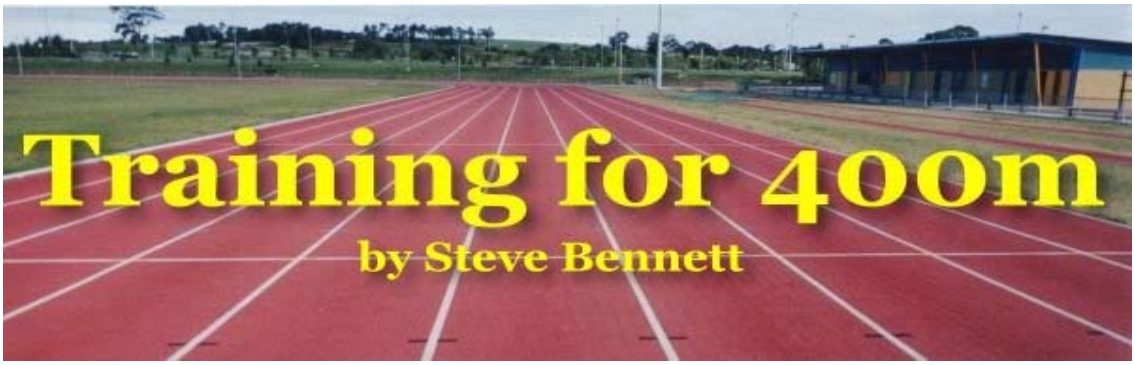

Introduction
The aim is for this book to provide a range of ideas to help coaches & athletes create their own programs which are more effective at preparing for the 400m event.

Some of the Information is the same as in the Developing Speed e-book but it has been tuned specifically to the 400m event.

This e-book will grow as it can be easily updated & all updates will be free.

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The New Biomechanics of Sprinting

There is a new technical model of sprinting that is being displayed by many of the worlds top sprinters and Michael Johnson certainly exhibited many of its principles in the 400m race.

It should be every athletes goal to gradually develop the most effective technique. So what are the latest ideas?

To increase any athletes speed means improving at least one of the following two things:
1. the number of steps the athlete makes per second (their cadence).
2. the effectiveness of each ground contact.

Cadence in a 400m race can be increased economically. It is very much related to decreasing recovery time (the time it takes to get the foot off the ground and back on the ground). Having a foot that hangs way out of the back of the body after ground contact is a common problem that increases recovery time. It is often caused by the athlete dropping their hips which causes a noticeably increased lower back curve (a butt out position). This creates a situation where the athletes compensate for their lack of knee lift by pushing more out the back. There are a number of problems associated with this excessive rear-side running action:

- Increased recovery time which results in a slower step-rate.
- Increased load on hamstrings which have to assist in the recovery action. Greatly increasing risk of hamstring injury.

- Decreased knee lift because knee lift is inhibited when hips are low and there also isn't enough time for them to be lifted higher with the late recovery. This consequently results in less powerful foot contacts.

Many of the worlds top athletes are now also trying to decrease rear-side mechanics. The plan has been to prevent the thigh from swinging back any further than just 20 degrees behind the plane of the trunk. To do this requires that the athlete maintains high hips. Therefore minimizing the increase in lower back curvature. To do this the athlete needs a high level of strength and control of the muscles that maintain good pelvic stability particularly the lower abdominals. To develop this strength takes a few years of training in the right way.

It is important that the leg folds up close to the butt on recovery *but* in an athlete that is recovering early enough the foot should be closest to the butt when the thigh has already swung forward. Athletes that are recovering late have thighs that are vertical when the foot is at its closest to the butt. Performing butt kickers drills with a vertical thigh is very counterproductive in developing good recovery mechanics. It is best to make sure that the drills are always done so that the knee is forward when the foot is at its closest point to the butt and also fully dorsi-flexed almost all the time.

Good leg recovery involves a cyclic action where the athlete strives to keep their big toe as close as possible to their shin (dorsi-flexion), high hips, early recovery and recovers their foot over the height of their opposite knee. The action looks and feels like "stepping over long grass". This cyclic recovery action allows the athlete to develop a much more powerful acceleration of their lower leg moments later. Many athletes run by recovering their foot by pulling it through low and straight up. This is much more energy costly and slower.

When an athlete is in the position of their highest knee lift and they are maintaining high hips as well as a dorsi-flexed foot. They are in a situation where they can generate using the gluteus maximus muscles a large amount of vertical force resulting in an explosive acceleration of the knee downward. If they have a dorsi-flexed foot their lower leg can swing freely (without contraction of the hamstrings). The result is a rapid flinging backward of the foot, this is often called negative foot speed. It has been reported that elite 100m sprinters can swing their feet backwards at speeds in excess of 50kph (30mph). Maintaining dorsi-flexion until the foot hits the ground increases the quickness of ground contact and also helps contact to occur further underneath the body minimizing breaking forces. Some athletes have incorrectly developed a technique that produces high negative foot speed but they do not maintain appropriate dorsi-flexion of their foot until ground contact. These athletes are at great risk of hamstring injury because they strike too far forward in front of their body which severely loads their hamstrings. Minimizing over-striding will also result in a higher cadence and a more powerful stride.

Active Foot Strike
Athletes should be aiming to impact the ground with a foot that is moving backwards. This is not unlike the impact when a kid is riding a scooter or a skateboard. The ground is moving backwards at a fast rate and when the foot first makes contact with the ground there is usually a jolt of deceleration before there is any propulsive force applied. This braking force can be decreased by creating a technique that has the foot moving backwards before it impacts and also making contact far enough back under the body.

Dorsiflexion
For the athlete to make an active foot-strike and have a quick contact with the ground. It is essential that the athlete maintains dorsi-flexion of the ankle (keep toes as close to shin as possible). This pre-stretches the calf muscles and prepares them for a much quicker more elastic impact. Maintaining dorsi-flexion also causes foot strike to occur later under the body.

