore it makes sense to do sessions that develop this condition early in the training year. Its effect will last into the competitive season, especially with regular top-ups.

The second comes from the principle of specificity expounded earlier in this chapter. The closer the runner is to major competition the more specific training must be. Race pace over a distance approaching race distance must be so familiar as to be second nature. So the most important training sessions close to major competition are sessions incorporating such work.

In between the beginning and the end as described above there needs to be a structure in the training program in which the training year is divided into phases. Sessions in each phase follow logically from sessions in the previous phase. For instance there can be a progression in speed from a session in one phase to a session in the next phase. The structure means that everything builds on what has gone before, and is directed to and prepares for the very specific training at the end.

## Controls

The purpose of everything an athlete does in training is to bring about improved performances. The athlete should be able to be confident that this purpose is being met; if it has not he has wasted his time and energy. The progress of an athlete is like a journey- from where he is at the start of training to where he wants to be at the endwhether that end be the end of the season, the end of an Olympic cycle, or the end of his career. Like any journey of any complexity this one needs a map, and the map is the training program. The next chapter will discuss training programs, so the rest of this chapter assumes there is one.

The training program is meant to bring about the desired results, and it might, but there are many reasons why it might not. Athletes are individuals, and as we have remarked before, what works for one athlete might not work, or might not work as well, for another. What seemed a good strategy at the beginning of the training year might be shown by experience to be somewhat flawed. A particular aspect of training might be
proving ineffective or even disadvantageous. These are not reasons for not having a program, but for adapting it as necessary.

In order to know whether the program is working, or in what respects it might not be working, it is necessary to have some tests along the journey. Those tests can be competitions in the competition season, but that could be too late to effect necessary changes. For instance the competitive season could be too late to find out that the athlete has insufficient aerobic fitness, because this takes time to develop, and in any case the work required might not be sufficiently specific for the stage of the training year. So tests are required along the way during the non-competitive season.

Training itself is one such test. A particular training session will be repeated over a number of weeks, and it is desirable that there is a goal to be reached by the time the sessions are discontinued. This will impose an expected week-by-week progression, and it will soon be obvious, after making allowances for contingencies such as weather, illness and temporary tiredness, whether the progression is forthcoming. If it is not, it needs to be asked whether a continuation of the session will produce the required progression. If the answer is "no", as is likely if there are no extenuating circumstances, then further sessions are unlikely to be successful. There is some reason why the sessions are not having the desired effect, and an alternative session needs to be substituted.

Progression in training sessions is necessary, but it is not sufficient to ensure that the training is going to translate into improved racing performance. Such assurance is provided by time trials. Typically a time trial will test how effective a training session series has been in bringing about what it was meant to achieve. For instance the session might have been intended to improve aerobic power, in which case the time trial could be an over-distance trial. The over-distance would emphasise the aerobic requirement more than lactic or speed requirements. For an 800 m runner the trial could be 1000 m and for the 1500 m it could be 2000 m . After making due allowances for weather, lack of competition, etc., there should be an expected performance for the time trial. If the expected performance is achieved or exceeded, well and good, the training is working. If the expected performance is not achieved, then the training is not working or not working sufficiently, and the training program needs to be reviewed. This is a feedback processthe results of the training are compared to the desired results, and the discrepancy is fed back into training in order to modify it such that the desired results can be obtained.

We need to consider in what way the training program should be modified if it is not producing the desired results. If the results indicate no improvement or even deterioration then a drastic change is called for. The training session intended to bring about the specific improvement is obviously not working. Is the athlete healthy enough to do the training, or is it too draining? If health is satisfactory and the early sessions were good but then fell away, it could be that the sessions are too hard or too frequent. If the athlete was never able to handle the sessions then it is possible that he is unsuited to the work and perhaps to middle distance. A try at some completely different training that is more suited to another event would be a good idea. If a time trial indicates there has been some progress but not as much as expected, and there is no sign of a plateau, then a continuation of the session designed to produce the improvement is indicated, even if the program calls for it to be stopped. If there was good progress over a number of sessions and then a plateau was reached, it could indicate that the session has been continued for
too long. In this case it should be terminated even if the program calls for it to be continued for some weeks.

The important thing is that a training program, even though essential, is not sacred. It can be altered, and it should be altered if there is good reason. It should be altered in the direction indicated by performances. The writing of programs is a learning experience that never comes to an end. The program for an individual is continually improved by amending and refining it, based on experience.

## CHAPTER EIGHT

## Training Programs


(photo from New York Road Runners - www.mensracing.com)

It is tempting to think that there is a single training program for middle distance running, or at least a best program, and that it is like a formula- you put in the ingredients prescribed in the right quantities and you will have success. Certainly success is the purpose of training programs, but there are many roads to get there. There has been a variety of programs used by successful middle distance runners, some of which will be more suited to an individual athlete than others. It is also well to remember that a program in a book is usually a snapshot of a small part of a running career, perhaps a phase in the training year, or at best a training year in an athletic career. As it stands, without explanation, it takes no account of what has gone before or what will come after. Also, implicit in the program but not stated explicitly, are the circumstances of the athletes for whom the program was successful. All of this is not a reason to ignore published training programs, but a caution to read them sensibly. Strict adherence to any
champion's program will not guarantee similar success. However all successful programs do have certain things in common, suggesting that any program which is to be successful must also have them. So there is much to learn from a study of programs of champions.

This chapter is about developing training programs, and is not meant to be the last word on the ideal program. Athletes vary, circumstances vary and goals vary, so it is reasonable to expect training programs to vary. The object here is to look at what is behind programs, so that athletes and coaches can build up their own. Of course what champions have used will be very useful in this endeavour.

## The Necessity of Planning

He who aims at nothing usually hits it.
Confucius (supposedly)
"Would you tell me please which way I ought to go from here?"
"That depends a good deal on where you want to get to", said the cat.
"I don't care much where ....." said Alice.
"Then it does not matter which way you go", said the cat.
".....so long as I get somewhere", Alice added as an explanation.
"Oh, you're sure to do that", said the cat, "if only you walk long enough." Lewis Carroll

If you fail to plan you plan to fail.
Anon.
The above quotations might seem frivolous, but they are very much to the point. Indeed they are often used at the beginning of management courses to make the point that management depends very much on planning. And guiding the destiny of a middle distance runner is certainly a management exercise. Whether the athlete has a formal coach or coaches himself, he has a coach. Peter Coe and David Martin in their book Training Distance Runners had this to say about coaching: "It may be that the simplest one word definition we are seeking that sums up the concept of being a coach is simply manager." Planning is an essential ingredient of management, and therefore of managing an athlete's development. It is essential in many aspects of training, from every day organising to the big picture. A large and important part of the big picture is training programs, and it is not possible to properly prepare a training program without planning.

The training program sows the seed of success, and then the resultant plant has to be nurtured, pruned and grafted as necessary. All of this is part of the plan. If there is no plan the athlete/coach does not know what he is pruning or grafting and can only hope about the end result. If there is no grand scheme for success, any success is likely to have been accidental and not likely to be repeatable. It is unlikely to be repeatable because there will no basis for knowing what works and what does not. A plan that fails is a plan that can be learnt from, improved, and made good. But how do you alter a haphazard collection of training sessions?

## Planning

Planning can be divided into long term, medium term and short term. Typically long term covers an athlete's career, or at least an Olympiad (4 year period). Medium term is typically one year, and short term is part of that- perhaps a phase of 10 weeks, or even as long as the competitive season. The three plans dovetail inside one another and are mutually consistent. Inevitably plans are altered, and to maintain consistency, when one is altered the other two should be checked to see whether they too need alteration.

Long-term plans are necessarily very general. At the beginning of an athlete's career, if such a time can be identified, the plan might be no more than a wish- for instance to be an Olympic champion. The plan does not become serious until there is some likelihood, even if only a low probability, that the dream will become a reality. Then it is time to see how the athlete might get there. It will be a 5 to 10 year plan, say from 19 to 24 years of age, to, at the extreme, 16 to 26 years of age. The longer the period of the plan the more general it will be. A basis of the plan will be the rate of improvement necessary to achieve long-term goals. For instance a 16 -year-old male 800 m runner might have a best of $1: 55$, and has a vision of being internationally competitive by the time he is 24 . He will need to be able to run $1: 43$, so an average rate of improvement of 1.5 seconds per year is required. Of course improvement will not be that steady, for any number of reasons, but that does not matter. What is important is that the long-term trend has to be in this order, and training programs must allow for it.

The long-term plan will also take account of what other sports the athlete is participating in. For a sixteen year old there might be two or three. There is nothing wrong with this in the early days. If an athlete has managed to produce promising performances while indulging in other sports as well, these could not have done him any harm. In fact some other activities are quite beneficial to the development of middle distance runners. Team ball games give a person a sense of balance in adverse circumstances, and an ability to hold ground in a bustling crowd. Ballet promotes flexibility. Nevertheless there will come a time when it is not advisable to continue these other activities, because they on top of running require too much energy, or because of the risk of injury. The long-term plan will ease them out, so that in post school years running will be the only serious physical activity.

A long-term plan for a middle distance runner should include getting plenty of distance into the legs early. The evidence provided by the Africans, particularly the Kenyans, is overwhelming. They spend much of their early lives running everywhere and running becomes second nature to them. We are speaking of the years from the time when they have to go anywhere, to their late teens, and certainly of their secondary school years. Their legs and lungs become very used to running. They have a head start when training gets serious. Any young people who might become middle distance runners should run everywhere they can. Running should be part of their lives and, as much as possible, the means of getting from one place to another. Unfortunately the modern western way of life militates against this. Children tend to be driven everywhere, and when they are 17 or so they obtain a driving license themselves and proceed to travel even less on foot. Participation in a variety of sports is one way to get plenty of running of a non-serious variety. As well, any young person who expresses interest in being a middle distance runner some day should be encouraged to take every opportunity to run everywhere possible.

The long-term plan might look at the progression of the number of training sessions per week and other measures of training load over the years. It is not necessary that the load in the later years turn out to be exactly as formulated in the program at the beginning. It is merely a matter of planning a sensible and manageable progression over the life of the plan.

Medium term plans typically concern a one-year period, and it is upon this that a year training program is based. The first thing that needs saying is that the medium term plan must be consistent with the long term plan, otherwise it is no use having the latter. It must take account of everything that was allowed for in the long-term plan. For instance if the long term plan called for development of speed early in the athlete's career, then the medium term plan in an early year should not be unduly emphasising longer work.

This plan will have some goals, which will be something like to achieve a year best performance of $3: 50$ for 1500 m , to have a bracket of runs in the range $3: 53$ to $3: 50$, and to be competitive in national under age events. This will determine the training to be done and hence the training program. The goals must be challenging, yet credible. They should be performance based since the athlete can control his own performances but not those of his opponents. Also performance-based goals can give rise to satisfaction to an athlete, which might not be forthcoming if the goals were finishing positions in races. Nevertheless a goal that emphasises being competitive is well worthwhile, because otherwise a stimulus to race well could be missing.

The plan will include the major competitions for which to be ready. It will prioritise these so that if any performances are to suffer, it will not be those in the most important competitions. Not everything during the year will be running or running related, and when these impinge on running it is necessary for the plan to take account of them. For instance there might be a major event for the athlete during the year, like an important examination. The plan must at least implicitly include the objective of a successful outcome in that event, so that running does not prevent it happening.

Short-term plans are typically for a phase of an annual training program, which might be anything from 6 to 12 weeks. The objectives here can be much more definite and meaningful, since the time span is so short. There is less reason or excuse for reasonable objectives not being met, so they are more hard-nosed and real. Whether and the extent to which they have been met determines the success of the phase and sets the scene for the next phase. Events within the phase are planned with closer attention to detail. Upon all this is the training program for the phase worked out.

## Weaknesses and Strengths

All of us have our strengths and our weaknesses. Our strengths enable us to conquer, and our weaknesses enable us to be conquered. To some extent an athlete can live with his strengths and weaknesses- by intelligent racing. However he will optimise his development as a runner by developing his strengths, and, as much as possible, by eliminating his weaknesses. The preparation of a training program will take this into account. Often weaknesses are so ingrained and so profound that it will take some time to do something about them. In these cases the problem will probably be addresses in the long-term planning and long term program. For instance if speed is perceived to be the
weakness, yet moving up in distance is not considered to be the best option, the emphasis in the early years might be on the development of speed.

There needs to be a word of warning here about putting too much emphasis on the elimination of weaknesses. Sometimes the weakness is natural, and no amount of training will eliminate it. Past a certain point the law of diminishing returns applies, and further gains will be non existent or negligible for an inordinate amount of effort. This can be very frustrating and discouraging to the athlete, and the effort would have been much better spent on developing strengths and learning to cope with the weakness.

Even when it is decided to take a long term view on the elimination of weaknesses, and it is spread over a number of years, it is unwise to neglect strengths altogether during this period. This would deny the runner confidence boosting training and racing, and could move too far away from a middle distance training pattern.

Given that every year is going to place some emphasis on eliminating weaknesses and some on developing strengths, when should each be done? Of course there will always be the endeavour to advance on both fronts, but the emphasis can shift throughout the year. In the final analysis it does not matter when each is done, as long as they are done, but perhaps some guidelines can be given. In the non-competitive part of the training year, when there is time and competitions are not bearing down on the athlete, there is the opportunity to work on eliminating or diminishing weaknesses. There is time for things not to work and then for change in direction. For instance there might be a style deficiency that is holding the athlete back. The non-competitive season is the time to try to rectify this, rather than the competitive season when there is increasing emphasis on racing.

Strengths are more natural and so they take less time to develop than weaknesses take to eradicate. The competitive season is the time to concentrate on the strengths. This will also provide a psychological boost to the athlete as he approaches major competition.

The one problem with this approach arises if the weakness is speed. The approach calls for speed to be attended to in the non-competitive season, which could be cold. Cold weather is not the ideal climatic condition for developing speed. However if speed is a weakness the competitive season will not allow enough time for a thorough assault on it. Considerable development work can and should be done in the noncompetitive season. Much can be done which is not blistering speed. Good speed habits can be learnt and absorbed.

## Sequencing the Building Blocks

Chapter 5 considered the various sessions that are the building blocks of a middle distance training program, and this chapter is about putting them together. The section on sequencing in the previous chapter provided some guidelines on how we might order the different training sessions over the training year. It is better to put the emphasis on aerobic work in the non-competitive season, whilst proximity to major competition calls for more specific training. In between there should be some gradual, logical progression.

Long runs, in excess of half an hour and away from the track, are predominantly aerobic in nature and training, and they are probably continued throughout the training year. As we have seen, the aerobic base is developed over the non-competitive season,
and its benefit lingers for some time with just a little top-up. So all that is needed in the competitive season is the top-up, which might be only one run a week. On the other hand when the aerobic base is being developed a greater frequency of long runs is required. A large volume of long runs cannot be undertaken immediately the training year starts, because this would be too much of a shock to the athlete's systems after a period of relative inactivity. A build-up is required so that the runner can adapt to the load. Therefore what we have is a fairly rapid increase in volume over the first few weeks to the desired level, then a fairly constant load for many weeks, an finally a gradual diminution in emphasis on long runs as the training year progresses towards major competitions. The intensity of the long runs will probably also diminish in the competitive season, because the big efforts will be reserved for more specific sessions.

Since shorter long runs, 20 to 30 minutes, are mainly for recovery, their use will be reasonably constant throughout the year. The very short long runs, 10 minutes or so, which come in sets of 2 to 4 , are to raise the maximum oxygen uptake. This is basic development work, so probably it belongs only in the non-competitive season, except for a few excursions in the competitive season for some variety or to ensure the benefits gained are still there.

We now turn to the sequencing of track sessions- those sessions set out at the end of Chapter Five (except for Sessions 13 and 14, which are non-track runs). These are repetition sessions ranging in repetition distance from 1000 m down to 60 m . They are in two groups- the first has incomplete recoveries between repetitions and the second has substantially complete recoveries. The distances of the repetitions in the first group are 1000 m down to 300 m , and in the second 60 m up to 200 m . The training effects of the two groups are quite separate, so the sessions can be considered separately.

Considering firstly the group with incomplete recoveries, we see that it also breaks into two subgroups. The first is the $1000 \mathrm{~m}, 600 \mathrm{~m}$ and 300 m with recoveries in the minutes. The length of recoveries for each is such that the 1000 m is mainly aerobic and the 300 m is mainly lactic. Therefore the 1000 m repetitions should come first in the program. Gradual progression of pace would dictate that repetition 600s should come next, followed by the 300s.

The second subgroup consists of the 300 m repetitions with recoveries in the seconds. The 45 -second recoveries make for a more aerobic session than the 90 -second recoveries, so that puts the 45 -second recoveries in an earlier phase than the 90 -second recoveries. The 300s in sets of three will be faster than the sets of larger number, and so will be in a later phase still. In fact it is fairly race specific work, so will come late in the program.

