Module 6

Speed and agility

Introduction

Speed and agility are important attributes in many sports, but often in very different ways, each sport having its own particular demands. For instance (as noted in an earlier module) fencing requires very quick footwork and acceleration but all movements are linear – forwards and backwards. In contrast, racquet sports are multidirectional, with as much lateral movement as linear.

In addition, different sports have different speed profiles. Racquet sports require very fast off-the-mark acceleration, but maximum speed over a longer sprint (30m to 60m) is less important. Rugby and football require both good acceleration and maximum speed. Therefore maximum speed and acceleration need to be differentiated in training.

Overview of the speed and agility module

In this module we look at how you can develop your speed and agility to meet the demands of your sport.

- Brian Mackenzie provides an overview of the principles of speed.
- John Shepherd explains how you develop your speed on a treadmill.
- Alun Williams and Mick Wilkinson explain how tapering can improve your speed.
- Joe Dunbar provides an overview of the energy systems and explains how you can develop your anaerobic capacity (speed).

The articles in this module are applicable to most sports.

Principles of speed training

Speed is the quickness of movement of a limb, whether this is the legs of a runner or the arm of the shot-putter. Speed is an integral part of every sport and can be expressed as any one of, or combination of, the following:

- maximum speed
- elastic strength (power)
- speed endurance

Speed is influenced by the athlete's mobility, special strength, strength endurance and technique.

Energy system for speed

The anaerobic-alactic pathway supplies energy for absolute speed. The anaerobic (without oxygen) alactic (without lactate) energy system is best challenged as an athlete approaches top speed between 30m and 60m while running at 95% to 100% of maximum. This speed component of anaerobic metabolism lasts for approximately six seconds and should be trained when no muscle fatigue is present (usually after 24 to 36 hours of rest).

How do we develop speed?

The technique of sprinting must be rehearsed at slow speeds and then transferred to runs at maximum speed. The stimulation, excitation and correct firing order of the motor units, each composed of a motor nerve (neuron) and the group of muscles that it supplies, makes it possible for high-frequency movements to occur. The whole process is not totally clear but the complex coordination and timing of the motor units and muscles most certainly must be rehearsed at high speeds to implant the correct patterns.

Flexibility and a correct warm-up will affect stride length and frequency (strike rate). Stride length can be improved by developing muscular strength, power, strength endurance and running technique. The development of speed is highly specific and to achieve it we should ensure that:

- flexibility is developed and maintained all year round
- strength and speed are developed in parallel
- skill development (technique) is pre-learned, rehearsed and perfected before it is done at high speed levels
- speed training is performed by using high velocity for brief intervals. This will ultimately bring into play the correct neuromuscular pathways and energy sources.

When should speed work be conducted?

It is important to remember that the improvement of running speed is a complex process, which is controlled by the brain and nervous system. In order for a runner to move more quickly, the leg muscles of course have to contract more quickly, but the brain and nervous systems also have to learn to control these faster movements efficiently. If you maintain some form of speed training throughout the year, your muscles and nervous system do not lose the feel of moving fast and the brain will not have to re-learn the proper control patterns at a later date.

In the training week, speed work should be carried out after a period of rest or light training. In a training session, speed work should be conducted after the warm-up and any other training should be of a low intensity.

Speed workouts

The following are examples of speed work sessions for a variety of running events:

Event	Speed session
100m	10 x 30m at race-pace from blocks with full recovery 3-4 x 80m at race-pace with full recovery
800m	5 x 200m at goal race-pace with 10 seconds' recovery 4 x 400m at 2-3 seconds faster than current race-pace with two minutes' recovery
1500m	4 x 400m at goal race-pace with 15-10 seconds' recovery 4-5 x 800m at 5-6 seconds per 800m faster than goal race-pace with six minutes' recovery
5000m	4-5 x 800m at four seconds per 800m faster than goal race-pace with 60 seconds' recovery Three x one mile at six seconds per mile faster than goal race-pace with two minutes' recovery
10,000m	3 x 2000m at three seconds per 200m faster than goal race-pace with two minutes' recovery Five x five-minute intervals at current 5K race-pace with three minutes' recovery
Marathon	Six one-mile repeats at 15 seconds per mile faster than goal race-pace with one minute recovery 3 x 3000m at 10K race-pace with six minutes' recovery