A common (sometimes taught) error is for the athlete to point their toes away from their shin in an attempt to run on their toes as shown in the image to the left. This method has a variety of negative consequences:
- Usually unless the athlete is very strong they will simply increase contact time because their foot will be forced into maximum dorsi-flexion after contact anyway. As a consequence controlling this rapid forcing back of the foot on impact puts a tremendous extra load on the anterior tibialis that often leads to lower leg injuries like shin splints, tibia stress fractures and even achilles tendonitis.
-The athlete running up on their toes (attempting not to let their heel hit the ground) is in much more of a pushing position. This means they will need to lean further forward to get maximum power out of an action that is more dependent on muscles in the front of the thigh. By leaning forward the athlete will also minimize the effects of the over-striding that they have because running with a pointed foot will cause foot contact to occur further forward.
-The forward lean usually is accompanied by an increased lumbar curve in the lower back. This often causes a situation where the athlete's pelvic position will make it less possible to have muscular activity from the important Gluteus Maximus muscles due to inhibited activation. The Gluteus Maximus in Elite athletes works very powerfully in concert with the hamstrings to create the backward sweeping action of the thigh and result in a fast backward "flinging" action of the foot. If the Gluteus Maximus is inhibited and/or weak, the hamstrings then are forced to take over the load. Often this means athletes that run in this way have lots of problems with their hamstrings accordingly.

Arm swing should involve having the elbows swing in front of the plane of the trunk. Not swinging them far enough forward limits knee lift and results in greater rear-side mechanics to compensate. The angle of the arms should be mostly about 90 degrees at the elbow. The only time this angle should increase is when the hands are behind the body and then they may open up to no more than 120 degrees. The opening up of the angle makes it easier for the athlete to have a more relaxed arm action and also allows the legs to complete the cycle of movement.

Forward lean
Athletes should aim to run at maximum speed with a very slight forward lean that is evident throughout the whole body. They need to keep their hips up and have the right balance of front-side and rear-side running action. Leaning too far forward will result in the athlete increasing the rear-side action and introducing all the associated problems.

Head position
Athletes need to keep their chins down. Having a head that tilts backward often is accompanied by an increased lumbar curve and lower hips. This will decrease knee lift and negative foot speed.

Running Tall
Athletes need to aim to run tall. This means they keep their body long, their hips up and can have a high knee lift. Many athletes run low and have legs that are quite bent as they pass under the body. This causes them to have effectively shorter legs and a shorter stride length. The key to improving tallness of the runner is to develop more strength and to always practise running tall.

Relaxation
All athletes should aim to develop relaxation. This means focusing on using muscle that are required for running and stabilization. It importantly means learning to switch off all muscles that are not required as much as possible. There are many situations where athletes can practise relaxation and seek to develop a good feeling when running that many athletes call rhythm. Young athletes particularly need to develop this skill because it is common for people to equate running at maximum speed with maximum tension. This is why this area needs

careful and regular attention. Tempo sessions aim to develop endurance and desirable movement habits while relaxed. Relaxation is much more easily attained during Tempo sessions because all running is done at lower intensities.
The 400m event especially needs athletes to be able to run relaxed as this optimizes economy and prolongs the athlete's ability to sustain speed.

Starting Technique

It is most important to distinguish between the technique when starting/accelerating and for running at maximum speed. Acceleration involves a significant pushing action where the quadriceps and calves are much more active. There is also as high a degree of forward lean as possible. The stronger and more powerful the athlete the more able they are to be leaning forward and apply a pushing force to the track. Many athletes and most kids are unable to apply enough force to start with the ideal technique because they are unable to push to straight their front leg when leaving the blocks or get anywhere near this in the steps that follow. However they should be encouraged as much as possible to strive for a strong forward leaning pushing action in the first 5-8 steps. It is important that the forward lean is evident throughout the length of the body not just a piked position from the hips or simply a head that is hung low. Its degree and effectiveness will improve as the athlete develops more strength and power.

The common mistake made by many athletes is to try to just stand up and run as soon as possible with the maximum speed technique. In a 100m race standing up tall early puts the body in a position where it is unable to generate the same amount of force to the track in a pushing action and also prolongs the period of time that the sprinter will need to spend maintaining the technique for maximum speed. This often causes athletes who stand up too early to lose more speed at the end of races while fatigued than their peers who maintained a better acceleration body position for longer. In a 400m race the start is an area where athletes often waste time but it needs to be more economical. But seeking an economical start in many athletes produces a lazy wasteful start.

Sprinting & the Nervous system

Considering the function of the Nervous system in Sprinting is very important. It has a limited capacity to recover from certain types of activity. This needs to be understood when planning training and especially when leading into competitions. Dan Pfaff coach of some of the Worlds leading Sprinters (Bruny Surin, Obadele Thompson and Donovan Bailey) has made the statement like "it is as if the human nervous is powered by a 9v battery and is therefore easily flattened". Sometimes in the days after certain types of training an athlete is unable to run with as fast a cadence as usual, often also accompanied by lower maximum power output. It is in this situation that an athlete is said to be "flat".

Most athletes have nervous systems that are very limited in their capacity. Because of this they will be unable to sustain maximum cadences or maximum power for very far at all. The upper limit is maybe only as far as 5s. The time most athletes can actually spend at absolute maximum speed will probably be below about 3s. In training they may be able to do about 3-6 experiences of maximum speed in a session at the most before they are flat. The time to fully freshen the nervous system after flattening sessions will likely be at least 72hrs. This makes it only possible to train for maximum speed once a week if the athlete is racing that week or twice a week if they are not racing.

The most important thing to recognize is that the athlete cannot train at super high intensity when neurally fatigued. When neurally fatigued the athlete will not be able to generate the force required to the ground quick enough which effects both their stride frequency & stride length. Training at maximum effort in this situation would simply be practising bad habits and an inferior motor pattern. This would then produce a more prolonged period of flatness.

Racing requires nervous system freshness for optimum performance. This means that the athlete should not perform training sessions that will produce lasting flatness that will persist to the competition date. Often athletes surprise themselves by performing better than expected after a period of minimal training stress, this is because of the nervous system being "fully charged".