The traditional approach to the shorter repetitions- the 60 m to 200 m - would be to do the longer runs in an earlier phase than the shorter ones. This is because the later phases are likely to have warmer weather, which would be more conducive to fast running. However this might not be the optimum strategy for a middle distance runner. He is not interested in fast 60s except as a means to fast longer efforts. He is interested in speed endurance, which will set him up with a good first lap in an 800 m . But it is not possible to have speed endurance without speed. So a reasonable approach would be to have the distance of the speed sessions increasing through the phases. In this way a good speed base is established first and then extended to good speed endurance.

There are other repetitions with substantially full recovery in the repertoire, namely $400 \mathrm{~s}, 500 \mathrm{~s}, 600 \mathrm{~s}$ and 1000 s . In a sense these can be regarded as a natural progression of the other streams. They are an attempt to hold on to developed speed as the distance progresses towards race distance, and they are revisiting distances that have been made familiar by earlier, slower work. So the ground has been prepared, the duration of effort has been learnt, and now speed, which has also been learnt, is gradually applied to the duration. As well as progression, another principle fixes these sessions towards the end of the training program, when presumably major competitions are approaching. That is the principle of specificity, which requires race specific work in the period approaching major races.

Specific repetition distances are mentioned above, but they are only meant to be indicative, as they were in Chapter Five. There is nothing exclusively correct about 300s, 600 s and 1000 s. They represent durations of effort having different demands, but other distances having similar demands would be just as good. The idea expressed in this section has been the sequencing of training sessions according to upward and downward progressions in distance.

## Individuality of a Program

There is a conflict that must be resolved between the desirability of training in a squad and the individual needs of an athlete. The latter does not usually submerge the former, and the squad should be considered the norm, but care is necessary to see that the interests of an individual are not sacrificed for the good of the majority.

There are many advantages in training in a squad. Perhaps the greatest is companionship, and shared discomfort certainly eases the burden of heavy training. Along with this comes the support and encouragement squad members give each other. As well there will always be someone who is prepared to keep the pace up and drag the others along. Most athletes will run faster in a group over any distance than by themselves. There are exceptions, and perhaps Herb Elliott was one of them, but most athletes will be better from being part of a squad. Athletics is an individual sport, and this is often presented as a disadvantage, because the participant is said to miss out on the shared experiences that go with belonging to a team. Being in a squad and sharing in the successes of fellow members, giving and receiving support, and forming friendships, will to some extent give athletes the benefits that are usually associated with team sports.

Despite the advantages of a squad, we need to ensure that the squad program does not submerge the interests of the individual. The key is to make use of the squad program and environment to bring the best out of the individual, without forcing him to do things that are not suitable for him. There will usually be some part of a squad program and some part of a squad session that will be useful to the athlete, and he will be useful to the rest of the squad. Perhaps he is not capable of as many repetitions as the rest of the squad because he is younger, or because his strength is in speed rather than endurance. The squad environment will give him the encouragement and the means to increase his endurance, and his speed will help them nudge up their pace. He might be programmed to finish earlier, having the same recoveries as the squad, or to finish at the same time, with some longer recoveries giving fewer repetitions.

The athlete might be able to manage the same number of repetitions but not the same distance. This could be because he is younger, or because his natural race distance is less. It is a simple matter for him to be programmed to run with the squad, but for each repetition to be shorter than those of his training partners.

Handicaps are another way of enabling athletes of differing abilities or strengths to work together for their mutual benefit. They are very useful for runners of different abilities, who need to do the same work but cannot do it equally well. It is demoralising for a runner to become progressively slower throughout a session as a result of trying to keep pace with more gifted runners in the earlier repetitions of the session, and falling further and further behind them. Furthermore he is practicing the execution of something he does not want- namely slowing down, and he is not practicing something he does want- namely getting used to running at a certain pace. It is far better for him to maintain a constant pace throughout the set, and it is easier for him to do this if he has a start in each repetition. In this way it is possible for him to be in touch with the squad for twice as long- as they are approaching him and as they are leaving him. Then they are of more use to him and he to them.

The important thing is that with intelligent programming it is possible to obtain progression for everyone, by recognising the individual needs of each athlete.

## Recording

The advantages of a program are maximised if the execution of it is recorded. Failure to do this makes it very difficult to know how much progression or otherwise there has been in the various sessions, or what has been the pattern of the progression over time. It will be very difficult to know the comparative progression of the different sessions, which would tell what is working and what is not. The effect of illness or other forced interruption will soon fade from memory. All of this will make it hard to learn the extent to which the program is working until race performances make it to too late. Also when it comes time to write the program for the following year there will not be a solid body of information on training performance on which to base it. So it is very important to have a good written record of training performances and associated information. Good knowledge is a keystone of a successful program, and a well-kept training record will provide such knowledge about effects of training.

The record of training performances should take the form of a training diary. There are a number of things worthwhile recording. As well as the times for the runs in a session the overall circumstances in which they are run is useful information. Times can differ significantly due to weather conditions, and what could seem on paper to have been a disappointing session could indeed have been a very good one disguised by wind or cold. Wrong inferences will not be drawn from recorded times if weather conditions are recorded with them. Other factors that could affect performance should also be recorded. These include health and stress factors such as pressure of work or study. This is not to say that these will affect performance, but rather that it is desirable to build up a profile of what does and does not have an effect on training, and if so, on what type of sessions. This will help the athlete or coach to read the signs, and avoid training that is likely to be injurious or unhelpful.

It could be helpful to record perceived energy levels. This is, on the scale of 0 to 10 , a measure of how energetic the athlete feels towards the training session about to
start. It might turn out to have no relevance to actual training performance on that day, or it might be quite indicative, but in any case it is handy to know. Again an athlete profile builds up, and if it shows after a period of time that low perceived levels are followed by low performances, it could be prudent for the athlete to do something less energetic and more useful when his perceived energy levels are not encouraging.

Weight and resting heart rate should also be entered daily in the diary. The weight should be taken at the same time and in the same conditions every day. It does not matter whether the scales are accurate; what is important is the trend over time and any sudden changes. A sudden fall in weight could indicate illness, and should be a signal to ease off. A fall or rise over time accompanied by loss of form indicates a problem that could be associated with diet, and eating patterns might need to be investigated. Resting heart rate is an indication, but by no means the only one, of aerobic fitness. It is therefore worth recording daily. A sudden rise in resting heart rate can be an indication of illness, and a signal to ease off.