Effective methods to develop acceleration:

- All maximum leg strength exercises improve acceleration, as do leg plyometric exercises. Particularly useful ones are standing long jump, standing triple jump, hurdle hops and combination jumps (horizontal).
- Sprint starts. For example, 20 x 5m with 30 seconds' recovery. These can be made more specific by incorporating reactions to signals (eg the ball) or starting from various positions (eg the floor).
- Foot speed drills. For instance, Frappier drills, complete maximum number of foot contacts in 10 seconds.
- Resisted accelerations. Athlete performs maximum 10m efforts with trainer pulling with tubing.

Always finish a workout with normal accelerations

Sprinting speed

Sprinting speed can be developed in a number of ways:

- **Towing** – the athlete is towed behind a motorcycle at a speed of 0.1 to 0.3 seconds faster than the athlete's best for a rolling 30m. This pace is held for 20m to 30m following a gradual build-up to maximum speed over 60m to 70m.
- **Elastic pull** – two tubular elastic ropes are attached to the athlete – two coaches, positioned forward and to each side of the athlete, extend the elastic to full stretch and the athlete is virtually catapulted over the first 10m from a standing or crouched start.

I am sure you can appreciate the potential dangers with these two methods. Downhill sprinting is a safer alternative for developing sprinting speed. A hill with a maximum of a 15-degree decline is most suitable. Use 40m to 60m to build up to full speed and then maintain the speed for a further 30m. A session could be comprised of two to three sets of three to six repetitions. The difficulty with this method is to find a suitable hill with a safe surface.

Over-speed work could be carried out on the track when there are prevailing strong winds – run with the wind behind you. Athletes must always be completely fresh for speed training if it is to be effective. Therefore no heavy weight training or hard endurance training should be done the day before.

Speed training sessions must always include long rest periods and focus solely on quality. Speed development is about teaching the neuromuscular system to operate at full speed and power and this is not possible if there is any fatigue. If rests are too short, the training will only develop speed endurance and not maximum speed.

Speed reaction drill

The athletes start in a variety of different positions – lying face down, lying on their backs, in a push-up or sit-up position, kneeling or seated. The coach, standing some 30m from the group, then gives a signal for everyone to jump up and run towards the coach at slightly faster than race-pace. Repeat using various starting positions and with the coach standing in different places so that the athletes have to change directions quickly once they begin to run. Speed reaction drills can also be conducted while controlling an item (eg football, basketball, hockey ball) with an implement (eg feet, hands, hockey stick).

Speed principles

The general principles for improved speed are as follows:

- Choose a reasonable goal for your event, and then work on running at velocities which are actually faster than your goal over short work intervals.
- Train at goal pace in order to enhance your neuromuscular coordination, confidence and stamina at your desired speed.

- At first, utilise long recoveries, but as you get fitter and faster shorten the recovery periods between work intervals to make your training more specific and realistic to racing. Also move on to longer work intervals, as you are able.
- Work on your aerobic capacity and lactate threshold. Conduct some easy-pace runs to burn calories and permit recovery from the speed sessions.
- Work on your mobility to develop a range of movement (range of motion at your hips will affect speed) and assist in the prevention of injury.

Seven-step model

The following is a seven-step model for developing playing speed.

1. Basic training to develop all qualities of movement to a level that will provide a solid base on which to build each successive step. This includes programmes to increase body control, strength, muscle endurance and sustained effort (muscular and cardiovascular, anaerobic and aerobic).
2. Functional strength and explosive movements against medium to heavy resistance. Maximum power is trained by working in an intensity range of 55% to 85% of your maximum intensity (1RM).
3. Ballistics to develop high-speed sending and receiving movements.
4. Plyometrics to develop explosive hopping, jumping, bounding, hitting, and kicking.
5. Sprinting form and speed endurance to develop sprinting technique and improving the length of time you are able to maintain your speed.
6. Sport loading to develop specific speed. The intensity is 85% to 100% of maximum speed.
7. Over-speed training. This involves systematic application of sporting speed that exceeds maximum speed by 5% to 10% through the use of various over-speed training techniques.