The way to find out an athletes tolerance to training and times required for recovery is to monitor it carefully. Athletes in my squad are clearly slower over a standing start 40m run by a noticeable amount on "flat" days. If a session of maximum speed sprints over 40m is planned and the athlete is indicating they are flat in their first run, then I often change the session into a more relaxed tempo session. We also avoid doing any maximum speed work in the 4 days prior to important races.

400m athletes need to improve their maximum speed so that they will find it easier to run the first 200m at the right pace. However they need to do speed training on days where it is safe and they are able to perform the work with high quality. Speed Endurance sessions can produce soreness and tiredness which can make speed training more dangerous in terms of injury risk. But Speed endurance work is less flattening on the nervous system because the cadences & forces are lower. The key thing to recognize is that pure speed sessions, plyometrics and very intense low repetition gym work flatten the neural system the most.

Strength Development

Athletes need to develop strength in a functional way. This means training with a variety of movements that are performed well. It is best to avoid training that isolates muscles like body builders do.

It is very important initially to develop strength in the muscles that provide stabilization especially postural strength.

It is best to perform an ever changing mix of activities. This is because it sustains athlete enthusiasm and ensures that the body keeps adapting. As an athlete reaches a higher standard then they will plateau in certain activities. Often the best way to move above a plateau is to do something else for a little while and then revisit the activity.

Many sprinters follow a double (or even a triple) periodized year. This means that instead of building all year to a single peak, that they focus on performing training that targets a specific area of development for a period of time and then changing to new area for a period of time and so on. Strength training is a big part of the periodization for all sprinters including the 400m.

I have had sport scientists explain to me that 400m athletes can benefit from extra muscle size near their prime movers as it can further enhance their ability to cope with high levels of blood acidosis. It is interesting to observe the musculature on most 400m male athletes is much less than 800m males. But the women in both 400m & 800m are similar in musculature which is in many cases almost as highly developed as the 100m sprinters.

Strength Training plan for a Double Periodized year

An example of how a year could be structured is below:

Phase 1 - Hypertrophy I / Conditioning 8 weeks
Phase 2 - Strength I - 6 weeks
Phase 3 - Power I /Conversion - 4 weeks
Phase 4 - Maintenance/Competition Peak I - 4 weeks
Phase 5 - Hypertrophy II / Conditioning 4 weeks
Phase 6 - Strength II - 8 weeks
Phase 7 - Power II/Conversion - 6 weeks
Phase 8 - Maintenance/Competition Peak II - 9 weeks
Phase 9 - Transition - Recovery 3 weeks

I believe it is better to train using a great variety of activities. This plan outlines changing emphasis it does not mean each phase is exclusive e.g. some medicine ball training may be done all year.

Hypertrophy/Conditioning Phase
Aims to create the right amount of muscle for the athlete and the event they are preparing themselves for. This would be aimed for by ensuring that there is enough time under tension in each exercise to create a stimulus for hypertrophy. Usually using 3-5 sets of 8-12. With sprinters we would tend to aim for functional exercises which are performed quickly as much as possible. We would try to avoid as much as possible using isolation exercises or slow lifting. The athlete is also comprehensively conditioned in this phase to being able to do good volumes of work on many muscle groups. This is also a very good time to do more ankle & foot conditioning as well as hip conditioning using hurdle drills etc.

The athletes supplement with small amounts of protein before,during & after all strength sessions. This ensures that there are always adequate amino acids circulating so that they spend minimal time in a catabolic state. This has allowed adequate hypertrophy to occur even in female athletes. The goal of the hypertrophy phase is not to get big for the sake of getting bigger, it is to get big enough to have the appropriate body type for the event and to create muscle that can give further gains in strength and ultimately power.

Strength Phase
The total number of reps in each set and overall is decreased to maximize the load being lifted. Usually 3-4 sets of 3-5 depending on the exercise.

Power Phase/Conversion
Exercises with a lighter weight than in the previous phase are used and the exercises are performed explosively. The athlete also is aiming to transfer as much power as possible into the specific running action. Some max strength work is continued but the emphasis is on power development.

Conversion/Maintenance
Training is performed to transfer as much strength as possible into the running action. The total loading of the activities are usually much lower in volume and the frequency in the week to allow for maximum quality in specific running training and for competition. The key aim is maintain strength but learn to use more of it.
Some max strength work is still performed but is greatly reduced in volume.

Track training during each Period.
Early in the first period emphasis is on tempo work and on short acceleration sprints to 30m. Max speed is the emphasis during power development phases. Speed endurance is emphasized more during the Maintenance phases. Generally there is a shift toward longer distances in each phase during the second period. The second competition period before the transition is the peak performance phase of the year.

Free Weight Training

During weight training young athletes are limited in what they can do with free weights by their ability to stabilize and therefore balance the weight. This means that the loads are often low initially in terms of total force. Machine weights do not develop stabilization strength and they allow the athletes to generate very high forces that are in a real situation beyond their ability to control. I believe it is best to start with free weights and get good advice from an instructor on technique. In fact, the more the athlete is monitored and shaped in technique the safer lifting will be as they become more advanced.

My strategy with athletes has been to use a great variety of exercises some of which are weighted to challenge stabilization and therefore develop increased strength in this area. From this type of training the athletes gradually improve their postural position and stability. This is something that has great transfer into improvements in the running action. Strength training initially should be focused on developing stabilization strength and core strength for sometime before it can sensibly progress to be really targeting the main muscles for propulsion (the prime movers).

Training in a way that improves running form and stabilization strength is an effective way to prevent injuries in any athlete. Many athletes that are advised to wait until their late teenage years to start strength weight training are missing out on an area of development that will likely help them avoid injuries.

I have found that athletes really enjoy the experience of gradually developing their strength in a variety of ways. The enjoyment being mostly a product of the perfected variety of things they have done and are doing.

Exercise Choice

There are many possible exercises that athletes should do. It is best to vary exercises regularly and learn perfect technique for each one.