Below is a list of the matters that might be recorded daily in the training diary:

```
1 Resting Heart Rate
2 Weight
3 Sleep- Quantity and Quality
4 Condition of Health
5 ~ A n y ~ E x t e r n a l ~ P r e s s u r e s ~
Emotional State
7 Recovery From Yesterday's Training
8 Perceived Energy Level For Today's Training
9 Weather Conditions
10 Training Performances (Times)
11 Comments on Training
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Obvious the athlete is the best person to keep the training diary. He is the original source of most of the data. Furthermore it makes him more responsible, more attuned to his progress (or lack of it), and better able to contribute to or decide upon his training programs.

## Monitoring and Amending

It is necessary to know how successful the training program is, and it is preferable to know before major competitions, when it would be too late to do anything about it. Therefore there need to be some measurements along the way. These should be compared to some standards that have been set when the program was prepared. After all, the program was set to achieve certain results, and the athlete needs to know that it is working. Alternatively he needs to know that the program is not working, so that it can be altered.

The most reliable checks as to whether the program is working are competition performances. As remarked above, performances close to major competitions are of little use as checks on the success of the program, because they are too late to allow any significant alteration to the program. Early competitions are of more use, particularly if they indicate that the program is working. If it is not working the competitions will indicate this. If the competitions are well selected, to explore both the short and the long
end, they can indicate that for instance the aerobic fitness is good but speed is wanting. There is still time to do something about it, but not as much as desirable, particularly if the deficiency is aerobic. The sooner progress is tested the better, because that will allow more time to do something about it. This means that monitoring in the non-competitive season is necessary.

Time trials are one way to monitor progress. They are the closest possible simulation of competition available in the non-competitive season. They have another advantage- the speed can be organised by well designed pacing, so that the best possible performance is obtained. That gives an accurate check on progress. There should be some expectation as to what performance will be achieved in the trial. That is what training is about; it is not an exercise sufficient unto itself, it is to achieve a certain level of performance. . There has to be some correlation between training and expected results. There ought to be some idea about what level of performance will indicate that the training program is working. Less than that will indicate that all is not well and the program needs revising. What level of performance should be expected is determined by a number of factors. These include maturity, a percentage increase on the same trial last year, and perhaps the additional increase that the emphasis of the program has been designed to achieve. It is possible to make an intelligent and realistic estimate.

The purpose of training is to bring about improvement, and this will be made up of in improvements in a range of characteristics- speed, lactic power, lactic capacity, aerobic power, etc. Trials are to check improvement in these components, separately if possible, so that necessary corrections can be made. A trial over the preferred race distance will show how much improvement has been obtained, but it will not show comprehensively where that improvement has come from. Under and over distance trials are useful for this purpose. Over-distance trials will indicate how successful aerobic training has been. Under-distance trials will test lactic capacity, lactic power or speed, depending on the whether the trial distance is long medium or short respectively.

If the trial performance meets expectations it suggests that the program is working and there is no need for any major change. In fact a change is probably inadvisable, unless there is a change in strategy, such as shifting the focus to another race distance. If the trial performance has not been to expectations then to some extent the program is not working and needs amending. Since the trial was specific, it will be known what ability is deficient, whether it is speed, lactic or aerobic. If the training to date has been designed to improve that ability, then it has not worked, or has not worked sufficiently. If there has been some improvement but not enough the indications are that more emphasis on the relevant parts of training is necessary. This could mean continuing that part of training on longer than originally intended in the program, or if it was to continue anyway, perhaps giving it greater emphasis in a revised program.

It sometimes happens that trials over all distances are unsatisfactory. In such cases it is not the wrong emphasis that is the problem but something much deeper. For some reason the whole program is wrong, and it would be presumptuous to believe that more of the same would turn the situation around. Perhaps the quantity is too great, or diet is wrong, or there is a health problem. It cannot be that the quantity or quality is too little, because even too little would have some positive effect. The best thing to do is to stop and do a thorough check of all the non- running factors. It is quite possible that one or more of these is preventing training having its desired effect. If all of these prove clear
it could be an energy balance issue. As we saw in an earlier chapter, energy input comes from intake of carbohydrates. And part of energy output, perhaps a large part, is training. If the former does not provide enough energy for the latter, the way ahead can only be a decline. A reassessment of diet is highly desirable. Only when all non-running issues have been cleared should training be resumed. If there is no reason to doubt the program it could then be recommenced in a condensed form, until some progress is obvious. Then it could be stepped up gradually.

Training performance itself provides a monitor on the effectiveness of the program. For any particular session that is repeated regularly through a phase of the program there is an expectation of progress. There ought to be a target of performance to be reached by the end of the phase. This will be based on experience, the percentage drop in event time targeted, and whether more or less improvement in this facet of the training is expected. Gradual though not necessarily uniform improvement is expected throughout the phase, so there can be continual monitoring.

A trend of ongoing improvement to the extent expected or better indicates that the program is probably working and should be continued. Some improvement, but not at the rate expected, calls for the program to be looked at. It could be that the program is reasonable but the expectations are unrealistic. Rate of improvement, even for the same amount of work, is not uniform, and there are many reasons for this. If the athlete is managing the program well it could be advisable to accept the lower rate of improvement and continue with the program. However if the program is usually a struggle, and early improvement has tapered off or improvement is very hard to obtain, it could be that the program is too hard. It could be advisable to scale back the program by introducing more easy periods or by reducing the volume. Sometimes a session tends to suffer and not to yield the expected improvement because it is the day after a strenuous session. Even if that strenuous session is well managed, and perhaps particularly if it is, it takes its toll and takes more than a day for recovery. The program might need rearranging.

It is also possible that improvement has been less than expected because the program has erred on the light side. If this is the case the athlete will have had no trouble managing the session in question. It would be reasonable to gradually increase the workload in that session or to introduce another similar session.

As with the time trials, it is possible that no session experiences any improvement, or early improvement has petered out. In this situation the program definitely is not working for some reason. Health is a possibility, and it should be the first thing checked. It could be the program that is at fault and this would usually be because it is too heavy for the athlete. It could be too heavy because of the immaturity of the athlete, or because the nutritional energy input is less than the attempted energy output. Investigation of eating habits and response to training will sort this out. If nutrition is definitely satisfactory the logical thing to do, after a short break in training, would be to reduce the workload of the program substantially and then build up slowly when some improvement is obvious.

There are a few principles to be employed in monitor and amending programs and they probably sum up all that has been said above.

- There is a correlation between training and results- bad results indicate bad training, for whatever reason.
- If honest training efforts are not satisfying performances, honest racing efforts are unlikely to be satisfying.
- Training needs to be monitored and checked against some anticipated levels of performance, to ensure training performances are satisfactory.
- If training performances are unsatisfactory, more of the same is unlikely to produce satisfactory performances, unless there has been some external influence, now eliminated, impeding progress.
- The possibility of external (to training) influences, such as immaturity, health and diet, should be considered in the event of sustained unsatisfactory training performances.
- If training performances are unsatisfactory a change in training program is necessary.
- The change should be such as to address the problems that were apparent in the training performance.
- A little progress with a light workload easily handled probably indicates the workload can be beneficially increased. A little progress with a heavy workload handled with difficulty probably means the workload can be beneficially decreased.


## Some Possible Programs

As remarked at the beginning of this chapter, there are a number of possible programs that have led to success for well-known athletes, and could lead to success for aspiring athletes. This section looks at a few of them and suggests another variation that builds on the logic followed in this book.

## CONVENTIONAL

This program is very basic and now quite old and outdated, and probably does not have a great following any longer. It consists of longs runs in the winter and shorter runs including sprints in the summer. It is one step in advance of only training in the summer. In the winter runners would train and compete in the same way as distance runners. They would run with and cover the same distances as distance runners, and would compete in cross-country races. In the summer they would compete in middle distance races, and the training would be aimed at that. Because this program was further developed into programs more useful today it will not be further considered. Anything that is of value in it is incorporated in programs below.

## THE LYDIARD PROGRAM

Arthur Lydiard was the coach and mentor of a large group of New Zealand athletes who were very successful in international middle distance and distance racing in the 1960s and 1970s. Foremost was Peter Snell, who won the 800 m at the 1960 Olympics and the $800-1500 \mathrm{~m}$ double in 1964. The cornerstone of Lydiard's program was marathon conditioning. Indeed in the non-competitive season it looks very much like marathon training, and that is the way Lydiard wanted it. It is much more marathon training than the off-season training for middle distance runners in the conventional program, which is basically distance training. Lydiard had middle distance and distance
runners doing the same training in the non-competitive season, so in this sense his approach followed the conventional one, but it was marathon training.

Lydiard claimed that his program was a balanced combination of aerobic and anaerobic training. There is no denying that it was successful, but it certainly was not balanced. It was heavily slanted towards aerobic training. In terms of number of sessions it was about $75 \%$ pure aerobic and some of the remaining $25 \%$ had a significant aerobic content. He believed in as many kilometres as possible of easy aerobic work. However easy was not slow. It was up near ( $70-100 \%$ ) the maximum of steady state pace. Maximum steady state pace is that which can be maintained, regardless of distance, without having to slow down. In other word it is the maximum pace without any lactic content. This pace induces a pleasant state of tiredness, but does not affect the ability to handle training the next day. Lydiard advocated running strongly but easily in training, always keeping something in reserve. The tempo of training increases over time, but the reserve is never used up.

He believed in the volume of aerobic training being measured in time rather than distance, because at the right pace it is time at it rather than distance that has the desired effect. If it were distance based, elite runners would train for a shorter time than less gifted runners. Nevertheless as a guide middle distance runners should do about 160 km a week of aerobic running during the base phase. This is work at or near maximum steady state pace; there would be additional kilometres of slow running for recovery. So it does involve a great deal of running, 10-11 hours of work at or near maximum aerobic effort as well as about 5 hours of slow recovery running.

Lydiard meant what he said about marathon conditioning. Not only was the total volume of running high, but also individual runs would assume marathon proportions. One run a week in the base period would be of 2 to 3 hours duration. If an athlete's daily average was 24 km , Lydiard believed that over two days this would be more beneficially achieved by runs of 32 km and 16 km rather than two of 24 km . The longer runs build greater muscular endurance. In particular, the heart is a muscle and longer runs increase its size and improve its ability to pump blood. He referred to research that showed the increased muscular endurance was due to the expansion of capillary beds and formation of new ones, which improved the transport and use of oxygen.

This base phase of aerobic conditioning contained nothing but aerobic conditioning, and Lydiard carried it forward to within 8 weeks of the beginning of the competitive season and 14 weeks of the first major race. It occupied 6 or 7 months of the year. He held that anaerobic work should only be done after a thorough development of aerobic capability and the raising of the maximum steady state performance to the highest possible level.

He did not believe that a long stretch of anaerobic training was required after this aerobic foundation. Four to five weeks would be enough. But firstly there has to be a transition from the slower aerobic work, in order to condition the legs for faster work. The work Lydiard prescribed for this transition was based on what he called "hill springing". Four to six weeks is enough for this, and each week consists of two or three days of uphill running, two or three days of leg speed work and one long run of the type employed in the aerobic phase. Also included is a supplementary 30 minute run every day. All of this amounts to about 150 km per week, so the volume of running is still well up. As the name suggests, the hill springing consists of running up a hill with a high
knee, springing action. The length of the hill is about 300 m . The leg speed work is runs over about 100 m , in which the emphasis is pulling the legs through as fast as possible. All of this work is away from the track, and indeed at the end of this phase the athlete has been at it for seven or eight months and still has not set foot on a track.

Then comes the four to five weeks of anaerobic work, and now most of the training is on the track. The training is part speed development (the CP system) and part lactic, with of course the aerobic maintenance work continuing on. The speed development work is interesting. It consists of runs over $80-100 \mathrm{~m}$, emphasising different aspects of speed. In the first couple of runs the emphasis is on fast leg action with high knees, and no concern about a slow forward movement. The second couple emphasise forward drive and long striding. In the third couple the emphasis is on lifting the torso up from the pelvis. Then in the fourth couple the concentration is on all of the above three aspects, and the pace is as fast as this concentration allows, but hopefully fast. This is followed by laps of 100 m fast and 300 m jog, the jog being at a pace that will enable the 100 m runs to be unaffected by tiredness.

The lactic work is nominally 15 to 20 repetitions over 200 m or 400 m , but Lydiard was not in favour of structured sessions. The length of the repetition, the pace and the recoveries are not of prime importance and could be varied. The important thing is that the athlete knows that he has dragged himself into high lactic acid accumulation. It is his feel for it that matters. This is not speed work because the accumulation of lactic acid precludes good speed, so it is essential that speed work be done as well, but of course on different days.

We are then into racing, and from now on the training is easier and more relaxed. As well as the inevitable long runs once a week there are sessions of fast relaxed striding and sessions of windsprints.

The following is a schedule of major daily sessions for a senior athlete for a training year. As well there would be the easy morning recovery runs on most days. The training load for a younger athlete (about 18 years old) would be about $75 \%$ of this. Information for this schedule is from a book entitled Running with Lydiard, by Arthur Lydiard and Garth Gilmore, published by Hodder and Stoughton in 1983.

## Marathon Conditioning ( 6 to 7 months) <br> MONDAY 1 hour easy fartlek <br> TUESDAY $\quad 1.5$ hours aerobic run <br> WEDNESDAY 5000 m time trial <br> THURSDAY $\quad 1.5$ hours aerobic run <br> FRIDAY $\quad 1$ hour fartlek including hills <br> SATURDAY $\quad 10,000 \mathrm{~m}$ time trial <br> SUNDAY $\quad 1.5$ hours or more aerobic run

Anaerobic Preparation (1 month)
MONDAY 10x120m leg speed
TUESDAY 1.5 hours aerobic run
WEDNESDAY 1 hour hill springing ( 300 m hill)
THURSDAY 1 hour easy fartlek
FRIDAY 10x120m leg speed

| SATURDAY | 1 hour hill springing $(300 \mathrm{~m}$ hill) |
| :--- | :--- |
| SUNDAY | 1.5 hours or more aerobic run |

Anaerobic Conditioning (1 month)

MONDAY
TUESDAY
lifts, sprints
WEDNESDAY
THURSDAY
FRIDAY
SATURDAY
SUNDAY

15-20x400m repetitions
about $10 \times 100 \mathrm{~m}$ high knees, long strides, torso
1 hour easy fartlek
$15-20 \times 200 \mathrm{~m}$ repetitions
$10 \times 100 \mathrm{~m}$ leg speed
3000 or 5000 m time trial
1.5 hours or more aerobic run

Early Racing Season (1 month)
MONDAY 2400 m of 100 m windsprints (2 per 400m)
TUESDAY 1 hour easy fartlek
WEDNESDAY 200 m and 600 m time trial
THURSDAY 1 hour aerobic run
FRIDAY $6 \times 100 \mathrm{~m}$ fast relaxed
SATURDAY race 800 m or 1500 m
SUNDAY $\quad 1.5$ hours jog
$2^{\text {nd }}$ Last Week Before First Major Competition
MONDAY 2000 m of 45 m windsprints ( 4 per 400 m )
TUESDAY 1 hour easy fartlek
WEDNESDAY race distance time trial
THURSDAY 3/4 hour easy fartlek
FRIDAY $6 \times 200$ relaxed striding
SATURDAY race 400 m or 800 m
SUNDAY $\quad 1.5$ hours jog
Last Week Before First major Competition

MONDAY
TUESDAY
WEDNESDAY
THURSDAY
FRIDAY
SATURDAY
SUNDAY

1600 m of 45 m windsprints ( 4 per 400 m )
3/4 hour easy fartlek
100 m and 400 m time trial
3/4 hour jog
1/2 hour jog
race
1.5 hour jog

Continuation of racing
MONDAY
TUESDAY
WEDNESDAY
THURSDAY

1 hour easy fartlek
$6 \times 200 \mathrm{~m}$ relaxed striding
race or 2400 m of 100 m windsprints ( 2 per 400)
1 hour easy fartlek

| FRIDAY | $6 \times 200 \mathrm{~m}$ relaxed striding |
| :--- | :--- |
| SATURDAY | race or time trial |
| SUNDAY | 1.5 hours jog |

The above is certainly a high volume program and heavily loaded in favour of aerobic development. It cannot be denied that it has been a successful program for some athletes. However there have been others who claim that they switched to it and their performances deteriorated. It is difficult to say what type of runner might benefit from this training regime. One theory is that Snell benefited because he was a big man and the large training volume was a weight control measure for him.

## THE CERUTTY PROGRAM

Percy Cerutty was an eccentric whose main claim to fame was that he coached the great Herb Elliott. Despite his excessive behaviour and utterances he had ideas that were well ahead of his times and are still relevant today. His main focus in training was the development of toughness, particularly mental toughness, which would enable the athlete to withstand the physical discomfort of a race, and to apply pressure on opponents when they too would be feeling that discomfort. There are many more hard sessions than easy sessions, except in the racing season when racing would provide most of the toughness. There was no such thing as an easy race for Cerutty; it was the athlete's best every time.

Cerutty did not believe in rigid training schedules. He regarded running as a free expression of the human body, and a schedule would inhibit that, either trying to force something that was for some reason just not possible or denying the opportunity for something special. He was in favour of more informal training settings. Nevertheless beneath this informal setting there was a very definite program. That the tracks, surfaces, distances and times were irregular does not negate this important fact.

The program has three basic phases- conditioning, transition to racing, and racing. Typical weeks of the program are shown below. Information about the program comes from a number of sources, including conversations with Cerutty and athletes he coached, and a book entitled Herb Elliott, The Golden Mile, as told to Alan Trengove, published by Cassell \& Co. Ltd in 1961.

Conditioning Phase (up to 6 months if single peaking)
MONDAY $\quad 16 \mathrm{~km}$ at "feel like" pace, hard over last 3 km
TUESDAY $\quad 10 \mathrm{~km}$ in am; weights in pm
WEDNESDAY $\quad 16 \mathrm{~km}$ hard against clock
THURSDAY $\quad 10 \mathrm{~km}$ in am; weights in pm
FRIDAY
SATURDAY easy fun run in am; hard 8 km in pm
SUNDAY $\quad 13-16 \mathrm{~km}$ in am; 13-16km hard in pm