Brian Mackenzie

How the Frappier super treadmill helps athletes run faster

Getting from A to B in the fastest possible time is the key to performance for most sports, whether you aim to run a marathon in just over two hours or go ‘sub-10’ for the 100m. Not surprisingly, improving an athlete’s speed is a highly valued training objective. This goal has been subject to much research, analysis and systematic treatment, and theories abound as to how it can be achieved. This article focuses on one particular speed development programme, known as the ‘Frappier system’. This method adopts a highly systematic approach to speed, with protocols for sprinters, games players and endurance athletes.

American John Frappier began developing his system in the 1980s. After gaining an MSc in sports science, he spent considerable time in Russia with the US junior gymnastics team, where he gained valuable insights into how the former Soviets trained for speed and power. (The Russians were probably the first nation to fully appreciate the benefits of plyometric exercises.) On his return to the States he started working with top NFL (American football) players and began to put together his thoughts on speed development. The first Frappier Acceleration Center opened in 1986 and there are now more than 100 such centres, mostly in the United States.

The system has put through its paces well over 100,000 amateur and professional athletes, the latter group including former tennis ace Steffi Graf, former 400m world record-holder Butch Reynolds, current top Kenyan middle-distance athletes, and numerous internationals and Olympians from an array of sports. The system now has an accredited UK centre in Chiswick (Sport Dimensions), run by Mike Antoniades and Ulick Tarabanov. Since opening the centre in the spring of 2001, they have worked with such notable performers as Chelsea and Bayern Munich footballers and England rugby players.

All athletes, whatever their sport, are put through a six-week 'level one' programme. This is personalised to the strengths and weaknesses of the individual and acts as a gentle introduction to the protocols and techniques of the programme, in particular the use of the 'super treadmill'. Progressions are strictly adhered to and strengths and weaknesses identified in order to ensure safe progression from one level to another. For those seeking absolute speed there are 12 levels to work through, while those after endurance progress through six levels. Both programmes utilise eight-week training cycles.

The 30mph-top-speed treadmill is the key aspect of the Frappier system, although specialised plyometric and weights drills also play a crucial role. It can take time to get to grips with running on the machine, but the combination of inclined/declined running potential (max 40% up, 10% down) increasing belt speed (max 50mph), and an emphasis on biomechanically correct sprinting form is geared to make you a faster athlete.

The Frappier system, just like any other systematic training programme, is based on the overload principle. It relies on the fact that the body will respond to speed overload in the same way it does to progressive resistance or endurance training stimuli – by developing an appropriate physiological response. For speed this means more powerful muscles and an increase in the relevant neuromuscular patterning that will enable an athlete to move faster. Butch Reynolds apparently recorded a speed of 28mph on the treadmill, which is way above the 23mph recorded by Maurice Green during his world-record run.

In technical terms, it is explained that incline running on the treadmill allows for the specific development of the key factors associated with acceleration. In terms of the running action, increased speed can only be accrued from a certain point in the running action. That is from the 'toe off' as the body shifts forwards over the grounded foot and extension occurs through the ankle to the hip. The incline permits the athlete to learn and maintain optimum knee drive, pelvic and trunk positioning and a dorsiflexed or cocked foot strike. Athletes are often filmed on the treadmill for specific technical analysis.

Sprint athletes used to be implored to run on their toes. On reflection, many coaches were probably really asking their athletes to run from a 'high hips' position, trying to prevent them from 'sitting' on each stride and thus denting forward momentum. But if this advice was taken literally, as it was and still is by many, it actually led to the athlete attempting tip-toed sprinting. This is detrimental to speed generation because a breaking effect is caused on each foot strike, as the ankle inevitably yields from its extended position, irrespective of lower limb strength. The dorsiflexed foot position minimises force-absorption and maximises force-return and is recommended not just by Frappier trainers but also by many other top coaches.