Bench Press/ Incline Bench Press / Vertical Dumbell Press - we tend to vary the angles and maintain progress.
Full Squat / Parallel Squat / Half Squat / Quarter Squat - we would tend to start deeper lighter and build more intensity eventually ending up with very heavy quarter squats in the power phases of the year.
Reverse Hypers/ Back extensions / Upright Rows/ Seated Rowing etc - It is important to do strengthen the back.
Cleans/ Hang Cleans - this is a key exercise for many sprinters - it has to be done quickly but it needs the right gym and good instruction.
Weighted Step-ups - we often do these in sets of 4-6 on alternate legs - early in each period we do them on a higher box and we progress to higher loads eventually on a lower box. This is a great stabilization development exercise. Athletes who have poor stabilization strength will show it during this exercise.
Weighted Crunches/ Hanging leg lifts/ Russian Twists/Hanging leg holds with variations/ Cable pulls (Woodchops) - There are a great variety of exercises that target the full range of abdominal muscles. We work them using Pilates & Swiss Ball to enhance control and posture, we also work them for endurance and also we work them for high levels of strength using exercises that present high forces.
Pullups - we do a range of these and sometimes they are performed loaded with weight or at other times are performed very quickly.

Power Circuit

A power circuit we have been doing which has been great fun and effective is detailed below:

Warrmup - includes cable pulls across, hang snatches , back extension

10 ankle bounces with a 20kg bar
6 jump ups onto a low box with 40kg - explosive
12 ankle bounces with in & out movement with a 20kg bar

6 step-ups each leg with a stomping active contact with a 40kg bar
4 quarter squats (Female sub12.00s athlete to 160kg)
2 x 4 bounds on carpet - measured from a standing start.

The circuit is repeated 3 times. Transition between exercises is not timed or rushed. Quality is valued.
The athletes then did a combination of Russian Twists, Hanging ab holds totally 5min some with straight legs - some with bent legs and med ball resistance, Reverse hypers, Inclined Med Ball catches. A quicktime video of some of the exercises is at www.athleticstraining.com/videos/midtorsogymdec2002.mov (it is 2.0Mb)

The choice of weight is based on the bounces being about 15% of quarter squat ability. The jump-ups and active step-ups were meant to be less than 30% of quarter squat ability over 4 reps.

Ankle Conditioning

If a runner has weak ankle dorsiflexors (muscles in the front of the shin) they will make a lot of noise when they run where those with well conditioned and functional dorsiflexors will make much less noise. It has been suggested that Kenyan athletes build up tremendous dorsiflexor strength and functionality because they spend their initial years of life running and walking endless miles while barefooted, instead of being in shoes. Consequently, many Kenyans are able to conserve energy during the stance phase i.e.. while their foot is in contact with the ground. This is because in addition to controlling plantar flexion, the dorsiflexors must also deal with the side-to-side motions of the foot and ankle during running, as well as the rotational motions which are a natural part of the running cycle. Any tendency of the foot to pronate must be controlled by the shin muscles. Any tendency of the foot to supinate must also be minimized by the dorsiflexors. It is important to condition the dorsiflexors to be able to cope with stress in the full range of directions. As well as improving efficiency, strengthening the dorsiflexors minimizes the risk of developing shins splints or stress fractures of tibia.

Exercise ideas for dorsiflexors (Anderson & Reynolds)

Shin Raises - athletes simply use their shins to lift toes up as high as possible when standing on their heels, perform 3 sets of 15. Progress can be made by varying both the range of motion and the speed. Athletes could also progress to doing them on one leg at a time.
Heel Step-Downs - Athletes step forward with one foot but by using eccentric contraction of the dorsiflexors they prevent the ball of their foot from descending any more than a few centimetres toward the floor. Maybe progress to 3 sets of 15 each leg. Athletes could increase the intensity of the exercise by taking longer steps and then to going down a high step.

Some ideas for shin conditioning during warm-ups are:
Walking on toes - Athletes walk high on their toes with their toes pointed straight ahead for 20 metres. Then 20m high up on their toes, but with the toes pointed outward with the rotation coming from their hips so that their whole leg rotates. Follow this with a high on toes 20m walk with toes pointed inward, once again by rotating from the hips.
Walking on heels - Athletes walk on their heels with their toes pointed straight ahead for about 20 metres and repeat like in the toe walks with their toes out for 20m and toes in for 20m.
Jogging on toes or heels - Progress can be made with both exercises by jogging gently while performing the above two variations. Further progress is made by skipping and this is of a much higher intensity.
Rhythm ankle bounding is performed by jogging along with very springy, short steps, landing on the mid-foot area with each contact and springing upward. In rhythm bounding the athletes ankles should act like coiled springs, compressing slightly as they land mid-foot and then recoiling quickly. This causes the athlete to bound upward and forward. Athletes progress toward performing a mixture of mini hops and rhythm bounding over 20m with around 100m of variations in total.
Dorsiflexion bounces are performed by jumping vertically and repetitively at close to maximal height, landing in the mid-foot area with both feet and then springing upward quickly

after each contact with the ground. Athletes should dorsiflex their ankles on each ascent and slightly plantar flex their ankles just before making contact with the ground. Maybe start with ten dorsiflexion bounces progress to thirty and then toward doing them on one leg at a time.
Rhythm bouncing is jumping around moderately fast, with medium height, and with maximal motion at the ankles, but minimal flexion and extension at the knees and hips. Combine these with some low fast bounces of less than a few cm. All Rhythm bouncing should be performed as if the landing surface is very hot. The athlete could start with ten bounces and progress to forty.
Advanced Rhythm bouncing involves jumping in various directions and then eventually developing the ability to do them on one leg. The challenge of doing them in different directions increases the ability of the shin muscles to handle the side-to-side and rotational stresses during running.

Foot conditioning

The muscles of the foot when well conditioned can contribute to running efficiency as well as prevent injury. Research by Unger & Wooden on the effects of an arch strengthening on athletes produced gains of 4cm in the vertical jump and 11cm on a horizontal jump.