The above amounts to $80-160 \mathrm{~km}$ per week. The volume is not as great as the Lydiard program, but Cerutty considered that marathon pace was too slow for middle distance training. The week should include about an hour on steep hills. Frequently there should be a run as long as 32 km , and an elite standard runner should do it in less than 2 hours. Although none of this in on a track, the elite athlete should have developed
some speed, to the extent that by the end of the phase he feels that he could accelerate to 12.5 seconds per 100 m pace from 15 seconds per 100 m pace.

## Transition to Racing Phase (3 months) <br> MONDAY <br> TUESDAY <br> WEDNESDAY <br> THURSDAY <br> FRIDAY <br> SATURDAY SUNDAY <br> $6-10 \times 400$ or $800 ; 3-5 \mathrm{~km}$ of free running 8 km flat out train with sprinters 30 minutes of sprint-jogs. rest <br> 5 to 10 km flat out on track 16 km hard

The above is only a sample week and perhaps not typical because typical implies more structure than existed in the program. The emphasis is on race preparation- getting ready for the efforts that will be required in racing. That does not have to be done on the track; it is attitudinal training as much as anything, and can be done anywhere. Some of it does have to be done on the track, because it is pace perception work. It involves checking speed against goal speed for the middle distance event, over $200 \mathrm{~m}, 400 \mathrm{~m}$ and 600 m . Once there is a perception of the correlation between effort and track speed, there is less need for track training. The idea is to work the required pace, and effort, up through increasing distance. It should become possible to run the required pace over any distance without a watch. Eventually it will become possible to run for one hour with the run densely packed with efforts over various distances at the required pace, or effort.

Then there is training for the event duration, which does not have to be done on the track. For example for an elite 1500 m runner this would involve efforts occupying three and a half minutes. It simulates as many race scenarios as possible. For instance it can mean simply running hard for three and a half minutes. Or it could be running fairly hard but varying the pace. Or it could be running comfortably for two minutes and then running as hard as possible for the remainder. An important aspect is to practice maintaining speed in the face of failing strength.

The hard runs above in the sample week can be exhausting efforts over difficult informal tracks a kilometre or two in length, embedded in a run of an hour duration.

There should be sufficient number of days between exhaustive efforts, otherwise the level of performance will fall off.

## Racing Phase

There is even less structure in this than the previous two phases. Cerutty believed in racing often, and with little exhaustive training in between. He believed that training was over by the time major racing commenced, and that an athlete could not put any more potential in. Perhaps performances could improve with racing, but this was a matter of discovering potential rather than increasing it.

A training session might be something like striding the straights and jogging the bends for 10 laps, or a session of unstructured surging. It is important that training leaves plenty of energy, both physical and mental, for racing.

Peter Coe was of course the coach of his famous son, Sebastian, twice Olympic 1500 m champion, holder of $800 \mathrm{~m}, 1000 \mathrm{~m}, 1500 \mathrm{~m}$ and mile world records in the late 1970s and early 1980s, and indeed holder of the 800 m record for 16 years and the 1000 m for 18 years. In contrast to the above two programs, Coe's is not divided into blocks which are very different in content. He advocated what he called the multi-tier approach. Each tier is in fact a phase, a block of some weeks, but the word "tier" is used to indicate that each is built on the one before. The main ingredients of the whole training year are four ranges of pace, and these are present in every phase. Information about the program was obtained from the author's discussions with Peter Coe, and from the book entitled Training Distance Runners, by David E. Martin and Peter N. Coe, published by Leisure Press in 1991.

The different pace ranges in Coe's multi-tier program are as follows:

- sub marathon pace,
- just below to just above marathon pace,
- $5000 \mathrm{~m}-3000 \mathrm{~m}$ pace,
- $1500 \mathrm{~m}-400 \mathrm{~m}$ pace.

All are present at any stage of training but the emphasis shifts from slow to fast as the year progresses. In Seb Coe's case this meant that he was able to run world-class indoor performances off his winter training because speed was always there. Peter Coe did not believe in allowing any part of an athlete's armoury to become untrained by being neglected for a period of time.

Each of the paces has significance for the development of a middle distance runner. The sub marathon pace provides basic conditioning of blood transport systems as well as gentle strengthening of tendons, muscles and joints. The pace is sometimes called "conversational", and its gentleness allows long duration, which gives plenty of the above conditioning. It provides the basis for all the other paces. Coe calls this aerobic conditioning.

The marathon pace (note that this is not marathon distance) is about maximum steady state pace and develops the aerobic system. It stresses only the aerobic system and thereby pushes up the pace that can be maintained by the aerobic system alone. As remarked before this means that the athlete will incur less lactic acid for the same race pace. Coe calls this anaerobic conditioning, which is perhaps not a good name for it, because it is about improving aerobic running.

The 5000 m pace is just under the pace that calls for the maximum oxygen uptake and the 3000 m pace is just over, so this running challenges the uptake and thereby raises it. This will raise the power and hence the speed of the aerobic component of running. Coe calls this aerobic capacity training, and again this is not a good name because capacity is about maximum possible amount, whereas this training is towards improving the power of the aerobic system.

The 1500 m and the 800 m paces are specific to the middle distance events and are worthwhile for that reason alone. From a technical viewpoint these paces, provided the volume of the session is sufficiently densely packed, stress and so increase lactic tolerance. In so doing they increase the capacity of (the amount of energy that can be derived from) the lactic system. The 1500 m pace as well trains the aerobic system to hold up the lactic effort in the face of advancing lactic saturation. The 400 m pace demands a powerful lactic system and so it is the power of the system that is trained. It
also trains the CP system to some extent because it is this system that provides the acceleration up to lactic speed. Coe calls this training anaerobic capacity training.

Coe's training year is divided into six phases, not counting the four week rest after the end of competition. These are:

| Phase 1 | establish aerobic base | 12 weeks |
| :--- | :--- | :---: |
| Phase 2 | increasing intensity | 8 weeks |
| Phase 3 | increasing intensity | 7 weeks |
| Phase 4 | consolidation | 6 weeks |
| Phase 5 | event fine tuning | 3 weeks |
| Phase 6 | competition | 12 weeks |

The fact that a variety of different paces have to be fitted into every phase, and that it is necessary to do each of them regularly within the phase, means that the different paces have to be fitted into every cycle. Since some of them will be repeated a number of times in a cycle, in order to give them greater emphasis, it follows that one week might be too short for a cycle. 14 days could be more appropriate. Alternatively a very short phase, such as Phase 5 above, could be a single cycle.

Below is a possible program for the first four phases of a training year, after the four-week rest.

## Phase 1-Establish Aerobic Base <br> $3 \times 4$ weeks

Week of $1^{\text {st }} 4 \quad 5-6 x$ aerobic conditioning run $0-1 x$ anaerobic conditioning run
$4 x$ mobility sessions
$0-1 \times$ circuits and weights $\quad 48-64 \mathrm{~km}$
Week of $2^{\text {nd }} 4 \quad 4-5 x$ aerobic conditioning run
$1-2 x$ anaerobic conditioning run
$1-2 x$ aerobic capacity training
$1 \times$ anaerobic capacity training
$4 \times$ mobility sessions
$1-2 x$ circuits and weights $\quad 72-96 \mathrm{~km}$
Week of $3^{\text {rd }} 4 \quad 4-5 x$ aerobic conditioning run
$2-3 x$ anaerobic conditioning run
$2 x$ aerobic capacity training
$2 x$ anaerobic capacity training
$4 x$ mobility sessions
$2-3 x$ circuits and weights $\quad 104-120 \mathrm{~km}$
Phase 2-Increasing Intensity 1
2x4 weeks
Week of $1^{\text {st } 4} \quad 3 x$ aerobic conditioning run
$3 x$ anaerobic conditioning run
$2 x$ aerobic capacity training
$3 x$ anaerobic capacity training
$4 x$ mobility sessions
$3 x$ circuits or weights
$112-120 \mathrm{~km}$
Week of $2^{\text {nd }} 4 \quad 3-4 x$ aerobic conditioning run $4 x$ anaerobic conditioning run
$2 x$ aerobic capacity training
$3 x$ anaerobic capacity training
$4 x$ mobility sessions
$3 x$ circuits and weights
120-128 km

## Phase 3-Increasing Intensity 2 <br> 4+3 weeks

Week of $4 \quad 3 x$ aerobic conditioning run
$5 x$ anaerobic conditioning run
$2 x$ aerobic capacity training
$3 x$ anaerobic capacity training
$5 x$ mobility sessions
$2 x$ circuits and weights 112 km
Week of $3 \quad 3 x$ aerobic conditioning run
$5 x$ anaerobic conditioning run
$3 x$ aerobic capacity training
$3 x$ anaerobic capacity training
$5 x$ mobility sessions
$2 x$ circuits and weights
104 km

## Phase 4-Consolidation

2x3 weeks
Week of $1^{\text {st }} 3 \quad 2-3 x$ aerobic conditioning runs
$4 x$ anaerobic conditioning runs
$3 x$ aerobic capacity training
$4 x$ anaerobic capacity training
$4 x$ mobility sessions
$1 \times$ circuits and weights 96 km
Week of $2^{\text {nd }} 3 \quad 2-3 x$ aerobic conditioning runs
$4 x$ anaerobic conditioning runs
$3 x$ aerobic capacity training
$4 x$ anaerobic capacity runs
4x mobility sessions
$1 \times$ circuits and weights 88 km

Typical sessions for the above are as follows.

- The aerobic conditioning runs can be short, at 8 to 15 km , or long, at 10 to 35 km.
- The anaerobic conditioning runs can be a couple of runs of 15 to 20 minutes at just above and just below lactic threshold, with an easy kilometre or so between them.
- The aerobic capacity sessions are typically repetitions of $3000 \mathrm{~m}(2), 2000 \mathrm{~m}$ (3) or 1000 m (6); the pace varies from $10,000 \mathrm{~m}$ pace for the longer repetitions to 5000 m or 3000 m for the shorter ones.
- The anaerobic capacity sessions typically repetitions of 200 m or 300 m at race pace or faster, possibly in sets of a few repetitions.

A 12 day block in the competition phase could be like the one below. It is really a 14 day block with some slack allowed for additional rest days if necessary.

| Day 1 | $3 \times 2000 \mathrm{~m}$ or $2 \times 1200 \mathrm{~m}+800 \mathrm{~m}+2 \times 400 \mathrm{~m}$ <br> Day 2 <br> over-distance fartlek | 5000 m pace |
| :--- | :--- | :--- |
| Day 3 | $6-8 \times 800 \mathrm{~m}$ | 3000 m pace |
| Day 4 | road run |  |
| Day 5 | $16-30 \times 200 \mathrm{~m}$ or $10 \times 400 \mathrm{~m}$ |  |
| Day 6 | rest (before race) or fartlek | 1500 m pace |
| Day 7 | race or time trial |  |
| Day 8 | $4-6 \times 400 \mathrm{~m}$ or $6-9 \times 300 \mathrm{~m}$ |  |
| Day 9 | road run | 800 m pace |
| Day 10 | $300 \mathrm{~m}+2 \times 200 \mathrm{~m}+4 \times 100 \mathrm{~m}+8 \times 60 \mathrm{~m}$ <br> Day 11 <br> over-distance fartlek | 400 m pace |
| Day 12 | rest for race next day |  |

Note that the pace is continually getting faster over the training block.

## THE MOROCCAN PROGRAM

This section outlines some content of the Moroccan training program that has been used so effectively by Hicham El Guerrouj, the world record holder for the 1500 m at the time of writing of this book. The author is indebted to an internet article by Mexican coach Marco Velediaz, which was published on Steve Bennett's Oztrack.

The training year is divided into five parts, following a rest period of about 6 weeks. The first part is the preparatory period and this lasts about seven months. It is divided into two phases, the first lasting four months and the second lasting three. The first phase is devoted to a multilateral preparation in all aspects of running and has as its objectives the development of aerobic endurance, strength and power. The second phase continues the development of aerobic endurance, strength and power, and also works on specific endurance and race pace.

The second part is a short period of about 3 weeks and it is the first competition preparation phase- in preparation for the first competition period. The aspects targeted in
this phase are race pace, specific speed and aerobic endurance. Then follows the first of the competition periods, which might be only a couple of weeks.

The second competition preparation phase is again of about three weeks and its aims are the same as the first preparation phase. It is followed by the main competition period, which lasts about two months.

Below are 21 day blocks from the first three phases of the training year. The two competition phases are so compacted with races that training is minimal, and the second competition phase is much like the first, so these three blocks are indicative of the whole program.

## First Preparation Phase (4 months)

This block of 21 days has 42 scheduled sessions, of which seven are rest sessions. Two days in the block are rest days, i.e. double rest sessions. There are 23 aerobic endurance sessions, more than one per day. The types of sessions, fairly evenly distributed throughout the block, and their frequency, are as set out below.

- 23 aerobic endurance sessions
- 7 strength sessions
- 3 power sessions
- 2 physical preparation sessions
- 7 rest sessions

In view of the fact that some of the above mean different things to different people, it is necessary to give some idea about what is meant here:

There are four different types of aerobic endurance session. The first is a shorter continuous run (30-45 minutes) that is maximum pace at the time, and the second is a longer continuous run (50-60 minutes) that is also maximum pace at the time. For El Guerrouj this would be typically 3 minute to 3 minute 10 second per kilometre pace, though it could be as fast as 2 minute 50 second pace. The third session is $4 \times 2000 \mathrm{~m}$ with 2 minute recoveries, which El Guerrouj does in 5 minute 10 seconds. The fourth is $6 \times 1000 \mathrm{~m}$ with 2 minute recoveries, which he does in 2 minute 30 seconds. It is interesting that the longer repetitions are only $3 \%$ slower than the shorter ones, indicating that he is not incurring much lactic acid at this speed, which means that his steady state speed is not too much below this pace. It further indicates that the continuous runs are probably just above or below marathon or steady state pace, and that he has superb aerobic fitness. This undoubtedly comes about from concentrating on working up the pace of the long runs over a period of time, continually stressing the limits of aerobic performance.

Strength work is weights work, either free weights or apparatus. They include half squats, squats, step-ups and lunges with free weights, and hamstring, quadriceps, abductor and adductor exercises on the apparatus. The weights are generally light and the repetitions typically number 16 to 20 .

Power work includes hill runs and plyometrics. The hills are $10 \times 300 \mathrm{~m}$ and the plyometrics include horizontal jumps and vertical jumps over hurdles.

Physical preparation includes general body weight exercises, with particular emphasis on the back and abdomen, drills and stretching.

## Second Preparation Phase (3 months)

Here is a block of 21 days in the second preparation phase. It has 42 scheduled sessions, two per day, and five of the sessions are rest. The make-up of the program for the 21 days is as follows:

- 26 aerobic endurance sessions
- 5 race pace sessions
- 4 power sessions
- 2 strength sessions
- 5 rest sessions

The sessions are evenly spread throughout the 21 days. A brief description of them is given below.

The aerobic endurance sessions consist only of continuous runs, and are at about the same pace as in the first preparation phase, but now only the shorter run (30-45 minutes) is employed. There are 30 minute runs as recovery.

Race pace work is fartlek or a track session. Fartlek with bursts of 6, 5, 4, 3, 2 minutes of fast running is used. The track session is a bracket of $1600 \mathrm{~m}, 1200 \mathrm{~m}, 800 \mathrm{~m}$, 600 m and 400 m , with recoveries that start at one minute and go down to 30 seconds.

Power work consists of up hill running, either $10 \times 300 \mathrm{~m}$ with jog back recovery or 5x 150m, and 200-300 multi-jumps.

Strength work is similar to the work in the previous phase.

## First Competition Preparation Phase (21 days)

This phase consists of a 21 day block, all of which is shown below. It consists of 42 scheduled sessions, of which four are rest. An outline is shown below.

- 18 aerobic endurance sessions
- 4 race pace sessions
- 4 speed sessions
- 11 warm-up sessions
- 4 rest sessions
- 1 race (at then end of the block)

The significant thing about this block is that it is much less demanding than the previous phases. More than one third of these sessions are rest or very easy. There is even a full day of rest. An outline of the content of the sessions is given below.

The aerobic endurance is now down to 30 minutes of continuous running at 3 minute to 3 minute 10 seconds per kilometre pace, and there is 40 minutes of lower intensity running as recovery.

The race pace sessions are 10 x 400 m with only 30 second recoveries. El Guerrouj runs these in 53-54 seconds, but even he needs help from a "rabbit" in the last 200 m of each repetition.

One speed session is 10 x 300 m with surges, which El Guerrouj runs in 35-36 seconds and again needs help from a rabbit to keep up the pace. Another is $6 \times 500 \mathrm{~m}$ with
surges, and he has help from a rabbit for the first 300 m in each repetition. In both of these sessions the rabbit is responsible for throwing in some unexpected surges, to which El Guerrouj has to respond. The aim is for El Guerrouj to improve his reaction every time the rabbit accelerates.

Warming-up consists of 30 minutes of easy running and 30 minutes of general exercises. The aim is an active rest.

## The Rest of the Program

There are three other phases, but they are very easily described. Such has been the preparation that very little needs to be done in the two competition phases except race. Also the second competition preparation phase is much like the first.

## FUNNEL PROGRAM

This is the author's own program and it pertains mainly to the 800 m event. It follows on from the section earlier in this chapter on sequencing the building blocks. That section talked about a progression downwards in distance of long repetitions and upwards in distance of short repetitions. This made sense in terms of logical development of the energy systems for 800 m running. There are a number of different sessions set out in Chapter Five that need to be put into appropriate sequences so as to obtain optimum development.

It is possible to dovetail all of these sessions together in a way that gives logical progression. There are three streams and they can all meet at 300 m repetitions. The long repetitions move down in distance and up in recovery and pace, towards the 300 s , while the short repetitions move up in distance and hold onto as much pace as possible, also towards the 300s. The distances meet, and so too does the pace. Both the long end and the short end have been developed towards specific quality work. The third stream is the repetition 300s. The increasing rests allow the pace to increase, and it trends towards the pace the other two streams are heading for. All the training to the point when the three streams meet has been in preparation for high quality specific work leading up to major competitions.

The name "funnel" comes from the idea that all of the preparation work in the form of above repetition sessions is funnelled into a stream of quality sessions gaining in specificity as the major competitions approach. The stem of the funnel will be discussed below. The program can be depicted in the shape of a funnel as shown below. The funnel begins with two parallel sides, which after travelling parallel for some time both taper in to a point. In between the two sides is another line, which travels to the same point. The top parallel lines represents establishing an aerobic base and the bottom represents establishing a speed base. The tapering in of the top line represents decreasing distance and increasing speed of the long repetitions, and the tapering in of the bottom represents the increasing distance of the short repetitions. They reach a common point, the 300 m , with inbuilt endurance and speed. The middle line represents 300 m repetitions with short but increasing recoveries, and the speed of these is also heading for the speed of the other two streams at their meeting point. Thus we obtain well-established 300 m efforts, fast, repeatable and manageable, which is the basis for further development of the attributes needed for successful 800 m running.

Along the stem of the funnel is the development of very specific quality training for 800 m . It begins with 300 m repetitions with reasonable recovery, say about $8-10$ minutes. The number would be about 5 or 6 . Following all that has gone before, this will allow the athlete to start at about 800 m average pace and improve on that over a period of some weeks. This will build a good specific speed base for 800 m . When there is sufficient improvement, in the order of 1.5-2.0 seconds average, the athlete can then step back to 800 m pace, but now with shorter recoveries. The repetitions now are in two sets of three, each set being a little longer than 800 m . The recoveries start at a manageable duration, perhaps two minutes, and progression is by reduction of the duration of the recovery rather than increase in pace. When the recoveries are wound back to about 1 minute it is time to move on again. The athlete is now ready to become about as specific as it is possible to be in training. In each set of the $3 \times 300 \mathrm{~m}$, one of the 300 m is dropped and the recovery between the other two is reduced to zero. In other words the session is $2 \times 600 \mathrm{~m}$ and the recovery between them is as much as is necessary to keep the second one at 800 m pace. These are close to the major racing period and so the rest of the training week is relatively light. They do provide the athlete with great familiarity with required pace and duration of effort.