How progressive treadmill training boosts speed capability

Readers may be questioning the use of a treadmill in the Frappier system. Here is how UK Frappier coach Antoniades justifies it:

'Our high-speed treadmill allows for specific neuromuscular recruitment and synaptic response. What people do not realise until they run on the treadmill is that it is manufactured to make it as close to running on a track as possible.'

In a recent issue of *Peak Performance,* US editor Owen Anderson questioned the use of such a machine in an athlete's training programme, arguing that foot strike time was increased. He wrote:

'Basically the athletes were trying to create more stability for themselves on the unstable fast moving and/or inclined treadmill by keeping their feet on the belt a little longer than usual.' The Frappier response is that progressive treadmill training allows athletes to achieve greater than 'normal' running speeds – ie, those achieved through track work. This, when coupled with the other exercises and drills in the system, is said to lead to optimisation of speed capability.

This belief involves a re-working of the over-speed principle, of which downhill sprinting and sprinting using elastic cords are other examples. These methods and the Frappier super treadmill permit athletes to run at higher than normal speeds. Because of this, their neuromuscular systems adapt to the stimuli of artificially enhanced greater limb speed capability, with the end result that these patterns are 'learned' and the athletes become faster. Away from the treadmill, speed theory has it that the extent of the assistance should not be greater than 4% of an athlete's normal non-assisted top speed, otherwise the stimulus (the decline or the elastic) does the work and not the athlete. The athlete needs to be able to 'fire' their limbs to generate power, not be 'dragged' to super-speed. It is because of this that the other speed enhancement methods are eschewed by the Frappier system. Antoniades explains that the downhill and elastic cord methods are harder to quantify and control than treadmill running, which offers control, regulation and incremental progression.

It is also important to point out that Frappier athletes are encouraged to continue with their normal sport-specific training. At the time I saw the Frappier system in action, Olympic bobsleigher Colin Bryce was being put through his paces while still involved in team training. The system certainly worked for him, as the former strong man became fast enough to push the two-man bob in Salt Lake in 2002.

Beyond the treadmill

What are the other aspects of the Frappier system and how do they contribute to greater speed development? Specialised weights and plyometric exercises have been constructed to complement the treadmill work. The 'pro-implosion' is a sprint arm action mimicking machine, which is also capable of 10 other moves. A dynamic and powerful arm drive is crucial to absolute sprint speed, and this machine conditions the upper body accordingly. The 'plyo-press' is a squat/leg press machine which enables the upper thighs to be loaded dynamically in a way that could not happen with free weights. Basically, athletes push themselves dynamically off the machine's platform (as if jumping) and then drive into the next lift/jump (as if performing a plyometric drill). This exercise is performed in a reclined position, with the option of increased resistance from the machine.

I myself had experience of a similar, if more rudimentary, system when competing in the former Czechoslovakia more than 15 years ago. This involved something like a child's swing. You simply plucked up courage, swung towards a wall and used your legs to push yourself dynamically backwards to invoke a plyometric response. Frappier obviously took some of these former Eastern Bloc conditioning ideas and refined them for use in his own system.

The Frappier system also offers a rehabilitation programme. 'This is particularly unique in the UK, as we get athletes or individuals back to fitness and competitive sport much more quickly and safely,' explained Antoniades. The system has demonstrated particular success with knee and back problems and, although rehabilitation is beyond the scope of this article, it does appear that miraculous recoveries are possible. Antoniades gave the example of Chelsea player Jesper Groenjaer, who had knee ligament surgery in September 2001. In February 2002 he was put through the Frappier system, while still in pain, only able to run at 70% (8mph) and with a big (35%) strength differential between his left and right leg. 'We got Jesper fit in two weeks,' enthused Antoniades. 'That was 12 sessions and he has been playing regularly in Chelsea's first team ever since.'