There are many simple ways to develop and maintain good arch conditioning e.g. spending time barefoot walking, doing smart amounts of running barefoot etc. An exercise called 'Toe grasping' can be performed by having the athlete stand barefoot with feet hip-width apart. They should then curl the toes of their right foot and then their left foot down and under, as though they are grasping something with the toes of each foot. It is recommended to do 2 sets of 50 repetitions with each foot. The aim should be for the athlete to try to pull themselves across the floor. Initially I have had athletes perform this exercise by having the athletes flex their toes in a pulling action to "scrunch" a towel under their feet.

Developing Athletes & Advanced Athletes

Developing athletes should work at building high levels of core strength and postural stability. They should also do as much bulletproofing as possible eg heel/toes, swiss ball, pilates, theraband, sand pit mini bounces and general conditioning. They should learn how to lift and progress with the loads slowly and safely. Initially they should aim to develop the right body dimensions for their event by doing a significant amount of hypertrophy gym work. It is important however that while they are doing this they are exposing themselves to plyometric activities. Athletes that don't do plyometrics as they develop are more prone to injury from using this mode of training than athletes that grew up doing plyos.

Advanced athletes should already have developed all of the qualities listed above and should maintain good standards in all of these areas. However, they can now focus on increasing their strength and power levels as high as possible. They should already have trained for hypertrophy of muscles that are required to establish the right amount of muscle mass for their event. Because of this they may in fact do less hypertrophy gym work than an intermediate level developing athlete.

Never underestimate just how much an athlete can improve in the gym over a long period of time. As long as people train smart and vary the program it is possible for athletes to make huge improvement in strength- power and therefore speed over a long enough period of time.

Power Development

It is important for kids to develop their ability to be bouncy - their elastic ability. The majority of kids used to play jumping games i.e.. skipping, hopscotch, fly etc. In the schoolyard often these games were played in hard leather shoes on concrete with hardly any consideration of shin injuries because they were most likely very rare.

Kids naturally learn to skip quite young and love to just do it instead of walking or running. I have watched my son as a toddler happily skipping spontaneously on many occasions. It is this attitude of "plyo play" that we need to expand on.

All bouncing activities develop the ability of the muscles to store energy elastically. It also improves the nervous systems co-ordination of similar activities. A kid that never plays these games or "bounces" in play will most likely never develop the elastic qualities as an adult to as high a level as his peers who did plenty of bouncing as children.

Typically running athletes with superior elastic abilities are the fastest. Even in endurance running events the winners are often the athletes with the best finishing kicks. Recent research has also shown that plyometric training increases endurance running efficiency meaning that athletes can run at a given speed with a lower energy cost.

The Principles of Plyometrics

From a physiological basis, if a muscle is pre-stretched or made to build up high tension, it will concentrically contract with a much greater force. Like when you flick an object with young finger after pulling the finger back and then releasing the tension. Plyometrics make use of this factor. The key in performing plyometrics is that the response from the ground must be immediate otherwise the exercise turns into a concentric contraction and does not involve the stretch reflex.

The theory behind plyometric training is to develop efficiency in the stretch/shortening cycle of muscle action. During the stretch (eccentric lengthening phase) of muscle action, a greater amount of elastic energy is stored in the muscle. This elastic energy is then re-used in the shortening (concentric) muscle action that follows, to make it stronger. The key is to shorten the switching time i.e. the time it takes for the muscle to change from the eccentric lengthening phase to the shortening work phase. The fundamental principle of plyometric

training is that it is the rate, not the magnitude, of the stretch that determines the utilization of elastic energy and the transfer of chemical energy into mechanical work. This means that this type of training does not need to be done in high volumes but instead it needs to be performed at manageable intensities of impacts.

Introducing Plyometric Training

Balance & Stabilization Tests and development of Basic Strength especially eccentric strength should come before serious plyometric training. Without adequate levels of eccentric strength, rapid switching from eccentric to concentric work becomes very inefficient. It is possible to evaluate eccentric strength through stabilization jump tests and observation of basic jumping exercises. A muscle contracts eccentrically when it acts as it lengthens to slow down the rate of muscle lengthening. e.g. when someone jumps vertically and lands their quadricep muscles contract eccentrically to prevent the athlete from falling to the ground. The quadriceps resist the downward motion by acting to try to keep the legs more straight. Concentric strength is the ability to contract a muscle to shorten it and apply a force to move a bone.

What to watch for during Plyometric exercises:
- If slow switching from eccentric to concentric work is observed, then eccentric strength levels are inadequate. Quick contacts displaying a rapid change of direction are essential.
- The foot strike must be on the full foot in order for the foot to help absorb the shock. It is incorrect to land completely on the heel or on the ball of the foot.
- The shock of the landing should be absorbed by a combination of the ankle, knee and hip joints working together that will absorb the initial shock of landing and transfer that force throughout the body's muscles.

Athletes should progress carefully with Plyometric Training. The method below was recommended by Vern Gambetta.
A/ Landing exercises
Standing long jump with two foot landing emphasis on "sticking" the landing. Athletes aim to land quietly on the full foot and absorb shock by bending at ankle, knee and hip. They could make progress to landing hops in a similar way. These training exercises improve eccentric strength.

B/ Stabilization jumps
Similar to landing exercises but hold for 5 seconds before initiating another hop or jump. When athletes can stick and hold 3 jumps progress to be able to stick and hold 3 hops on each leg.

C/ Jumping Up.
Jumping up onto a box (not down).

D/ Bouncing Movements in the one place
Ankle-bounces progressing to tuck jumps with quick contacts. It is important to perform them with an erect torso, good balance and by landing in the one place.

E/ Short Jumps
Start with 3 consecutive standing long jumps with two foot take off and landing.
Athletes could progress to 5 jumps, then to going up stairs jumping every second stair.
Eventually they should aim to perform single-leg hops and build up to 10 hops. Aim for a cyclic action of hopping (using an active foot-strike).

Moving past this stage of development should not be rushed. To avoid injuries and for the exercises to be most effective it is important to learn to perform all movements technically very well.