The above are the major sessions of the week, and of course not the only sessions. They provide the main focus of the program. Another sequence of sessions, also leading to the $2 \times 600 \mathrm{~m}$, can be run in parallel with the above. After the sessions of 5 or 6 by 300 m are well developed, they can be progressed by increasing the length and reducing the number, while trying to hold as much pace as possible. Thus we go to $4 \times 400 \mathrm{~m}$ and then $3 \times 500 \mathrm{~m}$, before reaching $2 \times 600 \mathrm{~m}$. The recoveries between repetitions become longer as the runner moves from 300 s to 400 s to 500 s to 600 s , in order to maintain the quality. Quality necessitates getting rid of as much lactic acid as possible between repetitions, and so the recoveries are long, consistent with finishing the session in reasonable time and also not becoming cold and stiff.

The outline of the major track sessions of the program, depicted as a funnel, is shown below.


Figure 8.1 Outline of the structure of the Funnel Program
Of course there are many other sessions in addition to those above, and these might be termed auxiliary sessions. Many of them are away from the track, such as long
continuous runs, shorter continuous runs or fartlek, hill running, plyometrics and weights. There is logical development of these as well. Early in the training year there is a higher volume of slower aerobic running. It is very easy for the first few weeks while the volume builds up and the legs and mind become used to long continuous running. When $3 / 4-1$ hour is comfortable the athlete settles on a narrow band of pace that is just below to just above maximum steady state pace. The aim then is to progress by gradually increasing the pace over the non-competitive season, without incurring significant amounts of lactic acid.

Maximum oxygen uptake sessions are also progressed during the non-competitive season. These are two or three runs of about 3 km , at maximum effort for the distance, and with recovery walk/jogs of a similar duration. Since these are hard sessions, and there are other hard sessions in the week, they will not be done every week but will be replaced every two or three weeks by some easier fartlek.

Hills begin at 300 m , perhaps 6 repetitions, and progress to 8 x 150 m and then $10 \times 75 \mathrm{~m}$. These are continued well into the competitive season, and perhaps with some variations right to the end.

Weights begin with strength exercises, in which the weights are near maximum and the repetitions are as few as three. After they have been developed for about 10 weeks and the amount of the weights has increased, the athlete moves on to power weights. In these the weight is reduced, the speed of action is increased, and the number of repetitions about doubles.

The above sessions take the athlete to the point when the quality 300 m repetitions start, or the beginning of the stem of the funnel. From then on the auxiliary sessions are mainly of a maintenance nature. Aerobic runs continue in order to maintain the aerobic benefits gained in the earlier phases, but they are less frequent and not as often intensive. Similarly there is speed maintenance work. Other sessions, such as hills, weights and plyometrics also continue, though to a lesser degree. The important point is that the athlete must be fresh for the sessions focussed on 800 m pace and distance, so the auxiliary sessions cannot be too demanding.

A possible program along these lines is given below.
Phase 1-Develop aerobic and Speed Base ( 10 weeks)

| SUNDAY |  | speed drills and $10 \times 300(45 \mathrm{~s}$ recov), |
| :--- | :---: | :--- |
| hard 400 |  |  |
| MONDAY | am | 30 min easy |
|  | pm | $6-8 \times 1 \mathrm{~km}(3 \mathrm{~min}$ recov) |
| TUESDAY | am | 30 min easy |
|  | pm | $3 / 4 \mathrm{hr}$ max steady state |
| WEDNESDAY | pm | $10-15 \times f l y i n g ~ 60$ |
| THURSDAY | am | 30 min easy |
|  | pm | $6 \times 300 \mathrm{~m}$ hills |
| FRIDAY | am | weights (strength) |
|  | pm | 2 or $3 \times 3 \mathrm{~km}$ hard or easy 1 hr fartlek |
| SATURDAY |  | rest |

Phase 2- Transition to Specifics 1 (6 weeks)

| SUNDAY speed drills and $8 \times 300$ (90s recov.)hard 400 |  |  |
| :---: | :---: | :---: |
| MONDAY | am | 30 min easy |
|  | pm | $6-8 \times 600$ (5min recov) |
| TUESDAY | am | 30 min easy |
|  | pm | 1 hr max steady state |
| WEDNESDAY | pm | $10 \times 100$ with recov |
| THURSDAY | am | 30 min easy |
|  | pm | 6x300m hills |
| FRIDAY | am | weights (strength) |
|  | pm | 2 or $3 \times 3 \mathrm{~km}$ hard or 1 hr easy fartlek |
| SATURDAY |  | rest |
| Phase 3- Transition to Specifics 2 (6 weeks) |  |  |
| SUNDAY |  | speed drills and $8 \times 300$ ( 2 min recov), |
| hard 400m |  |  |
| MONDAY | am | 30 min easy |
|  | pm | 6x500(6min recov) |
| TUESDAY | am | 30 min easy |
|  | pm | $3 / 4 \mathrm{hr}$ max steady state |
| WEDNESDAY | pm | $6-8 \times 150$ with recov |
| THURSDAY | am | 30 min easy |
|  | pm | $8 \times 150 \mathrm{~m}$ hills |
| FRIDAY | am | weights (power) |
|  | pm | $2 \times 3 \mathrm{~km}$ hard or 1 hr easy fartlek |
| SATURDAY |  | rest |
| Phase 4-Specific 1 (6 weeks) |  |  |
| SUNDAY |  | $5 \times 300$ or $4 \times 400$ with max recov |
| MONDAY | am | 30 min easy |
|  | pm | 12-16x200(1 min recov) comfortable |
| TUESDAY | am | 30 min easy |
|  | pm | $3 / 4 \mathrm{hr}$ max steady state |
| WEDNESDAY | pm | 8-10x flying 60 |
| THURSDAY | am | 30 min easy |
|  | pm | $8 \times 150 \mathrm{~m}$ hills |
| FRIDAY | am | weights (power) |
|  | pm | 45 min easy fartlek, or occasional |
| $2 \times 3 \mathrm{~km}$ |  |  |
| SATURDAY |  | rest |
| Phase 5-Specific 2 (6 weeks) |  |  |
| SUNDAY |  | 1 hr easy run |
| MONDAY | am | 30 min easy |


|  | pm | $2 \times 3 \times 300$ (2min reducing), plenty |
| :---: | :---: | :---: |
| between sets |  |  |
| TUESDAY | am | 30 min easy |
|  | pm | rest or 40 min max steady state |
| WEDNESDAY strides | pm | $3 \times 500 \mathrm{~m}$, max recoveries, or easy |
| THURSDAY | am | 30 min easy |
|  | pm | $10 \times 75 \mathrm{~m}$ hills |
| FRIDAY |  | rest |
| SATURDAY |  | race or time trial |
| Phase 6-Specific 3 (6 weeks) |  |  |
| SUNDAY |  | 1 hr easy run |
| MONDAY | am | 30 min easy |
|  | pm | $2 \times 600 \mathrm{~m}$, max recovery |
| TUESDAY | pm | 30 min max steady state |
| WEDNESDAY | pm | $6 \times 100 \mathrm{~m}$, full recovery |
| THURSDAY | am | 30 min easy |
|  | pm | $10 \times 75 \mathrm{~m}$ hills |
| FRIDAY |  | rest |
| SATURDAY |  | race |
| Phase 7-Major Racing Season (6-8 weeks) |  |  |
| SUNDAY |  | 45 min easy run |
| MONDAY |  | $4-6 \times 1$ st 200 of 800 |
| TUESDAY |  | 30 min max steady state or 30 min |
| easy |  |  |
| WEDNESDAY |  | $8-12 \times 200 \mathrm{~m}$ (1 min recov) race pace |
| THURSDAY |  | $8 \times 75 \mathrm{~m}$ hills |
| FRIDAY |  | rest |
| SATURDAY |  | race |

## Notes

1. The above program is for mature athletes and would need to be reduced for under-age and less experienced athletes.
2. Each of the above weeks is maximum. Every fourth week or so would be reduced to about half load to allow adequate rest, recovery and adaptation. Also any session could be eliminated or lightened if the training load is producing tiredness.
3. Plyometrics can replace power weights on some occasions.

## CHAPTER NINE

## Racing


(photo from New York Road Runners - www.fast-women.com)
Compared to the previous chapter, this chapter is very short. It is short because if the training has been right the racing should come as a matter of course. The training has not been an exercise sufficient unto itself; it has been for racing. There should be nothing in the racing that has not been experienced and learnt in the training. All the fears, anxieties, mental anguishes, physical discomforts that will be experienced in a race have been faced and overcome in training. There is no pace, no duration of effort, no exertion required in a race that has not been endured in training. Thorough preparation should give the athlete belief in himself- belief that he can do what is required to provide a satisfying performance. Sustained fast running will be a habit and a very satisfying experience, and the athlete will be eager to test the limits of his ability.

## Two Types of Races

There are two types of racing performance, and the athlete must be able to master both. The first is proper racing, in which the athlete's finishing position is more important than anything else. When this applies to everyone in the race, as it does in championships, there is no pacemaker and the pace at any stage of the race is the outcome of the interaction between the competitors. The pace is less important than position, but what constitutes optimum position in the field at any stage will very individual. So this type of race is not particularly predictable and not easy to plan for. Nevertheless it is the best test of an athlete's all round mental and physical ability. A complete runner will not be dictated to, and will ensure he runs so as to obtain the best possible placing.

In the other type of racing success is measured by times. This is unfortunate to some extent, because it diminishes the importance of racing, and head to head competition is the essence of sport. However there is some interest in who is the fastest, and who is faster than whom, regardless of how well they can race. Hence world and national records are regarded as important, even if a holder never wins a major championship. Furthermore entry to major competitions is usually dependent on an athlete having achieved a certain time for the event. Therefore an athlete must be also able to run so as to achieve the fastest time he is capable of, and he must be able if necessary to ignore the race going on around him.

## Avoid Being Cast in a Mould

An athlete should not see himself as a particular type of racer, be it a front-runner or a sit-and-kicker. To do so is to limit the chances of success. Such an attitude requires the race to be run in a particular way, and the competitors might not be so obliging. If he fancies himself as a sit-and-kicker and relies on front runners spending all their energy and coming back to him, he will be confused and confounded if the best of them also want to play the waiting game. Similarly if he likes to run at the front and someone else wants to, keeping in front could be such an effort that he incurs excess lactic acid early and is unable to resist challenges in the latter stages of the race. This could happen because the other runner is better or it could happen because the other runner is suicidal, but the outcome is the same- the compulsive front-runner will produce an inferior performance. Ideally an athlete will have so prepared himself in training that he has a good idea of pace and what he is capable of, and will have the confidence and the sense to race accordingly. He will have the confidence to take the lead if it is within his capability and then defy others to pass him, and he will have the sense to hang back from the lead and wait for the leaders to come back to him if he knows the pace is too fast. If he can do both of these he is in the best position to maximise his chances of success.

It follows that a fixed race plan can be a hindrance. Some race plan is necessary, otherwise the athlete would not even know how fast to start, and would only react, perhaps too late, to what others are doing. If he does have a race plan, and the others do not, he has the advantage because he is in a position to dictate terms and is able to control the race. However race plans of a number of runners in the one race is likely to produce a situation that could not have been envisaged, and it is essential that an athlete can respond quickly, sensibly and assertively. The plan might have to be re-made on the run. This is
the alternative to waiting and hoping, and is much more likely to be successful. At any stage the athlete should have a mental picture of how he will run from there to the finish, even if the picture has to be adjusted a few times.

## Preliminary Rounds

How a runner should attack these depends on how good he is. Any runner will naturally have the aim of reaching the final with minimum effort. Minimum effort usually involves running as easily as possible for as far as possible, but only those who are very sure of their overall superiority can afford to take this approach. They must be sure that their aerobic fitness is so good that they will not accumulate as much speedkilling lactic acid as their competitors, and they must be also sure that their speed is better. Many a good runner has been eliminated in preliminary rounds by underestimating his opposition and overestimating his own ability.

If a runner is sure of his superiority he can afford to play the waiting game, but he must be careful. In the last quarter to one third of the race he must be sure that he has the field covered and should be moving up as economically as possible. He must keep his eyes on the field and be prepared to cover any charge to the line. A charge late in the race might not leave him enough space to catch the bolter, unless he has already moved within striking distance. In short, the closer to the finish the closer he must be to the lead. Qualifying is more important than saving energy.

For those athletes having no right to believe themselves superior to the rest of the field, attack is the best strategy for qualifying, but surprisingly few seem to realise this. If the race is being run the way the top runner wants, which is probably slowly, it certainly is not in the interest of the other runners, and they are unwise to allow it to happen. If the top runner does not want a solid early pace then this is precisely what another runner should be trying to give him. It might unsettle him and cause him to become indecisive, lose concentration and run badly, or it could even take him by surprise and leave him with too much ground to make up. If a runner wants to qualify for the next round, he should do his best to see that the race is run the way he wants it, not the way another runner wants it. A runner maximises his chances of progressing through the rounds by controlling a race.

If a runner does not consider himself the fastest in the field, he should ask himself what he thinks he needs to do to qualify. What time will be faster than anyone else can run or wants to run? That is what he should set out to do. If he thinks he will have to run to his best to qualify, then that is what he should be attempting. Since the ideal pace distribution in an 800 m run is for a first lap about one second faster than the target average, he should set out to run the first lap accordingly. In the 1500 m the ideal pace distribution is even, and so he should set out at a pace that is the target pace. It is a forlorn hope to expect that he can run any slower in the first half of the race and keep in front of faster runners at the end. How often do we hear a runner who has been eliminated say after hearing the winning time, "I could have run that". Why didn't he?

## The 800m Race

It is crucial whether an athlete can run fast by himself or he needs someone to help him. If he needs assistance his chance of success is limited. He can only win or place well if someone provides the pace he wants. That is not the sort of runner an athlete should aspire to be. He should have trained such that he can run fast by himself, and furthermore he should have trained his mind to be prepared to do it in a race.

If this means leading, even leading all the way, he should not be shy of it. It is the safest place to be in an 800 m race. He avoids all the skirmishes that take place back in the pack as runners jostle for their supposedly ideal positions, and he is clear of the tripping that is always likely at a change of pace. He can just concentrate on his running rather than worry about who is getting in his way and how he is going to get out of where he is. And the runners behind have to run faster than he for a distance if they are to pass him. To go from 1 metre behind to 1 metre in front in the space of 20 metres requires a speed superiority of $10 \%$ for the trailing runner, and provided the front runner is not slowing down too much, this is probably beyond most runners. Joaquim Cruz won the 1984 Olympic 800 m by leading most of the way. In doing so he defeated Seb Coe, who was the world record holder and was still in exceptional form as he showed in his 1500 m victory. Despite Coe's brilliance, he could not get past Cruz.

A couple of things need to be said about leading. The first is that there is a difference between leading sensibly and going crazy. Leading is not a licence for the athlete to see how fast he can run without regard to how far. That is courting disaster, and he will almost certainly become so saturated with lactic acid that he can only stagger home behind the most of the field. He must always have the feeling that he can reach the finishing line with only minimum deceleration. The other thing needing to be said is the opposite. Unless he is clearly superior there is no point in leading slowly. If the runners behind allow this to happen it is almost certain that at least some of them want it, because passing the leader would be easy. And if this is what they want, it is not for the benefit of the leader. He should be trying to make life as difficult as possible for the rest of the field while trying to make it as easy as possible for himself. He is in a good position to do this from the front, because he decides the pace, and it is the pace that he wants. Furthermore he runs no further than necessary, has no interference, and, unlike some behind him, is where he wants to be.

Certainly those behind will want to pass him, and unless he is clearly superior some will attempt to gain the lead. If they are good enough they will, and there is nothing more he can do about it, but at least he has the satisfaction of knowing he has done his best. However if a runner attempting to pass him is not better by a significant margin, the leader has the advantage, because the effort to hold the lead is not as great as the effort needed to gain it. Obviously big efforts to hold the lead a long way out will be debilitating, and could wreck him as well as the runner trying to pass him, leaving them both sitting ducks for other runners. It is a matter at every stage of running so that he can last to the finish without suffering lactic speed collapse. Within this limitation it is possible for the front-runner to make it increasingly expensive for anyone to pass him as the finish approaches. He can afford to ignore a furious charge 300 metres out, because either the tear-away runner is superior and cannot be beaten, or has misjudged his own ability and resources and will be staggering before the finish. On the other hand 50 metres out he will defend the lead with everything he has.

Whether the athlete leads or not, there is a particular speed distribution that will lead to his fastest 800 m , and this should be his strategy. Chapter 4 discussed the ideal pace distribution, and this or a minor variation on it will be the optimum for a runner. If he goes out harder than that in the first lap he will pay dearly in the second, becoming powerless to do anything he wants to do, and will finish in a slower time than planned. If he goes out slower, he will not make up the difference in the second lap, mainly because he will not have utilised his CP system effectively in the first lap, and will not be able to call upon it in the second. Again he will not optimise. So regardless of what position in the field the athlete can sensibly hold, his best strategy is to run with the pace distribution likely to give him his best time.

An exception to the above ideal pace distribution might be a athlete who is not a specialist 800 m runner, but who is as much or more at home over 1500 m . Such an athlete will not be as strong relatively in the CP system but will be stronger in the aerobic side. Consequently his first lap/second lap differential will probably be less than 2 seconds. As discussed in Chapter Four, Steve Cram was such an athlete. Nevertheless the best strategy, if it is possible, remains the ideal pace distribution for the athlete's fastest time.

It is necessary to have the above strategy, but there are often forces at work in a race that might impede its implementation. Unless the athlete is in front, other runners can prevent him from running the speed he wants to run. This is particularly the case if he is running second and on the inside. He can run no faster than the runner in front, and a stream of runners passing him without a break on the outside prevents him for getting out to do anything about it. He has to wait for all of the runners who so desire to pass him before he can change pace or position. On the inside behind the leader is about the worst position for a runner to take, because he has no control over the race, or even over his own pace. Some runners so trapped attempt to do something about it by barging out, but this is not only illegal, it is unfair. Other runners have taken the trouble to put themselves in an advantageous position, and a runner who allows himself to take the easy option and tuck in behind the leader(s) on the inside has only himself to blame, and have no right to disadvantage his competitors in order to extricate himself.

An exception to the above warning is if the pace is fast. Then the field is likely to single file quite quickly and the danger of having a stream of runners passing on the outside is not as great.

If an athlete does not run on the inside all the way then he covers extra distance. There is a trade-off between running the extra distance and not being trapped on the inside. The slower the pace the less the extra distance matters. The race is always from where the athlete is to the finish, and the extra distance already covered only matters to the extent that it has it has deprived him of energy needed for the rest of the race. If the additional energy used to date is small, it is a small price to pay for being in a good position to be able to contest the rest of the race. On the other hand if the pace is fast the extra distance covered does matter. There will be significantly less energy available for the 90 metre race to the line and this could be telling. It is instructive to look at how much extra distance is covered by not running on the inside; a knowledge and instinct for this will enable the athlete to make sensible choices. There is no problem about the first 110 metres because that is in lanes. However if an athlete runs one lane wide for the rest of the race he covers an additional 11.4 metres. This is $1.4 \%$ of the total distance, and he
would have to be $1.4 \%$ better or about one and a half seconds faster than a runner hugging the inside all the way, in order to be on level terms with him at the finish.

It follows from the above that if the pace is slow it is better to travel wide rather than be trapped on the inside of the pack, but that if the pace is fast an athlete should not travel wide for very far and should only do so in order to be poised to take a favourable position on the inside.