The Frappier system does seem to offer real potential for speed enhancement, having taken speed and power development theory from around the world and quantified it into a systematic methodology. Speed is a unique conditioning aspect. It depends on eliciting a very specific physiological response, one that can actually be hindered if the wrong training is performed. The Frappier system seems to have successfully put into one box the right equipment that an athlete needs to get faster.

John Shepherd

Why tapering after intense training boosts sprinting speed

What makes a winning sprinter? The answer to this apparently simple question is a complex one including such elements as mental approach, diet and even clothing. But since sprinting performance is heavily dependent on speed of limb movement, one of the biggest single factors contributing to success is physiology [1]. The muscle fibres in the winning sprinter's legs are able to contract faster over the short period of the sprint than those of their less successful counterparts. Recent research findings have improved our knowledge of how human muscle adapts to training, and the extent to which muscle can alter its ability to meet the fast movement velocities demanded by sprinting performance.

A muscle consists of a bundle of cells known as fibres, bound together by envelopes of a connective tissue called collagen. A single fibre comprises a membrane, many nuclei containing genetic information, and thousands of inner strands running the length of the fibre, called myofibrils. Muscle force production is accomplished through the interaction of two protein filaments that make up the myofibril, actin and myosin.

One component of the myosin filament, known as the myosin heavy chain (MHC), determines the functional abilities of the entire muscle fibre. This heavy chain exists in three forms: I, Ila and IIb. Type I fibres contain a predominance of type I MHC and are commonly called slow-twitch, while fibre types Ila and IIb contain a predominance of type Ila and IIb MHC respectively, and are known as fast-twitch. Slow-twitch fibres are so-called because the maximum contraction velocity of a single fibre is approximately one tenth that of a type IIb fibre[2]. Type I fibres also produce less maximum force than type IIb fibres[3]. Type Ila fibres lie somewhere between type I and type IIb in their maximum contraction velocity and maximum force production.

Because of the high velocity of contraction and the large forces they produce, type IIb fibres are probably one of the key elements required for successful performances in speed-dependent pursuits like sprinting. It is therefore not surprising to find that successful sprint athletes possess more of these IIb fibres than the average person[4]. But is this part of a sprinter's make up pre-determined by genetics? Or can the proportion of type IIb fibres in muscle be increased through training?

Training effects on fibre type

Virtually all the available evidence suggests that the answer to the last question is no. In fact, it has been suggested that type IIb MHC and therefore IIb fibres constitute a 'default' fibre type setting in humans when activity is absent, and evidence of high proportions of this fibre type in paralysed muscle supports this theory [[5]]. It has also been known for some time that increases in activities like strength or power training can lead to conversion of muscle fibres. But, unfortunately, this conversion operates in one direction only, changing fast type IIb fibres into slower type Ila fibres[6]. Moreover, if heavy loading of muscles continues for a month or more, virtually all type IIb fibres will transform to type Ila, with obvious consequences for sprinting potential[7].

What happens when heavy strength training stops? Do the newly formed type Ila fibres revert to type llb? The answer is yes, but recent research has revealed some extraordinary results to which a simple yes does not do justice.

Scientists from the Copenhagen Muscle Research Centre examined training and detraining effects on muscle fibre type distribution[8]. Biopsies (muscle samples) were taken from the vastus lateralis muscle of nine young sedentary males. All the subjects then undertook three months of heavy resistance training, aimed predominantly at the quadriceps muscle group, which ended with a second muscle biopsy. The subjects then abruptly ceased training and returned to their normal sedentary lifestyles before providing a third biopsy three months later.

Biopsies from the vastus lateralis were analysed for muscle fibre type distribution and number. As was expected, there was a decrease in the proportion of fast-twitch IIb fibres (from around 9% to 2%) during the resistance-training period. The researchers expected that the proportion of IIb fibres would simply be restored to pre-training values during the detraining period. However, they found to their surprise that the proportion actually doubled to around 18% after three months of sedentary living!