F/ Long Jumps
Aiming to add more horizontal velocity. Develop the technique of alternate leg bounding and of single leg hops. Carry out 10-20 contacts.

This is as far as most athletes may need to progress. A program should be designed that has a variety of jumps from all stages. They should be performed within a range of volume and intensity that is suitable for the athlete.

G/ Shock (Depth) Jumps
To raise power to the highest levels shock jumps can be used. This consists of jumps off boxes or rebound jumps over hurdles placed at mid-thigh height or higher. The training stress is high and this method should not be used with beginners of any age. Jumps over hurdles is a common method of plyo training BUT it is important to recognize that this is an advanced form of plyometrics. The intensity of the shock is proportional to the height of the drop.

Some Plyometric Activities

Bounces over 104cm plyo hurdles

Alternate leg bounding from a standing start

4 bounds & a jump into a sandpit from a standing start. We usually do up to 5 attempts. When alternate leg bounding the athlete needs to strive to stay upright , have a high knee action, flat footed active contact and a vigorous arm action. With most alternate bounding the athletes strive for maximum distance and the total distance is measured noting improvement throughout the year. These are performed in racing flats on a Mondo surface and we have not had any problems with injuries from it. Almost all plyometrics is done in racing flats or light trainers- the only exception is speed bounding.

Athletes in my squad have recorded distances up to 15.0m with 4B+J.

Alternate leg bounding from a running start.

4 bounds & a jump into a sandpit from a 5m, 10m or a 8 stride run-upt. We usually do up to 5 attempts. Running start bounds are more advanced and the athlete needs to have a more active & quicker contact with the ground. As the athlete reaches higher levels they may occasionally do 9 bounds & a jump from a 8 stride run-up.

Running & bounding up short hills on grass.

Running & bounding up hill is great conditioning for more intense bounding and can be a safe way to work the glutes very hard without stressing the lower leg to the extent that any other kind of plyometrics can. We often do repeats of 60m up a grass hill where the athletes run 20m then bound 20m and then run 20m - repeating this 10-20 times with a few minutes rest in between reps.

Hurdles bouncing with double leg

This is very valuable activity but athletes need to progress slowly to greater heights while maintaining very quick contacts. It is very common to see people doing this activity over hurdles that are too high and the athlete is collapsing and therefore jumping not bouncing over each hurdle. We do 8 sets of 3 hurdles and make certain that athletes are doing them with quick contacts. We do them in flats over plastic plyo hurdles on mondo. The most advanced athlete who is strong in the gym has been able to bounce over 3 at a height of 104cm. Athletes can aggravate their knees with this activity if they progress to quickly and collapse foward on impact. The solution is to start low and be quick off the ground.

Hops over hurdles with 2 strides in between

This is a very high intensity exercise that should only be done by athletes who have great stabilization strength and have high levels of eccentric strength. The athlete hops over a plyo hurdle and lands with an active foot then takes one stride with the other leg and then on the next foot contact with they hop again over the next hurdle. They hop on the same leg usually over 3-4 hurdles. Each contact should be powerful and active. We usually do 3 sets of 4 hops with each leg. I have a sub11.80s 100m female athlete who can do these over 105cm.

Hurdle bouncing with single leg

This is even more intense than hopping with 2 strides in between. Few athletes will be strong enough eccentrically to be able to bounce very high at all using the same leg over plyo hurdles. This activity tends to cause contact times to be arguably too long to be as beneficial for the athlete as many other activities. It may stimulate increases in eccentric strength more than anything else and be great for Triple Jumpers. If you try this I recommend that you keep the height of bounces low and insist on contact times being very quick.

Speed bounding

Speed bounding involves the use of alternate leg bounding but values both speed and distance. The athlete bounds rapidly over a set distance usually of either 20m or 30m. An observer counts the number of strides required to bound the set distance and also records the time to bound the distance usually starting the watch from the athletes first movement. The speed bound index can be calculated by mutiplying the number of strides by the time in seconds. With my squad I usually count strides to the nearest quarter and time to the nearest tenth. eg over 30m a sub11.80s 100m female has covered the distance in 4.24s and with 12.75 strides. This is a score of 4.24 x 12.75 = 54.1

Speed bounding from a running start

This is the same as the above with the added stimulus of a running start usually of 10m or 8 strides. Athletes who are just strting speed bounds from a running start can start with a 5m start. The running start causes the contacts to be much faster which is more difficult for the athlete if they are not powerful, but the activity is much more specific to maximum speed sprinting. An example of a score is with a female sub11.80 athlete who has done 4.37 x 11.0 = 48.0 for a 10m running start and 30m of speed bounds.

Speed hopping

Speed hopping over a distance of 25m is an activity that athletes can also perform. The aim is for the athlete to cover the distance as quickly as possible and the time is recorded from the first movement of the athlete. Speed hopping is very much a skill that the athletes need to learn. We usually only do a maximum of 3 repeats of a 25m of speed hopping when we use it.

Periodization

The athletes in my squad use a variety of Plyometric activities throughout the different phases of the year:
Hypertrophy/Conditioning Phase - Alternate Bounding from a standing start, Standing Long Jump, Hill running & bounding
Strength Phase - Alternate Bounding from a running start, hurdle bouncing double leg, hopping with 2 strides between,
Power Phase- Alternate bounding from a running start, speed bounding, hurdle bouncing double/single leg, speed hopping, 4 bounds
Conversion/Maintenance Phase - speed bounding from a running start

During the power phase an example of a typical dedicated plyo session for an advanced athlete is:

Warmup (Mixed)
Speed Drills
6 x 3 hurdle bounces double leg (alternating with a light weighted vest 3kg & using no weight)
3 x Hops with 2 strides between over 4 hurdles each leg
3 x 25m speed hops
Warmdown

The use of speed bounds is usually integrated into a track session.

Some bounding can be performed in the Gymnasium eg 3 sets of 2 x 4 alternate leg bounds These are often done as part of a power circuit and we have mostly done them straight after performing a set of 4 quarter squats.