As remarked above, it is unwise for an athlete to go into a race with an inflexible race plan. In particular he should not have a plan that is based on being in certain positions at various stages of the race. Unless everyone is very obliging, that plan could be difficult to adhere to, and could turn out to be an inappropriate strategy. It could force him into pace pattern that cannot produce his fastest performance. It is necessary to have something of a plan; otherwise all the athlete does is react to what others are doing. But the plan should be pace-based rather than position-based. The athlete cannot ignore position altogether of course, because position could stop him running the pace pattern he wants. So the plan must be flexible, as must the athlete. The 800 m is a fast moving race, with small margin for error, little time for indecision and considerable potential for lost opportunities. The athlete must be definite as to his intentions at the start, able to think quickly and act decisively as the race progresses, and must have the self-belief to carry it through to the finish.

## The 1500m Race

Some of the above advice for 800 m racing also applies to the 1500 m race, but there are sufficient differences in the way the two events are run to give rise to different strategies. The main difference in the two events is that whereas the pace distribution in the 800 m is fairly predictable, in the 1500 m it is anything but. Championship races and top non-championship 800 m races tend to be won in a fairly narrow time band only a couple of seconds wide. There have been exceptions but they are rather rare. The overriding tactic seems to be to beat the opposition by running fast all the way. That is sometimes the way in the 1500 m , but more often in championships the real race is over the last lap or two. In non-championship events, in which the promoters are interested in fast times, the pace of course is on for the full distance, and strategies are more like those in the 800 m event.

Let us consider the non-championship 1500 m event first. The sensible aim in this for all except the pace makers is the fastest time possible. Then finishing positions will be determined on runners' ability to run to their potential. The potential we are talking of here is not racing potential but fastest time potential

We saw in Chapter Four that the ideal pace distribution for achieving an optimum time performance in a 1500 m run is even pace for most of the race, with perhaps a faster start for about 100 m to achieve a good position and a faster finish of about the same distance to optimise finishing position. These short stretches of faster speed are acceleration bursts and utilise the CP system. The constant speed in the rest of the race calls for the aerobic system to increasingly hold up a flagging lactic system. It is this flagging lactic system that makes it difficult to hold the right pace. Good pace judgement is required, as is concentration to ensure that it is maintained. It is very easy to allow the pace to slip away, particularly when the mind is allowed to dwell on other matters, such
as an unhelpful action of a competitor, perceived tiredness, and fear of not being able to hold the pace to the finish. As well as concentration, self-belief is required, and this is borne of thorough preparation. As long as the training has been done, belief that the pace can be maintained, determination to maintain it, and concentration to ensure that it happens, will produce the desired results.

In the early stages of a non-championship race it is easy for a less capable athlete to get carried away and go with the pace of the leaders. Similarly it is easy for a gifted athlete to go with the early pace of an over-enthusiastic pacemaker. Such running will lead to a sub-optimum performance, because well before the finish the aerobic system will not be able to hold up the saturated lactic system, the legs will cease to function properly, and the speed will drop dramatically.

If the early pace is much below the average speed required, the athlete will certainly be able to run faster in the second half, provided he has not lost direction through having lost contact with the race he should have run. However he will not be able to run fast enough in the second half to make up for the lost time in the first half. That would be too easy and there are only honest ways to good performances.

We come now to what is the most interesting- the real race, in which there is head to head contest and times do not matter but placings do. Here there is no protection of a pacemaker to guard against injudicious choice of pace. It is all with the contestants to decide what the pace will be at any stage and how the race will be run. So it is a contest not just of physical ability, but of pace judgement, quick thinking, ability to size up a situation, and decisiveness. This is true also of the 800 m race, but the essential difference is in the duration of the race. This adds another dimension to the 1500 m . In the 800 m if the runner chooses the right pace for the first 200 m he can then just slide away from it gradually over the rest of the race. To some extent his run is programmed in the first 200 m . This is not so for the 1500 m runner. After the first 100 m or so of running for position he then needs to hold his ideal speed for $1200-1400 \mathrm{~m}$ in order to optimise his effort. That is very difficult to do without the aid of a pacemaker and few attempt it in championship races. Even Filbert Bayi, who led all the way in his world record run in the 1974 Commonwealth Games, eased up in the middle two laps. So champion 1500m racers usually adopt strategies that are sub-optimal with respect to times but optimise use of their racing skills. This is why there is such a wide range of winning times in championship 1500 m races.

One tactic that can be employed is that of Bayi in the 1974 Commonwealth Games. He set out at faster than the average pace he wanted for the first 400 m , and no one went with him. Had he continued with that pace $(54.4 \mathrm{~s} / 400 \mathrm{~m})$, he would have been struggling early in the third lap and a sitting duck for those coming after him. So he eased back to about $58 \mathrm{~s} / 400 \mathrm{~m}$ pace for a couple of laps while he waited for the onslaught. They certainly chased him in the last lap but he had a 55.4 second effort to respond with. The essence of this tactic is to take command early, to let everyone know, or think, that the issue is decided there and then, and then to ease of and conserve energy for when they wake up to the fact that they are not necessarily out of the race.

A more common tactic is to run conservatively for the first part of the race, expending as little energy as possible. How conservatively depends on what other competitors will allow. After the first part, which is really only an introduction, comes the last part, which is the real race, and maximum energy is expended on it. The distance
of the last part is a matter of judgement. When does the runner take off in his run to the finish? This depends on what he perceives to be his strengths relative to the rest of the field. If he knows that he does not have brilliant speed he will not leave his effort to the last lap, because the slow pace up to then will leave his opponents plenty of energy to exploit their superior speed. He will move before then to take the sting out of their finish. On the other hand if a runner knows that his 400 m speed is better than that of anyone else in the race provided he is still fresh, he will want the pace to be as slow as possible until as late as possible, preferably until into the final lap. He will be pleased if no one wants to push the pace until then, and could even go to the front early with the intention of slowing the pace down to his liking. Of course he should not be allowed to get away with it, but sometimes bluff is a powerful weapon. So a runner will commence his run to the finish at a distance from the finish he believes to give his best advantage compared to his opponents. It is a mater of judgement and very likely a judgement that will have to be made on the run. He should not be shy of it. Success is more likely to go to the runner who is decisive rather than the one who only reacts.

The runner who shows to himself and the field that he knows what he is doing and will dictate terms has a good chance of success. The race is more likely to be run his way than that of anyone else, and if he is a good judge, his way will be best for him and not for others. One of the best illustrations of this was Henry Rono's victory in the final of the 1500 m at the 1988 Olympic Games. The first 800 m was a dawdle. It was covered in just over 2 minutes, with no one interested in forcing the pace. However the first significant move took place as the field came down the home straight from 600 m to 700 m . With the slow pace and without having to cover any extra distance, Rono had no trouble going from near the rear of the field to the front. The next 100 m was very interesting. Rono slowed the pace even further to 15.6 seconds per 100 m . Surprisingly he was allowed to get away with it; he was not doing this for any benefit other than his own. The slow-down was obviously to lull the rest of the field into a false sense of security- nothing was going to happen yet. But it did. From the 800 m mark Rono progressively picked up the pace and thereby stayed in front. The sectional times for the next six 100 m sections were: $14.4,14.0,14.1,13.9,13.1$, and 12.8 . Rono knew he had a couple of very fast men behind him- Cram and Elliott. But he was making it progressively more expensive for them to pass him, and after a few hundred metres to do so would have cost them dearly. So they waited and hoped. And while they were waiting they had to run faster and faster. Not only was it becoming more difficult to pass him, it was even becoming costly to hang on. He was acting and they were reacting. He slowed to 13.4 seconds for the last 100 m , but by that time he had run any finish out of them. His was still the fastest last 100 m . It was a masterly display of taking command and keeping it.

There is another aspect to Rono's performance. Obviously no one else wanted to go 700 m out from the finish, so Rono did. This is a good tactic. For a start it catches them unaware, and immediately puts them in a position of having to decide whether to stick to their plans or respond. It has the potential to create confusion and uncertainty, which will not help their racing. Secondly it probably is something they do not want, and what they do not want is probably to their disadvantage, so to the advantage of the person making the move. If he goes when they want to go he is meeting them on their terms, or worse. So he goes when they do not want to go.

Herb Elliott's Olympic win in 1960 was somewhat similar. He also set sail for home at the 800 m mark and was in front from then on. It was a little different though, and it illustrates another idea in 1500 m racing. Whereas Rono was just over two minutes at the 800 m point, Elliott went through in $1: 58.0$. To put that in context, that was the average pace that won the Olympic 1500m just four years earlier. And Elliott was not finding it easy, so we can assume the rest of the field considered the pace fast enough. They were then in the third lap, in which the natural tendency is to ease up a little, in order to conserve energy for a race home in the final lap. Elliott wanted to do this too. However he was probably mindful of the dictum of his coach, Percy Cerutty- take the lead at a decisive part of the race and make every other competitor do his utmost to keep up. Conquering in his mind his perceived tiredness, he poured on the pressure and put in a lap of 56 seconds. Once he applied this pressure the rest of the field was running for second place. He drove hard into the final lap, in case any of the others were about to challenge him. His 100 m sections up the back straight and around the final bend were 13.6 seconds. By the home straight he was spent and could only manage 14.4 seconds, but it no longer mattered. No one was chasing him. He won by pouring on the pressure when the others were least able or least willing to resist it, and then maintaining that pressure so they had no chance to recover some initiative.

The above few paragraphs apply to athletes who are contenders for victory. Obviously there will be a number in any race who have no realistic chance of winning if the top runners run sensibly. What should be their strategy? In the first place they should be aware that top runners do not always run sensibly, and should be ready to seize the opportunity. The opportunity could come from the favourite chasing a time he is not capable of on the day, and tiring badly well before the finish. More likely it will come from the favourite overestimating his finishing ability and leaving himself too much to do at the end. The less gifted runner can capitalise on both of these errors by running to his potential himself, and being watchful of the way the race is unfolding. It is harder for him because the only way is to run to his potential, and this requires concentration and effort all the way. He has less margin for error in pace judgement than his more gifted opponents. Nevertheless the rewards of unexpected victory or even a good finishing position make it well worthwhile. In short, the best though the most difficult strategy for less favoured runners is to set out to run their best time, and they do this by running a fairly even pace that will give them that time. Then they will not be beaten in a time that they could have run, and they will be in a position to take advantage of any mistake of supposedly better runners.

## CHAPTER TEN

## Middle Distance and the Young Athlete



The preceding chapters endeavoured to show what elite middle distance running is about. They identified the distinguishing characteristics of middle distance running, what energy systems are used, how these are trained, how this training is arranged into training programs, and how to race. All of this is particularly directed at runners who have chosen middle distance as their speciality. But what of those young people who show some aptitude for middle distance running? What of those young people who have not yet done enough to show any particular aptitude, but are interested in middle distance? What of those who seem more interested in other events or even other sports, but who look like they could be good middle distance runners? A training program for mature athletes is not likely to be suitable or even acceptable for these young people, but we do not want to lose them. They need nurturing and guidance, so they can advance to being elite seniors. This chapter is devoted to guidance for juniors, and in particular as will be expressed later in the chapter, guidance via a coach.

There are many possible answers, but the only one that means anything to anyone in the long run, especially to the athletes themselves, is "one who becomes an elite senior middle distance runner". We see many promising, even apparently brilliant juniors, but very few of them are still prominent as seniors. It is most unlikely that this state of affairs is what they want. Faced with the choice of being a champion junior or a champion senior, most would choose to be a champion senior. We are letting them down if we do not attempt to help them to be what they want, if at all possible.

Given that being an elite senior middle distance runner is what matters most to juniors, there are some implications. Many of these the junior will not be aware of, and will need guidance and reassurance. In the first place they might need convincing that it is a good senior they want to be. Below are some of the implications flowing out of the desire to be prominent in senior years.

An athlete does not have to be an elite junior in order to become an elite senior. There are many factors at work in the maturation of middle distance runners. Some mature earlier than others for a variety of reasons. The length of time they have been running is one factor. Their physical maturity is another. So too is their emotional maturity- confidence is all important in producing results, even if in early years it borders on cockiness. But all of these things come to pass for everyone eventually. When they do the advantages like early maturity are gone and we do not have young adults showing out against adolescents. With girls the effect of maturity can be the opposite. In their pre-pubescent years they can have a high power to weight ratio, and their performances can be quite astounding. Maturity brings its problems, and there is some adjustment to be gone through, after which all are competing on an equal footing with respect to the development of the female body. The important thing is that in adulthood all the advantages and disadvantages associated with different rates of growing up are gone, and it is then that the real competition takes place.

Following from the above is the observation that there is plenty of time. Middle distance runners are at their best in the mid to late twenties. So an athlete at the age of 16 has about 10 years in which to reach his peak and achieve his utmost goals. He does not have to do it tomorrow or even this season. If he can take the long view he can escape many of the mistakes that prematurely end a runner's career or stop him reaching his potential. He can afford the time to play safe and miss a competition, because there will be many more opportunities. He can rest for a week, a month, a year, whatever it takes, to be completely rid of an injury. There is no hurry; there will be plenty of time and opportunities for good performances, and anyway junior victories do not matter in the big scheme of things. They are nice to have, but it does not matter if they do not happen.

What does matter is progress. As long as on the whole there is year-to-year improvement, all is well. In the occasional year there might not be any because of injury or illness, but it is the general trend that matters. If a 16 year old needs to improve 10 seconds to be as good as he wants to be when he is 26 , then an improvement rate of 1 second per year is required. This time 10 seconds faster than his best is his vision, the goal he really wants. The improvement of 1 second a year is the general direction he is heading in, but we know there will be deviations along the way. In the first five years the climb is likely to be steeper, because some improvement is will come just from the maturation process. Improvement of 1.5 seconds a year could be aimed for, and this
could come from zero improvement in a particular year, made up for by a 3 second improvement in another. Then in the second five years, when only training will bring about improvement, a gain of half a second a year might be the aim. Again there might be no improvement in one year, with this being compensated by a 1 second improvement in another year.

In short, a good junior middle distance runner is one who prepares well to be a successful senior. The following sections give some ideas on this preparation.

## When To Specialise

There is plenty of evidence that late starts to a middle distance career are not necessarily a disadvantage, and that early starts do not necessarily lead to success. Nevertheless it seems to be the case these days that people do not take up athletics in their late teens or early 20s. If they have not become involved to some degree by their mid teens they tend to by-pass the sport. There are too many other activities to attract them, and many of them are much easier. They need to experience the excitement of athletics and perhaps taste some even minor success in their mid teens in order to be attracted to the sport. Then there is some chance that they will be there when it begins to matter- in their late teens.

In the early to mid teens it is better if the young person is involved across the spectrum of track and field events. In fact it is even good if they are involved in a variety of sports or physical activities. A person might in fact be more suited to another sport and could finish up enjoying it more if given the chance. It would be a pity to have that person in athletics, because his enjoyment and his potential would be diminished. So ideally the exposure to sports and physical activities at an early age should be wide, so that the best choice can be made. But even if the person does eventually choose athletics, the experience in other sports will be beneficial. Football will give an athlete a physical toughness he would not obtain in early age running, and he will be better able to hold his position in a rough race. Ballet will impart flexibility and control that could not be gained from athletics. Swimming will provide marvellous aerobic conditioning. Within athletics early teenage people should advance on a broad front, so that a good choice can be made of the best event(s) to concentrate on. As long as they enjoy it, running should range from sprints to distance, and they should also jump and throw. There is plenty of time- time to have fun, to try different events and even different sports, and eventually to make a choice about what suits best.

The only problem with the above approach is that other sports might not have the same liberal attitude. Unfortunately some sports, or some coaches in some sports, are quite possessive and obsessive in their attitude to young sports people, and they make unreasonable demands on their time and commitment. They want the young people to concentrate on their sport exclusively, and they apply such pressure as to squeeze out other sports. If athletics takes a more liberal approach this only makes it easier for athletics to be excluded. What approach should be adopted in this situation? Perhaps the first approach by a parent or athletics coach should be to the coach of the other sport, to see whether some reasonable compromise can be worked out that will allow both sports to continue. The argument would be that this would be in the best long-term interest of
the young person, and perhaps the two sports could complement each other. If this approach fails and the young person is still interested in athletics, he should be advised to continue the other sport if he wants to, and to keep in touch the best he can with athletics, even if it is not much. Persuading him to give up the other sport because it was being unreasonable could be depriving him of the opportunity to excel in something to which he is well suited. If he is more suited to athletics and he keeps in touch, it is likely that eventually he will decide to make a complete break in favour of athletics. It is important in the interim for athletics to keep in touch with him. A reasonable approach and a genuine interest are likely to be successful, as long as the other sport is not the better option for the young person.