How heavy training followed by tapering produces 'overshoot'

So it seems that a pattern of heavy resistance training followed by decreased activity causes first a decrease then an overshoot in the proportion of the fastest fibre type in the trained/detrained muscle group. An explanation for this overshoot currently eludes researchers, but the findings accord with the theory that muscle fibres 'default' to type IIb with a (relatively) decreased level of activity[5].

Further research using trained athletes as subjects would add weight to these findings. But until then, sprinters may draw the following conclusions: a large increase in training volume for approximately three months will decrease the proportion of IIb fibres in the trained muscles; a subsequent reduction (not cessation) in training volume relative to the heavy resistance training phase should not only reverse this decrease but lead to a significant overshoot in the proportion of IIb fibres. In consequence, the potential for the rapid and forceful muscle contractions so crucial to sprint performance should be enhanced.

This conclusion is in line with the current training practices of many sprint athletes. In the lead-up to the competitive season a heavy resistance training phase is followed by a taper in training volume and intensity[9]. On the evidence of the Copenhagen research, others would be advised to follow their example, with three months of heavy resistance training followed by three months of relative detraining, with relatively reduced training volume in the run-up to key targeted events.

However, as is usually the case, new research findings will probably refine these recommendations over the coming years.

Alun Williams and Mick Wilkinson

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Take up the anaerobic challenge

Come April, hundreds of runners are digging around at the back of the wardrobe, trying to find that old pair of track spikes. A quick dust to get rid of the cobwebs and it's off to the track, adrenaline pumping because the time has come already for the first track workout of the summer. The county champs are only a month or so away, and you are thinking that you have got to get some speed in the legs before the serious stuff gets under way.

But how often do you seriously think about why you are going to the track, what workout you are going to do, and exactly how it is going to help you reach that peak performance on the track, when it counts? Most people tend to gather at the track and do the group session without even stopping to think what the training effect is doing to their body, or how they are going to progress next week, or the week after.

To be sure of what the session is for, how to structure the session in terms of duration and recovery, and how the session may fit into your overall programme, it is important to understand energy systems – how the body makes energy available for exercise – especially when running close to your maximum.

The exercising body has three major sources of adenosine triphosphate (ATP), which is the basic unit the body uses to produce energy in working muscles. Two of these are short-term and do not immediately require oxygen, while the other is more long-term, but does require the availability of oxygen. Therefore, the first two are described as 'anaerobic', while the third, the oxidative pathway, is classed as 'aerobic'.

The anaerobic pathways can be further subdivided into the high-energy phosphagen system and the glycolytic pathway. These two short-term energy systems can produce a lot of energy very quickly, but also fatigue rapidly. For example, the high-energy phosphagen system can produce energy at up to three times the rate of the aerobic oxidative system, but fatigues within a number of seconds. This system uses either ATP stored within the muscle or creatine phosphate, which can help produce more ATP via chemical reactions. After a sprint, this system can be repleted, which takes place quickly at first (the first 50% is repleted within 20 or so seconds) and then more slowly (the second 50% takes about 170 seconds). This has important consequences for training programmes.

At a high intensity, the glycolytic pathway can supply energy to the muscles, but again the time-span is limited. If the oxidative system simply cannot supply enough oxygen to cope with the demands of the workload encountered, lactate will start to accumulate in the muscle tissue, which soon diffuses into the blood. If the lactate accumulation is great, the ability to contract the muscle will be inhibited, and there will also be a feeling of pain for the runner.

Recent research studied the muscle metabolism of subjects running a flat-out 400m (*Medicine and Science in Sports and Exercise*, April 1991). It was seen that after 100m, creatine phosphate decreased from 15.8 to 8.3mmol/kg, while peak muscle and blood lactate was 3.6 and 4.7mmol/kg. The rate of muscle and blood lactate was seen to have reached maximum between 200m and 300m. Running speed dropped significantly in the second half of the 400m and the end level of creatine phosphate had fallen to 1.7mmol/kg, while the muscle and blood lactate had shot up to 17.3 and 14.9mmol/kg. The study suggests that the acceleration phase tends to rely on the breakdown of creatine phosphate to produce energy, while the lactate levels start to reach a 'detrimental' point after 300m and lead to a decrease in running speed.