Competition and Plyometrics
We usually reduce the amount of plyometrics or cease it all together during the peak competition period because it is very challenging to the nervous system and can very easily produce periods of flatness that will negatively effect performance in competition.

Improvement of Technique

There is only one way to develop good technique and that is to practise perfecting it. It also means avoiding practising bad habits because that is counterproductive. However developing athletes usually do not have the strength to run with perfect technique so there is a problem. The solution is to design training to minimize the opportunities to be practising bad habits and to maximize the training that develops good technical habits. The guidelines below may be helpful in creating this situation.

Guidelines for Improving Sprinting Technique.

- Practise sprinting mostly over short distances. >15.0s runners over 30m, 15.0s runners should do sprints over 30-40m, 13.0s runners over 30-50m, <12.0 runners over 30-60m etc.
- Make use of flying start sprints where the relaxed acceleration is followed by a short period of maximum speed sprinting.
- Practise sprinting at maximum speed only when fresh and not more frequent than every 72hrs.
- Perform maximum speed sprinting only in volumes that allow the highest quality of running to be evident. Stop after the first significantly slower rep or have a much longer rest. e.g. 2 x 3 x 30m sprints
- Rest between reps 3-8min
- Practise sprinting with perfect technique at sub-maximal efforts.
- Perform drills perfectly or avoid doing them until learned properly. Do them in short perfect segments.
- Combine drills with sprinting e.g. 3s high knees cycling drill accelerating into a normal run while maintaining the same body position and height.
- Develop the required specific strength so that the athlete can improve body position.
- See all run throughs in the warm-up as opportunities to practise running so that it can be perfected.
- Avoid racing fatigued and don't over-race. Either do it really well or don't race.
- Use regular video analysis of technique doing every aspect of training. Use it to learn how to shape better habits.
- Be patient and keep shaping the athlete's technique. It will take years.

Endurance Development

Some ideas for developing General Endurance

- Long Bushwalks - occasional events - great overall conditioning plus good mental training.
- Circuit Training - maximum variety of exercises - possibly competitive.
- Speed Ball - performed for fun
- Med ball exercises - maximum variety of exercises
- Cross country running - running easily to see the scenery quicker than walking, maybe simply run and walk.
- Playing team sports - great development as long as movement quality is valued and athletes are not expected to play slightly injured.
- Play activities - swimming, cycling, skateboarding, rollerblading, ice skating, roller skating, skipping, paddling, rowing, dancing etc.

Specific Endurance Training

Once an athlete has acquired a good background of general conditioning which would mean they have a few years of accumulated activity, then they can more exclusively work at training specific endurance. However even at this stage athletes need to periodically perform more general endurance training and this is usually done in the first stage of any buildup period.

A variety of concepts to do with specific endurance are introduced below:

Speed Endurance

Sprinting over any distance further than that required to accelerate to maximum speed involves speed endurance. An athlete can maintain absolute maximum speed for no more than about 3 seconds. In developing athletes it is probably no more than 2s. It takes a most athletes about 5s to reach maximum speed which is somewhere near the 30-40m mark. They can the then hold maximum speed for about 20m before there is a gradual decline in running speed. This means that the last 40-50m involves a gradual deceleration from the absolute maximum speed that is reached. If the athlete loses form dramatically near the end there can even be a rapid drop in speed in the last 20m. Elite male sprinters reach their maximum speed at closer to 60m and then hold it for 20m before losing speed over the final 20m.

The endurance that needs to be developed to improve performance in the 100m for developing athlete is the endurance of (near) maximum speed. There is however a big problem in this area of training for all sprinters. Most training that aims to improve endurance of near maximum risks "habituating" a slower maximum speed. e.g. When an athletes does 4 x fly60m sprints at maximum effort with 2min rests they are doing a speed endurance session. The theory is that the nervous system in this session gets 4 experiences of what it processes is the athletes absolute maximum speed. This potentially can cause a drop in the athletes effective maximum speed when they are fresh. Because of this conflict in training many coaches of elite athletes choose to focus firstly on developing maximum speed to a new higher level and then they train to put the required amount of speed endurance training at a corresponding higher speed on top of it as the major race season approaches. For some athletes the primary way that speed endurance is developed is in races only. This explains the growing breed of specialist 200m athletes as athletes that are focusing more effort on developing speed endurance at the slightly lower speeds evident in the 200m event. But because of the lower amount of maximum speed focus these athletes can have a lower standard of performance in the 100m than what is possible for them. They have however made their choice and in some cases it is a very good one.

Developing athletes should do only a small amount of training for endurance of maximum speed. It is best to gain the required speed endurance simply from races over 100m and

200m. It is important in doing it this way that athletes aim to maximize the quality of their performance. This means not racing too often or when tired. When athletes focus directly on improving speed endurance by the use of speed endurance sessions they will likely be improving short term speed endurance at the expense of developing more maximum speed during that training period. Plus they will also be most likely "training in" bad habits that will limit the athletes long term development and increase the risk of injury. It is best to cycle between periods of maximum speed development and speed endurance development with any athlete. With developing athletes it is best to hold as the highest priority the goal of avoiding training bad habits and maximizing opportunities to acquire good ones.

It is possible to train to improve endurance of near maximum speed indirectly by working to improve the athletes strength, power and their ability to hold good running form when fatigued. 100-200m reps performed at sub-maximal speed while holding a good sprinting position will help athletes stay in a faster position while fatigued in races. Doing some sprint drills perfectly over longer distances than usual may also help to improve the endurance of good running form.

It is most important to always maintain focus on improving form and in developing steadily the maximum speed of the athlete. Performing training with the aim of developing endurance of high speeds always risks compromising this path.