The mid teens is time to limit the range of sports under active participation. It is time to start doing a bit of serious training for athletics, and it will not be possible to engage seriously in more than one other sport at a time without bringing on tiredness and loss of form. This age is also probably early enough to begin narrowing the range of athletic activity. A person who is heading towards being a middle distance runner will converge to running events, perhaps including hurdles, leaving the throws and jumps behind. It is worthwhile continuing with both the sprints and distance, though distance running could be a winter activity and could consist of cross-country running or aerobic type training in some other sport. Both the short and the long end are going to be part of the basis of middle distance training, so they are both worth developing. Also it is too early at this stage to say what event the athlete will best suited to, so it is well to keep the options open.

From the mid to the late teens, perhaps earlier for girls, youths will turn into women and men. Most physical growth will have taken place. Informed preferences will have developed. It should be in this period that a decision is made to specialise in middle distance running. Also in this period the remaining sport still under active engagement, if there is one, will drop out. The athlete will leave school and the justifiable commitment to another sport in the school environment will come to an end. This will free up time to give middle distance training and competition the commitment they will need from now on.

It is not necessary at this stage to decide between 800 m and 1500 m , unless the choice is obvious. Both are beneficial to the other, so it is worth continuing both in parallel as long as possible. An early decision could be the wrong one. A young person for instance could choose 800 m on the basis of some less than satisfying 1500 m performances, but these performances might be due to insufficient aerobic development. Similarly he could decide on 1500 m , when the lesser 800 m performances have been due to insufficient speed development. Time is needed to sort these things out, and there is time. During that time one event will continue to benefit the other. What could make the choice obvious fairly early is an aptitude for an event either side of middle distance. An athlete who is at home and performs well at 400 m will probably choose 800 m as his middle distance event, and if 3000 m or even 5000 m is as comfortable to him as middle distance he will probably choose 1500 m .

Whenever the athlete does make a choice in favour of 800 m or 1500 m , he must not neglect races in events either side as his career develops. If he does, there are going to be races at his favourite distance that will find him lacking in either speed or
endurance. An 800 m runner who is uncomfortable at 400 m could lose contact in the first lap and be out of the race. If he is uncomfortable at 1500 m and dodges the event, there will at times when an 800 m race takes on some characteristics of the longer event and he will be found wanting. It is the same with 1500 m . Whatever his event, he is a less than complete runner unless he becomes comfortable at events either side of his chosen event.

## Get the Movement Right

As we have said and repeated, there is plenty of time. There is time to do things properly, and this is more important than winning races at a young age. In particular, there is time to develop a good style. What is a good style? There are two aspects. It must be sufficiently powerful and it must be economic. The first is not usually a problem. It comes with maturity and muscle development, which can sometimes be aided by weights work. However this is not sufficient. It is not uncommon for a young athlete to perform above his peers initially but then slip below them as the years go on. Often this is due to early physical maturity or superb fitness disguising a wasteful running action. Success lasts for a while, but eventually the higher standard required cannot be delivered with an action that sprays energy all over the place. The athlete is going to need every bit of energy propelling him in the forward direction and cannot afford any waste.

There is no such thing as a single perfect style. Each individual is different and none is perfect. So what constitutes a style that is powerful and at the same time economic will vary slightly from runner to runner. However a close observation of the top middle distance runners in the world in any era will reveal styles that have much in common. They are smooth, free flowing, without any extraneous body movements and, except in advanced stages of exhaustion, apparently effortless. This is the movement the aspiring middle distance runner has to try to emulate.

It is all very well to state the above, but runners cannot see themselves. They need someone to tell them what they are doing. A coach would do that, and there will be a section on the desirability of having a coach later in this chapter. But even someone telling them is insufficient, because their perception of what they are doing will probably be different from what the observer is seeing. For example it is not uncommon for young runners with insufficient strength to run with a stoop. When they can be persuaded to hold their trunk in a more upright position they are sure they are really leaning backwards. Ideally they need to see themselves in order to have a proper perception of how they are running. A video camera will enable this. Not everyone can afford a video camera, but if neither the runner nor the coach has one it should be possible to borrow. It is well worth the effort.

It is worthwhile spending time when results are not so important getting a smooth economical style. It usually involves running well below maximum speed over and over, and this is not the sort of training conducive to high quality middle distance performances. It is not the sort of training a mature runner wants to be doing in preparation for major championships. It is much better to be doing it when the results are not so important, which is when the athlete is young. The development of a good style is
one factor, a very important one, in the overall development of the young middle distance runner.

A good running style is a good habit. It is something the person does not have to think about because it is ingrained. Like all good habits, it has come about from having been learnt and practised until it is second nature. On the other hand a bad habit has also been learnt and practised, and the longer it has been practised the more of a habit it will be. The more ingrained the bad habit the longer it will take to eradicate it. Logically then, the sooner good habits are developed the better. It is the one aspect of training that is best done in the early years, and in these years it is the best thing that can be done.

## Training

The framework of this has already been covered, and all that is necessary here is a little advice for the aspiring middle distance runner. The energy systems are the same for the junior as the senior, so the basic framework is the same. This section concerns being sensible.

An earlier section of this chapter spoke of the desirability of having a wide range of running events at the mid teens stage and gradually narrowing it as the runner approaches maturity. The training should reflect this, though more events must not mean more training. The formal training need not be very much, but general physical activities including training should provide some preparation for the range of distances contested. Speed is going to be an important part of the armoury of the middle distance runner, and indeed the amount of speed a runner has is going to put a ceiling on how fast his middle distance running will be. So it is worth developing from an early age. This will be done in formal training. An integral part of this is good movement, which was covered in the previous section.

The long end is equally important and deserves special mention. However this does not mean that there has to be large slabs of distance running in formal training. Rather it should be part of the lifestyle of a young person. It is significant that in Africa today, as in the Western world a generation ago, running and walking is the normal mode for young people of moving from one place to another. Without being aware of training, without stress, and with fun, they are developing their aerobic system. This is difficult in the Western world today where children tend to be driven everywhere in a motor vehicle. However there are ways around it. One is participation in sports requiring plenty of running, particularly continuous running. The various codes of football are examples. It should not be difficult for an aspiring runner to do more running during football training than is required for football. This can continue until football is squeezed out, probably towards the end of schooling. As well, a young person who hopes to be a middle distance runner will seize every opportunity to run anywhere rather than be transported. Young people have the time and the opportunity that they will not have when they are older, so they should seize them. This running should be viewed simply as an enjoyable means of travel. Distances and times do not matter, as long as there is plenty of continuous running in a week. In a sense, the worst impact on a young person's general fitness activities can be obtaining a driving licence. Whereas before obtaining the licence they used to walk or run from home, now they drive wherever they can, even short
distances. Not only does this deprive them of the opportunity to obtain general fitness, it also develops the habit of physical laziness. This is not to say that an aspiring middle distance runner should not obtain a driving licence. It does mean that having the licence should not cause a change in the physical side of lifestyle.

Particularly for a young person, too little training is better than too much. If spectacular improvement is forthcoming, it is highly likely that the amount of training, even though little, is right. There is a great temptation for both athletes and coaches to increase the amount of training in this situation, in the belief that if a little training produces that level of performance, more training will produce an even higher level. Very often this is not so, because the original amount of training was optimum, and more training leads to worse performances. The improvement probably has been coming from the natural process of growing up rather than from training, and the additional training leads to tiredness, which impedes performances. It is very easy to increase the training load slightly from a low level if that is considered beneficial. The low training load will have done no harm and the effect of the increase can be gauged to see whether the new training load should be maintained. However the situation is different if the training load has been too much. Then there is likelihood that it has done harm. Reducing the load is essential, but this will not immediately cure the problem. It might be some time before the young body and mind recover and improvement comes. So too little is definitely better than too much.

Some of the training has to be formal and on a track, particularly as the runner develops. The pace of the efforts in a session begins to matter. It is often necessary for the runners to time themselves, because the coach cannot time everyone in a group. It is important for the young athlete to be completely honest in his timing, otherwise progression could be just wishful thinking. The timing procedure should be the same from session to session. If the athlete has a five step rolling start for a particular distance run he should always have a five step rolling start for that run. The watch always starts on the start line and stops on the finish line.

It is unfortunate to have to give the next piece of advice, but it has to be said. A young athlete should never believe the times that another athlete tells him he has done in training. They will usually be wrong or misleading. For instance a set of 300 m runs with a flying start, the fastest of which is 43.9 seconds, is quite likely to be related as a set of 300 s in 43 seconds, with no mention of the flying start. It is not that the athlete is necessarily dishonest, though some are. It is more likely that he is enthusiastic and supremely optimistic, and that is what he believed he could do. All the allowances he makes are positive; none are negative. There are two possible detrimental effects of believing an exaggerated report of a training session. The first is that an honest athlete will be discouraged, because he cannot emulate that session when he thinks he ought to be able to perform as well as the other runner. The second is that the athlete could subconsciously get seduced into the same optimistic timing. If he does, the times become meaningless and useless as a report on training performance.

## Racing

Even though results of racing are not absolutely important for young runners, racing itself is important. There is a difference between being able to run fast and being able to race, particularly in middle distance. While some young people are naturally competitive, and this is highly desirable in racing, it must be tempered with good sense. That sense is best gained from experience, as long as the athlete is willing to learn.

It is important for the athlete to run in races he can win, and races he is unlikely to win. The only proviso is that, whatever the chances of success, he should be reasonably competitive for most of the distance with part of the field. It does no good for a young runner to be alone way out in front or way off the back of the pack. Such solo performances can be achieved in training or a time trial in an atmosphere that is neither demoralising nor ego-inducing. Paradoxically there is sometimes some comfort for young runners in races in which they cannot be expected to be well placed, because there is a built-in excuse for them. There is somewhere for them to hide from the moment of truth that a real challenge will provide. So they should seize the opportunity of a race they should win, or be well placed in. It does not matter if they do not succeed; the important thing is that they have faced the challenge and tried. They should not be frightened of failure; that is just a stepping-stone to success. Similarly they should not avoid races where they are likely to finish well back. These provide measuring sticks that drive home to athletes that they still have a long way to go if they want to be competitive in the big wide world. They also provide opportunity for improvement, because there are plenty of other runners to key off without worrying about conserving energy to avoid defeat.

The only bad races a young runner (or any runner for that matter) will have are those from which he does not learn. There is plenty of time for learning when a person is young, and he should not be afraid of learning, even if it exposes him to the danger of being beaten. Every race is a learning experience, whatever the outcome. If the result is up to expectations or better, there will be reasons for that, and those reasons will be part of a bank of knowledge for future racing. On the other hand if the result is worse than expected it will be for particular reasons, and this is vital knowledge for the future. Also a race is the real test. An athlete can think he is in good form, even with good reason, but it only matters if he can prove it in a race. He can learn from a race what form he is truly in. Chapter 8 spoke of the necessity of having good recording, and the early days of serious training is not too early to develop the habit of writing down everything relevant relating to training and racing performances. Everything learnt in races should be recorded, otherwise it is likely to be forgotten and the learning will be wasted.

The only bad race is one the athlete does not learn from, and the only one he does not learn from is a race in which his effort is not genuine. Any sort of a mistake provides a lesson and any success teaches or reinforces some piece of wisdom, but a less than honest effort teaches nothing except that it is a waste of time. After such an effort the young athlete will not know what might have happened if he had dug deeper here or made a break there. He will be no further advanced in his knowledge of what works and what does not, or what his limits are.

A young runner should experiment with different tactics in races. Not only will he learn the circumstances in which particular tactics work or do not work, but he will also be preparing himself for the occasions when any of these tactics are necessary. The
time to be experimenting is when he is young and the results are not as important. It is a luxury he will not have later on.

It is important for the young runner to run against juniors sometimes and seniors sometimes. It is easy for him to hide from the truth by only running against seniors, whom he cannot be expected to beat, and avoiding juniors who are real competition. So he needs to put his credentials on the line by racing juniors sometimes. However to race only juniors until no longer a junior is inadequate preparation for the real world of senior middle distance racing. The step up to senior races could be too big and disillusioning. Frequent senior races while still a junior, and the result is less important, will provide a gradual introduction to senior races. They also provide a measuring stick by which to gauge readiness for serious senior racing.

Earlier in this chapter there was advice that a middle distance runner should be or make himself comfortable at the two distances either side of the favoured event. In preparation for this, and to advance on an initially wide and then narrowing front, the young athlete should take the opportunity to race over a range of distances. As it becomes apparent that he dos not really have the aptitude for them, the distances at the two extremes will be dropped off. However the longer a broad range of race distances can be continued the more thoroughly prepared the athlete will be at maturity.

The aspiring middle distance runner would be wise to race in all situations, whether the situation is considered to suit or not. That means in all weather conditions, against all opponents, in all moods, in any place, as long as in good health. The aim is to get on top of situations, to conquer them, and not to have to avoid some situations in later years.

The young athlete does not have to learn only from experience. The wise ones will critically watch other races, particularly involving elite runners. They will learn from the mistakes as well as from the sound tactics of the athletes they hope to emulate or even surpass.

## Have a Coach

There have been a few mentions in the book about a coach, without the assumption that every athlete will have a coach. However it is very important for a young athlete to have a coach. Later when he is more experienced he might find that he no longer needs one, but when he is a junior he definitely does. There are two main reasons why this is so.

The first is that an athlete cannot see himself run. This of course applies to any age but it matters much more to a runner who is learning. The need for a good style was discussed above, and acquiring one is part of the learning process. The young athlete has no appreciation of what his style is like and needs to be told. If the style is good, that knowledge will be reinforcement and encouragement. If there are faults, he will have to know what those faults are so that he can work on correcting them. So he will need a knowledgeable and experienced person with good communication skills to tell him what he is doing. It should be the same person from session to session so that progress or otherwise can be detected and passed on to the athlete. That person is the coach.

The second is that no matter how intelligent a young person might be, he knows little about middle distance running and what is required for success. He will learn of course, but will learn better with some sound guidance. Initially there is no chance that he will know as much as a coach. Even if the coach is inexperienced his seniority will probably make him more observant, more practical and more reasoning.

Athletes sometimes outgrow their coach, particularly if the coach specialises in starting young runners off. Sometimes the outgrowing occurs because the coach genuinely is not good enough to carry the athlete forward, due to lack of knowledge, unwillingness to learn, poor communication skills, or a clash of personalities. However the athlete would be most unwise to hop from one coach to another, in the hope always that the new one will have the secret formula, the lack of which has been stopping him from being the champion he believes he should be. The possibility that the present coach is unsuitable should always be allowed, but this situation is probably the exception and should not be regarded as the first option unless the relationship is beyond repair. Coaches make mistakes, they are inexperienced at the beginning, and they can have blind spots. However provided the relationship between athlete and coach is good, the best first option is for the coach and athlete to learn together. The prime requirement to enable this to happen is openness between athlete and coach and a genuine concern for each other. It is true that a coach can make a good athlete, but it is also true that an athlete can make a good coach, by enabling him to learn.

The young athlete should not be afraid to make suggestions to the coach. The coach does no know everything and in particular does not know how the athlete is feeling. It would be unusual if on occasions the athlete does not know better than the coach what should be done. The athlete should put his opinion forward and both should discuss it. A good coach will not feel threatened and will welcome the athlete's input. Two heads are better than one.

Having a coach does not absolve an athlete of all responsibility for managing his running. He should not need to be told everything. Rather as he matures he should assume more and more responsibility for the routine functions of training and racing. As well as making a better athlete, this will free the coach for more strategic thinking about the athlete's development.

## Lifestyle

It is natural for a young athlete to be enthusiastic about his running, particularly if he is running well and improving, and there is the temptation to become obsessive about it, even to the extent of neglecting consideration of other matters. That temptation must be avoided. As has already been said, athletics is not everything and there are more important things in life, including people and study. To neglect either would be a mistake that the young athlete will regret in the future. Both matter more than athletics, and their impact will be around much longer than athletics. All of us need people, and all of us need the career that study will lead to. We need both more than transitory sporting success.