Putting it into practice

Where does all this fit into my training, you may well be asking? If you are a middle-distance runner, you need a great deal of speed, especially in the 800m event, and the ability to run fast, be it from the gun or at the end of the race. If you are thinking this does not apply to you because you run the 10,000m or the marathon, think again. Remember how fast the last lap of the 10,000m was in the last major games that you watched; remember how Douglas Wakiihuri easily dealt with Steve Moneghetti in the London Marathon. Whatever the event, right down to a Southern League 5000m, it seems almost inevitable that you are going to need an element of speed.

The most critical distinction to make in planning your anaerobic training is deciding whether you are about to do a session to train your high-energy phosphagen system, or train for pure speed, or work on the anaerobic endurance or speed endurance aspect. Both need to be worked on if you are to be fully prepared when you reach the start line, but they will need quite different sessions.

Think for a minute about why you do intervals. For the aerobic system, they are useful because, according to American physiologist David Lamb, they can increase your maximal aerobic capacity, help you to perform at a high percentage of your VO_2max, and increase the distance that you can run fuelled by a set amount of oxygen (ie, your running economy is improved). With intervals, you can perform a greater overall volume of work than in the steady state, albeit with rest in between. These are preferred in anaerobic training, but by manipulating the work-to-rest ratio you can control what energy pathway you are going to train in your session.

If you are going to train your body for speed, you need to work in short bouts, with lots of recovery. This means that to avoid accumulating large amounts of lactate, the sprint should be of about 10 seconds' duration, and the recovery should be up to three minutes because it takes about 190 seconds for ATP and creatine phosphate to be repleted in the muscle. So, although you may be a distance runner, if you are to train this system effectively, you have to train like a sprinter. The work periods are hard but you should get to like the more leisurely recovery.

The shape of your session

How do I progress with such a session, you are probably asking? You do not want to increase the duration of the repetitions, otherwise you are starting to train a different pathway, so try to improve the quality of the sprints; that is, run quicker. This should happen over a series of weeks with practice, as the body becomes more coordinated and the neuromuscular ability is improved. Your pure speed session may look something like:

- five x 60m to 80m with three minutes' recovery between sets

This can then progress to three sets of sessions, with about six to eight minutes between sets. The recovery can be reduced very gradually, as the rate of repletion is improved with the training. Therefore, the recovery between sets can be chopped first to, say, four or five minutes, followed through the weeks by slicing 10 seconds off the rest between repetitions. There is no evidence that the total amount of ATP or creatine phosphate increases in the muscle through repeated weeks of training, but the recovery rate should improve, as should the quality of work, which is the aim of the actual session anyway.

In deciding what sort of intensity to run at, remember that this is a quality session when you should be at maximal speed, so heart rate is not a good indicator at such intensities. The session should be used most in the pre-season period, so once or twice a week in April and May would be the recommendation and once a week for maintenance once the season is under way.

In building anaerobic endurance, the session needs to be of sufficient intensity to challenge the lactate system, yet not so fast that extreme tiredness is encountered and the session is ruined. Here there are far more options, and many top runners train in different manners. There is a case for doing what suits and works for the individual, but certain principles still apply.

For middle-distance runners, the suggested total volume of the session may be two to three times the competition distance, but this will depend upon the quality of the session. If the intervals are run quickly, you will not be able to run many, despite ample recovery, yet if the repetitions are a few seconds slower, far more will be endured. It is common to start off the pre-competition with a series of steadier repetitions, building on the endurance gained over the winter and speed up as the season progresses. This means that the session for a two-minute 800m runner may be:

- 10 x 200m in 30 seconds (with 60 seconds' recovery)

As the season progresses the speed of the repetitions can increase, which will be allowed for by more recovery. This means a month later the session for the same athlete may be:

- four x 200m in 26/27 seconds (with two minutes' recovery)

As competition gets closer the athlete will be in a better position to handle longer anaerobic repetitions, with good recovery, so the same athlete may attempt:

- two x 400m in 54/ 55 seconds (with about 10 minutes' recovery)

In all three cases, the glycolytic pathway will have been challenged, and large levels of lactate will have accumulated by the end of the session. However, the athlete will be in a better position to handle the race condition by completing the third session, as this is a bit more specific to the demands of 800m.

Another idea is to practise running repetitions with a decreasing recovery during the session. Here the athlete gets used to trying to maintain pace under greater conditions of fatigue. The athlete may be performing repetitions of 300m, as this was seen earlier to be the distance where the accumulation of lactate peaks. You would choose this type of session in order to train your body for lactate tolerance. This sort of session would also take place during the pre-competitive season, or in the early competitive phase. Such a session might be:

- five x 300m with a recovery of 3, 2.5, 2 and 1.5 minutes

The pace would be dictated by your ability; the aim would be to run at near-race-pace throughout the session; you are not trying to run faster, as in the previous case. To get the same type of effect again – that is, being able to run fast in a state of tiredness – the 1984 Olympic gold medallist Joaquim Cruz used a session in the competitive season of two sets of:

- one x 600m (1:18) jog 200m, one x 400m (51/52) jog 200m, one x 200m (23/24)

There were three minutes in between sets. Training at such a blistering pace is essential for anyone running 800m in 1:42, but the session could be mimicked with more realistic splits by any 800m runner. The session trains speed endurance, with a picking-up of the pace as you progress.

Some of the Kenyan 5000m runners have been seen to do similar types of sessions in terms of metabolic demand (ie, lactate tolerance) but structured in a different manner. One such session is:

- 10 x 400m with five minutes' recovery

The times for these repetitions for the faster 5000m runners (under 13:30) were a staggering 54/55 seconds, but it should be remembered that this was near the middle of summer, where they wanted to maintain a fast pace. That is why the relatively long recovery of five minutes was allowed. 1500m runners in this country use a similar session of 10 x 400m, but they would use a shorter recovery and a steadier pace, so not training the same energy pathway. Steve Cram has been seen to do such a session in the pre-competitive phase, where he will run the repetitions around four-minute-mile pace (60 seconds a lap) off a minute recovery. Such a session, however, is greatly challenging to the aerobic system as well as the anaerobic system, making it more relevant to the end of the preparation period.

The right session for the right phase

The key to anaerobic training is performing the correct sessions at the right phase of the year. By the time the track season starts, the bulk of the work must have been completed. The only track sessions you need will be maintenance sessions, which consist of a few fast repetitions, with a long recovery, like the two x 400m sessions for the 800m runner. If you run 5000m, why not try something like the Kenyan session in more realistic splits, but with the same type of recovery? A 1500m runner might try:

- three x 600m with seven to eight minutes' slow jog recovery

The pace will depend on the ability again, but the recovery is chosen because in the trained athlete the lactate clearance should take about seven minutes, with slow jogging. This means that you will not be starting the next repetition with an already high lactate level, and the quality of the session should be maintained. Commonly quoted sessions of Seb Coe are:

- six x 800m in 1:51 to 1:56 with about 90 seconds' recovery

But this does not mean you should be drawn into such speed endurance efforts. It should be remembered that this is a key session for a top-level athlete preparing for a specific championship. It is hardly the sort of workout that he would be completing every week. The athlete that reads such sessions and tries to copy will break down quickly. It is important that you select the pace according to your ability at the time and make sure that the recovery is specific to the demands of the session and the time of year. Early-season work will be slower, and you should progress to quicker work, compensated by longer recovery to maintain the quality.

The physiological adaptations to this type of anaerobic endurance training take place within the muscle. The enzymes that control the chemical reactions to produce energy start to work in a more efficient manner. Lactate tolerance is also improved within the working muscles.

Planning your anaerobic training in advance is the only way to achieve your best. This may mean training alone sometimes, but if you want to get the best out of yourself, rather than simply be the best in your training group, you may have to plan and go it alone. So, before you head off for the track this season think first of what you want to train, and then think whether the session you are about to tackle is really going to challenge the body in the way to take you to your peak performance.

Joe Dunbar