Athletics is a precarious activity. It can be brought to a halt tomorrow without warning and without any chance of prevention. The young person who has put all his eggs in the athletic basket is likely to find them all broken, and will have nothing to provide him with satisfaction. It would be so much better if he still had people and learning pursuits in his life. These are worthwhile, and will sustain him in his time of disappointment.

Some young people have dreams of being a full time professional athlete. There are some professional athletes of course, but very few. Not many earn enough to feed themselves, and particularly to feed themselves into the future, which they would have to do if they do not have any other marketable skills. Given the number and potency of the misfortunes that can stop or retard an athletic career, even besides inadequate ability, it is foolish to focus entirely on professional sport for long-term nourishment.

Some people are by nature loners, and do not need a social life. However most people do. If the aspiring young middle distance runner is one of these, he should not neglect his social life for athletics. It is a false set of priorities and values to drastically reduce social life in favour of athletics, and it probably also is unnecessary and ineffective. Athletics should be part of the life of the young person, not the whole life, because the person is more than just an athlete.

It is very important for the young athlete to enjoy participation in athletics. Enjoyment is a prerequisite to a long involvement in athletics. Why do something you do not enjoy if you do not have to? Those responsible for his participation must make sure that he does enjoy it. Some success will help, so he should be guided into some races in which he can perform well. Improvement is very important, because it gives hope for the future. His advisors must make sure there is some improvement. This should come fairly naturally to young people as they grow towards maturity, and if it does not there is something wrong with the training. The young athlete needs protection from disillusionment that comes from working hard and going backwards. Since he will be spending considerable time participating in athletics, and this is time he could be spending with friends, it is desirable that he is in a good club atmosphere where he can have friends and athletics.

A young athlete's ego should be kept in check. His performances are sufficient indication of how good he is, and they will speak for him. His words will not make his performances any better, and in the medium or long term they will not make people value them any more. Furthermore he is going to need friends, support and encouragement when things go bad, as they inevitably will, and these are more likely to be forthcoming if he has been modest when on the way up.

The important thing for the young athlete is to reach his potential, not to be the best in the world. If getting the most out of himself is his aim, then he can be satisfied at the end of his career with what he has achieved, and he can be happy. All the way along he should enjoy athletics, and be satisfied that he is doing his best. Then if greatness can come, it will.

## APPENDIX 1

## Graphs Showing Comparison of Actual and Modelled World Record Speeds

Below is a plot of actual world record speeds and also of world record speeds calculated from the model, both on the same graph. It shows that the model is a close fit to the actual records.


Figure 1 Actual and Modelled World Record Speeds
Below is a plot of the same information as in the above figure, but with the distance axis on a $\log$ scale. This is in order to expand the short end and give it more emphasis. The long end is shortened, but still gives sufficient emphasis to the events.

Figure 2 Actual and Modelled WR Speeds with Distance on Log Scale


## APPENDIX 2

## Mathematical Model of the Lactic System

## Model of Lactic Speed Collapse

There is a maximum speed available from the lactic system and obviously the actual speed of the runner, once the CP system has finished, is equal to or less than this. Either the speed is equal to the maximum available immediately, in which case the analysis below applies immediately, or it is less than the maximum available speed but above the maximum aerobic speed. If the latter, lactic acid accumulates, reducing the speed potential of the lactic system until the maximum available speed falls to actual speed.

The mathematics below models the operation of the lactic system from the instant maximum available speed equals actual speed.

Let:
$\mathbf{t}=$ time measured from max available speed reaching actual speed
$\mathbf{v}_{\mathbf{m}}=$ max available speed
$\mathbf{v}_{\mathbf{0}}=$ speed when max available speed reaches actual speed
$\mathbf{v}_{\mathbf{a}}=$ maximum aerobic speed
Then:
Lactic acid produced per second $=\mathrm{k}\left(\mathbf{v}_{\mathbf{m}}-\mathbf{v}_{\mathbf{a}}\right)$, where k is a constant.
Therefore total accumulation of acid $=\int k\left(\mathbf{v}_{\mathbf{m}}-\mathbf{v}_{\mathbf{a}}\right) \mathrm{dt}$.
Therefore loss of speed potential $=\mathrm{h} \int \mathrm{k}\left(\mathbf{v}_{\mathbf{m}}-\mathbf{v}_{\mathbf{a}}\right) \mathrm{dt}$, where h is a constant

Therefore $\mathbf{v}_{\mathbf{m}}=\mathbf{v}_{\mathbf{0}}-\mathrm{hk} \int\left(\mathbf{v}_{\mathbf{m}}-\mathbf{v}_{\mathbf{a}}\right) \mathrm{dt}$.
Therefore $\int\left(\mathbf{v}_{\mathbf{m}}-\mathbf{v}_{\mathbf{a}}\right) \mathrm{dt}=-(1 / \mathrm{hk})\left(\mathbf{v}_{\mathbf{m}}-\mathbf{v}_{\mathbf{o}}\right)$.
The solution to the above integral equation is:

$$
\mathbf{v}_{\mathbf{m}}=\mathbf{v}_{\mathbf{a}}+\left(\mathbf{v}_{\mathbf{0}}-\mathbf{v}_{\mathbf{a}}\right) \mathrm{e}^{-\mathrm{hkt}}
$$

This equation says that in this period after the maximum available speed has fallen to actual speed, the speed begins at $\mathbf{v}_{\mathbf{0}}$ and falls away to $\mathbf{v}_{\mathbf{a}}$, the aerobic speed.

We look now at the deceleration in this period after maximum available speed reaches actual speed. Deceleration (negative acceleration) a is given by:

$$
a=d v_{m} / d t=-h k\left(v_{0}-v_{a}\right) e^{-h k t}
$$

$$
\text { At } \mathbf{t}=0, \mathbf{a}=-\mathbf{h k}\left(\mathbf{v}_{\mathbf{o}}-\mathbf{v}_{\mathbf{a}}\right)
$$

For a 1 min 42 sec runner, reasonable estimates of speeds and lactic constants are as follows:
max. possible lactic velocity $\mathbf{v}_{\mathbf{l}}=10 \mathrm{~m} / \mathrm{s}$
velocity at beginning of lactic phase (at 200 m ) $\mathbf{v}_{\mathbf{i}}=7.9 \mathrm{~m} / \mathrm{s}$
velocity at end of lactic phase (start of lactic collapse) $\mathbf{v}_{\mathbf{0}}=7.6 \mathrm{~m} / \mathrm{s}$ aerobic velocity $\mathbf{v}_{\mathbf{a}}=5 \mathrm{~m} / \mathrm{s}$ ( 10 km in 33:20, marathon pace 2 hr 21 min )
It can be shown that these velocities imply that the runner has lactic constants $\mathbf{h}$ and $\mathbf{k}$ such that

$$
\mathbf{h k}=0.00126 .
$$

Therefore the deceleration at the beginning of this lactic collapse phase, according to the equation above, is

$$
\mathbf{a}=-0.0293 \mathrm{~m} / \mathrm{s}^{2}
$$

Compare this with the deceleration during the long period of deceleration following the CP phase. The model $1: 42$ runner has run the last 600 m in 77.5 seconds, during which hid velocity has fallen from $7.9 \mathrm{~m} / \mathrm{s}$ to $7.6 \mathrm{~m} / \mathrm{s}$. ( 200 m sectors in $25.5,25.8$, 26.2) This deceleration is:

$$
\mathbf{a}=-0.0134 \mathrm{~m} / \mathrm{s}^{2}
$$

In other words, once maximum available speed falls to running speed the deceleration approximately doubles. It is for this reason that an intelligent athlete tries to avoid this situation before the finish. The situation is graphically represented in Figure 1 below. The gently sloping line on the left shows the velocity from 200 m to 800 m . The curve on the right shows the lactic collapse that would take place if the runner were to go further. It illustrates the importance of controlling the pace so that the point of lactic collapse is not reached before the finish.


Figure 1 Speed drop-off when lactic collapse occurs

## Strategy Prior to Point of Onset of Lactic Collapse

The above shows what happens to a runner's speed if he reaches the point of lactic speed collapse before the finish. Consequently he plans to reach that point right at the finish. If he runs so as to reach it beyond the finish, if he were to keep going, he does not optimise his performance because he has under-utilised his lactic system. So the question is "how should he distribute his effort during the operation of the lactic system, i.e. after the CP system has finished. Basically there are two strategies, though obviously variations of either or both are possible. The two strategies are a constant pace, which lasts until maximum available speed falls to the pace, hopefully at the finish line, and a gradual deceleration, which continues until the more rapidly falling maximum available speed reaches actual speed, again hopefully at the finish line. The latter is illustrated by the sloping line at the left in Figure 1 above.

Considering the steady pace case first, we let $\mathbf{v}_{\mathbf{s}}$ be the steady pace. The other terms are as already defined. We have

$$
\mathbf{v}_{\mathbf{m}}=\mathbf{v}_{\mathbf{l}}-\mathbf{h k}\left(\mathbf{v}_{\mathbf{s}}-\mathbf{v}_{\mathbf{a}}\right) \mathbf{t}
$$

We denote the time at which $\mathbf{v}_{\mathbf{m}}$ reaches $\mathbf{v}_{\mathbf{s}}$ as $\mathbf{t}=\mathbf{T}$. It follows from this that

$$
\mathbf{v}_{\mathrm{s}}=\left(\mathbf{v}_{\mathbf{l}}+\mathbf{h k T} \mathbf{v}_{\mathrm{a}}\right) /(\mathbf{1}+\mathbf{h k T}) .
$$

We now compare the above pace with the average pace in the gradual deceleration case. It is legitimate to do this as long as the deceleration is uniform. Firstly we have to establish a common basis for comparison. The time to maximum available speed falling to running speed in the steady pace case is $\mathbf{T}$, and we ask what the speed distribution in the deceleration case must be in order that the same conjunction of speeds is reached also in time $\mathbf{T}$.

For the gradual deceleration case, using the terms already defined, as well as letting $\mathbf{v}$ be the actual velocity, we have:

$$
v_{m}=v_{1}-h k \int_{0}^{t}\left(v-v_{a}\right) d t .
$$

The solution to this integral equation is:

$$
\mathbf{v}_{\mathbf{m}}=\mathbf{v}_{\mathbf{l}}-\mathbf{h k} v_{i} \mathbf{t}+1 / 2 h k v_{\mathbf{i}} \mathbf{t}^{2} / \mathbf{T}-1 / 2 h k v_{\mathbf{0}} \mathbf{t}^{2} / \mathbf{T}+\mathbf{h k} v_{\mathbf{a}} \mathbf{t} .
$$

At $\mathbf{t}=\mathbf{T}$ we have $\mathbf{v}_{\mathbf{m}}=\mathbf{v}_{\mathbf{o}}$, and this leads to:

$$
\mathbf{v}_{\mathbf{a v}}=1 / 2\left(\mathbf{v}_{\mathbf{i}}+\mathbf{v}_{\mathbf{o}}\right)=\left(\mathbf{v}_{\mathbf{l}}+\mathbf{v}_{\mathbf{i}}+h \mathbf{k} T\right) /(2+\mathbf{h k} T) .
$$

We compare the two speeds by taking the difference. This works down to:

$$
\mathbf{v}_{\mathrm{av}}-\mathbf{v}_{\mathrm{s}}=\left(\mathbf{v}_{\mathrm{i}}-\mathbf{v}_{\mathrm{s}}\right) /(2+\mathbf{h k T})
$$

As long as $\mathbf{v}_{\mathbf{i}}$ is greater than $\mathbf{v}_{\mathbf{s}}$, and it does not make any sense for it not to be, the difference is positive and therefore the gradual deceleration strategy is superior.

## APPENDIX 3

## Determining Mixed Aerobic- Lactic Repetitions

Aerobic pace is marathon pace, or a pace that can be sustained almost indefinitely. It could be sustained by a middle distance runner for the full marathon distance if he prepared for the effort, but in the context of middle distance training it is a pace that does not cause the runner to want to slow down in an effort of about an hour. It is obviously slower than $10,000 \mathrm{~m}$ pace, which has a lactic content and does carry the urge to slow down.

The 400 m pace is the best indication of lactic pace. The 100 m and 200 m are predominantly creatine phosphate events, and there is a not insignificant component of aerobic energy in the 800 m .

It turns out that the 3000 m pace is half way between the above two, and we use it as the bottom end of the mixed aerobic-lactic paces. Anything slower than that is predominantly aerobic, and better done in long runs away from the track. The pace of the faster repetitions extends up into the middle distance region.

Below is a package of repetitions, encompassing speeds ranging from 3000m pace to 1000 m pace. The distances of the sessions are about twice the distance indicated by the pace. This volume provides a reasonable training load, though some athletes could tolerate more.

| Repetitions | pace | multiple of pace dist |
| :---: | :--- | :---: |
| $6 \times 1000$ | 3000 m | 2 |
| $6 \times 600 \mathrm{~m}$ | 2000 m | 1.8 |
| $10 \times 300$ | 1500 m | 2 |
| $8 \times 300$ | 1000 m | 2.4 |

Figure 1 Mixed Aerobic-lactic Sessions
We now need to determine what the recovery interval should be between repetitions. We do this by firstly choosing a recovery interval for the $6 x 1000 \mathrm{~m}$ that can be supported by reasonable argument and then choosing recoveries for the others that give the same overall lactic effect.

A 3000 m effort at 3000 m pace would use up $100 \%$ of the available lactic energy. In broad terms a 1000 m effort at 3000 m pace would use up $30 \%$. On the assumption that a $100 \%$ dose of lactic acid could be dissipated in 30 minutes, $10 \%$ would be dissipated in 3 minutes. The build up of lactic acid throughout the set would be as follows:
$30 \%-10 \%+30 \%-10 \%+30 \%-10 \%+30 \%-10 \%+30 \%-10 \%+30 \%$
$=110 \%$ after 6 repetitions.
Therefore 6 repetitions with 3 minute recovery intervals seems reasonable. Furthermore it provides a rhythmic 1:1 effort to recovery ratio, which is appropriate for a pace that is midway between aerobic (requiring no rest) and lactic (requiring no repeat).

Next it is necessary to make an estimate of speeds of repetitions relative to some competitive speed, say 800 m speed. An estimate of these is given below:

| Repetitions | Relative Speed |
| :--- | :---: |
| 800 m | 1.0 |
| $8 \times 300$ | 0.94 |
| $10 \times 300$ | 0.88 |
| $6 \times 600$ | 0.82 |
| $6 \times 1000$ | 0.73 |
| aerobic | 0.64 |

It does not matter if these are not very accurate; they are being used to determine recovery intervals, which will be subject to rounding off anyway.

Now we calculate the difference between relative speeds and the aerobic speed in order to obtain a measure of lactic power used.

| Repetitions | Lactic Power Content <br> $6 \times 1000$ |
| :---: | :--- |
| $0.73-0.64=0.09$ |  |
| $6 \times 600$ | $0.82-0.64=0.18$ |
| $10 \times 300$ | $0.88-0.64=0.24$ |
| $8 \times 300$ | $0.94-0.64=0.30$ |

We obtain lactic energy of each repetition by multiplying the lactic power by the time required for the repetition. For a good squad of senior athletes the times aimed for might be as indicated in the calculations below. Again it is not important to be particularly accurate because all we are doing is determining a reasonable, logical recovery interval.

| Repetitions | Lactic Energy |
| :---: | :--- |
| $6 \times 1000$ | $0.09 \times 180=16.2$ |
| $6 \times 600$ | $0.18 \times 96=17.3$ |
| $10 \times 300$ | $0.24 \times 45=10.8$ |
| $8 \times 300$ | $0.30 \times 42=12.6$ |

The lactic acid associated with the above energy has to be dissipated, and we have already determined that it will be dissipated in the $6 \times 1000$ repetitions by 3 minute recoveries. The recovery for the other repetitions is determined by proportioning the 3 minutes in accordance with the relative lactic energy, and the relative number of recoveries. In other words we multiply 180 seconds by two ratios. The first ratio is of the energy of the repetition to the energy of the 1000 m repetition. The second ratio is of the number of recoveries of the $6 \times 1000(5)$ to the number of recoveries of the repetition.

| Repetitions | Calculation | Recovery | Recovery <br> (Rounded) |
| :---: | :---: | :---: | :---: |
| $6 \times 1000$ | 180 | 180 |  |


| $6 \times 600$ | $180 \times(17.3 / 16.2) \times(5 / 5)$ | 192 | 180 |
| :---: | :--- | :--- | :--- |
| $10 \times 300$ | $180 \times(10.8 / 16.2) \times(5 / 9)$ | 66 | 60 |
| $8 \times 300$ | $180 \times(12.6 / 16.2) \times(5 / 7)$ | 100 | 90 |

The above forms a nice package of repetition sets that hangs together well. The recoveries are factors of 3 minutes (half and one third). A variation of this, which forms an even neater package, is obtained by reducing the recoveries of the $10 \times 300$ set to 45 seconds. This is a considerable reduction on the calculated 66 seconds, but it provides a 2 to 1 ratio of the recoveries of the 300 m repetitions. This is useful if the training year starts with the $10 \times 300$ set, because it puts more emphasis on aerobic training, and then it provides a big jump in recovery when training moves on to $8 \times 300$, and motivates a considerable lift in speed. Also it provides an approximate $1: 1$ ratio of effort to recovery, as for the $6 \times 1000$ set, and this is a good aerobic start to the training year.

# Oztrack Recommended Resources 

Click here<br>For an updated References \& Resource List (Online)

## Paul Cheks Swiss Ball Video 'Better abs,buns \& backs"



My squad do this Swiss ball workout 2-3 times a week for most of the year.

## Paul Check's Swiss Ball Exercises for Athletes Vol 1 - VHS



Excellent Training Video Series that shows how to train using a Swiss Ball for best effects.
Paul Check's Swiss Ball Exercises for Athletes Vol 2 - VHS


Excellent Training Video Series that shows a full Swiss Ball workout that is performed using the right methods.


This video contains $2 \times 20$ minute workouts - They are great to incorporate with other workouts or use alone when time is limited. Workout 1 is all pilates. Workout 2 combines yoga and pilates. My squad does this 2-3 times a week.

How to strengthen the lower parts of your legs, and prevent (or repair) shin-splint problems.
by O. Anderson and W. Reynolds
http://www.pponline.co.uk/encyc/0161.htm

## Back to Basics

by Vern Gambetta
To do with development of children and physical activity http://www.gambetta.com/a97001p.html

## Functional Balance

by Gary Gray and Vern Gambetta
Ideas to do with balance training
http://www.gambetta.com/a97002p.html

Too Loose Too Much
by Vern Gambetta
The truth about stretching
http://www.gambetta.com/a97003p.html

## Following the Functional Path

by Vern Gambetta and Gary Gray, PT
Functional training explained
http://www.gambetta.com/a97004p.html

## Leg Strength for Sport Performance

by Vern Gambetta
The functional way to strength train legs
http://www.gambetta.com/a97006p.html
Learning to Move
by Vern Gambetta
http://www.gambetta.com/a97007p.html
Plyometrics: Myths and Misconceptions
by Vern Gambetta
http://www.gambetta.com/a97008p.html

Neuromuscular adaptations following prepubescent strength training. Ozmun, J. C., Mikesky, A. E., \& Surburg, P. R. (1994).
http://www-rohan.sdsu.edu/dept/coachsci/vol66/ozmun.htm

## Strength Training for Children

by J. Graham
http://www.faccioni.com/Reviews/childstrength.htm

The Use of Medicine Balls for Speed \& Power Development
by A. Faccioni
http://www.faccioni.com/Reviews/medballtraining.htm
The Role of the Mid-Torso in Speed Development by A. Faccioni
http://www.faccioni.com/Reviews/midtorsospeed.htm

Plyometrics
by A. Faccioni
http://www.faccioni.com/Reviews/plyometrics.htm

Dynamic Warmup Routines for Sports
by A. Faccioni
http://www.faccioni.com/Reviews/Warmup.htm

Speed Training for Team Sport Athletes
by A. Faccioni
A range of good ideas
http://www.faccioni.com/Reviews/teamspeed.htm

Pilates ReTraining of Lumbar Stabilisation Muscles
Some explanation of value of Pilates exercises
http://www.faccioni.com/Reviews/pilates.htm

USA Sprint Tech Info.
by Adrian Faccioni
(Power Point Presentation)
486Kb zip file
Brilliant description and analysis of modern sprint biomechanics and training.
http://www.faccioni.com/articles/USA\ Speed\ Presentation\ 2000.zip

The Inner Unit - A new frontier in Abdominal Training
by Paul Chek
Great article
http://www.coachr.org/innerunit.htm

## The Outer Unit

by Paul Chek
Great article outlining importance of specialized core conditioning
http://www.coachr.org/outer.htm

The Use Of Swiss Balls In Athletic Training-
An Effective Combination Of Load And Fun
By Klaus Bartonietz, Germany, and Debbie Strange, New Zealand

Some explanation of value of Swiss Balls
http://www.coachr.org/sb.htm

## Young Athlete Conditioning

by Adrian Faccioni and Di Barnes
Excellent article
http://www.faccioni.com/lectures/juniorcondition.PDF
'Run-Play' Training
Some Creative training ideas
http://www.pponline.co.uk/encyc/0272.htm
Proceedings of the Conference on Strength Training \& the Prepubescent
Information about safety of strength training for kids
http://www.sportsmed.org/Publications/..\%5Cpdf\%5Cstrength training_prepubescent.pdf
Why sprinters should cock their ankles
Explanation of Dorsiflexion
http://www.pedigest.com/sample/biomechanics.html

## The Simple Secrets of Developing Great High School Sprinters

by Bryan E. Hoddle
Some useful ideas and explanation
http://www.watfxc.com/TF/TF\ Education/Hoddle1.htm

## Training for Speed by Charlie Francis



A recommended book on Sprinting. Contains plenty of great sprint training ideas. Written by the coach of Ben Johnson who ran 9.79 for 100 m in the Seoul Olympics. For more information

Speed Agility and Quickness
by Brown, Ferrigno and Santana


Heaps of ideas for activities that develop Speed, Agility and quickness.

## Training for Speed and Endurance

by Peter Reaburn (Editor), David Jenkins (Contributor)


The contributors to Training for Speed and Endurance are sports specialists keen to bridge the gap between laboratory findings and athlete preparation. They are all involved in the training and preparation of elite athletes, and their aim in writing this book has been to provide practical guidelines for developing and maintaining speed and endurance fitness for both individuals and team players. Training for Speed and Endurance will make sense of all the new techniques and the latest research. It will be of interest to anyone wishing to gain up-to-date information on training principles and will be of particular value to those individuals or team players who need to focus on speed and endurance. The book is an excellent resource for coaches, individual athletes, health and physical educators of senior students, and tertiary students of sports science.

Sprints \& Relays: Contemporary Theory, Technique and Training by Jess Jarver


Great compilation of recent research to do with Sprints \& Relays.

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