Sub-maximal Speed endurance

Training to develop endurance of speeds lower than maximum avoids some of the problems outlined above. However it is very important than an athlete rarely practises in a situation where there is loss of form. Young athletes lose form very easily because of their relative lack of stabilizing strength as the athlete develops strength this should grow to be much less of a problem. Training at the various speeds that are raced over 400-1500m is appropriate. It is better to focus on shorter repetitions in training because athletes are able to maintain good form much easier for all of each run if the distance is kept short. As the athletes improve in ability to maintain good form it is then appropriate to perform training repetitions over progressively longer distances. 100m-150m runs are great to use with many athletes e.g. 4 x 150m rest 5min focusing on 400m pace. These can be performed starting and finishing in a variety of places on the track. This is a better session than having an athlete attempt 2 x 300m at 400m race pace because they will likely lose running form at about 200m & practise bad habits for the last 100m. It is often best with athletes to allow plenty of recovery so that high quality of movement can be maintained. It is best to teach that the primary goal of tempo training is to practise running smoothly and is not simply suffering to improve fitness.

I have seen that it is possible for early stage developing athletes to improve their 400m performance a large amount by improving maximum speed, relaxation/rhythm at race pace, general endurance, overall strength and plyometric ability. Training regularly for specific endurance by activating the anaerobic system fully is something that is not necessary for athletes in the early stages of their development. When really wanting to put the icing on the cake in the peak of the comp season a great short session could be something as simple as 2 x flying start 150m or 200m runs with a 3min rest between reps. This may only need to be done 2-3 times in a season combined with maybe just 6 good quality 400m races for a early stage developing athlete to perform with a good result in a 400m race.

In conclusion, it cannot be emphasized enough the importance of seeking to develop relaxation and rhythm at race speeds without fatigue effecting movement patterns. However that does not mean it is not desirable to perform killer sessions when they are mature enough from good conditioning to be able to complete the sessions in the right way.

Advanced athletes

More advanced athletes can do a greater volume in their relaxed tempo sessions. My squad often perform 2-3 x 300m reps about 3-4s slower than maximum speed. They are run in a relaxed way with 10min rest between reps.

They can also do a greater amount of training during certain periods that is aimed to

developing endurance at near maximum speed. One session we have used often has been 2-3 x flying start max effort 80m runs - done with a 2-3min recovery period.

More 400m ideas will follow in the next few sections of this book.

An Introduction to 400m Preparation

The one thing successful 400m athletes have in common is that they have to be aggressive and tough. But there are great extremes of variety in the way that 400m athletes can be prepared. Athletes can be 200/400m types such as Cathy Freeman or Michael Johnson or 400/800m types like Jearl Miles-Clark or Alberto Juantorena. Some also may be pure 400m specialists with balanced ability over 200m & 800m like maybe Anna Guevara or Felix Sanchez.

Athletes when racing the 400m event need to be able to run at a high percentage of their maximum speed for a prolonged period. A pace analysis of the World Championships in 1999 showed that Michael Johnson's maximum average speed over 50m was 10.09 m/s where the maximum speed reached by Maurice Greene in the 200m was 11.09 m/s & in 100m was 11.90 m/s. This means that Michael Johnson needed to use over 85% of his maximum speed during a 400m race and he was still running at an average of 9.54 m/s between 200m & 300m. This is still over 80% of his maximum velocity. Improving maximum speed in any athlete can improve their ability to maintain speed in a 400m because they will have more speed in reserve. However maximum speed training comes with a greater risk of injury than slower endurance work. Maximum speed training is also much more taxing on the nervous system producing flatness that can effect the quality of sessions that follow in at least the next 48hrs. It may also be of interest that the maximum speed averaged over the fastest 50m segment of a 400m race can easily be reached within 25m of maximal acceleration. This means that regular 30m sprints from a standing start can be effective at developing the levels of speed required for the 400m event.

There is however, much more to improving the ease of an athletes speed than expanding maximum speed. Many 400m athletes tend to have longer strides coming from more power. This means they tend to get more of their speed from stride length rather than high stride rates. This makes sense scientifically as high stride frequencies will be more taxing on the nervous system and may require more energy especially from the upper body which will be more difficult to relax at higher rates. Stride length can be improved in a variety of ways by the smart & consistent use of weight training, plyometrics & hills. Ideas for these areas of training have already been outlined in this e-book.

Some may argue that Michael Johnson is a big exception to the theory of 400m athletes focusing on stride length. Michael Johnson tended to maintain very high stride frequencies throughout the entire 400m event. He did this by having exceptionally short contact times with the track and probably by doing so was able to lose less energy on each impact than the other athletes. Michael Johnson also had a surprizingly long stride which came from extremely high levels of power.

Minimizing wasted energy due to over-striding is worth working on with any athlete. Over-striding occurs when athletes contact the ground too far forward. Over-striding results in a jolt through the body that can cause injury and results in an excessive loss of momentum during the first instant of ground contact. One simple way to decrease over-striding is to find a slight downhill slope and have the athlete run down it aiming to run smoothly by minimizing the feeling of impacts that occur. This can be achieved by intentionally aiming to contact the ground further under the body. The effect of over-striding will be magnified for the athlete & they will easily be able to learn how to adjust the position of contact in a way that has the desired effect. They should do maybe 2 sets of 3 x 50m hills with 2 runs on the flat after each set. Doing this simple session regularly should produce a noticeable decrease in the extent of over-striding. The most common time for an athlete to over-stride is at the end of a 400m race so it is worth doing some work on the track when fatigued to optimize the athlete's ability to finish most effectively.

Developing high levels of endurance is very important for the 400m event but it is essential that it be based on developing endurance of race speed. The ability to be able to run the first 200m fast & be able to not blow up in the closing stages is very much related to the amount of

speed the athlete has in reserve in the first 200m and then the speed endurance to maintain a high percentage of that pace. Endurance that is developed at slower paces uses different running biomechanics & is limited in its transfer to the 400m race. General conditioning is of great value but is essential to perform appropriate specific work at the right pace & also simulating conditions of race like fatigue. 800m athletes have highly developed speed endurance at their race pace but if you put them in a 400m without specific race pace work & without having them race some 200m events. Then their performance at 400m will likely be below what is expected. They also will have a weakness in being able to compete against 200m types in an aggressive race. The faster 200m type athletes will often blast the first half of the race & blow up in the final straight. 800m type athletes would be expected to finish strongly but since they are slower in maximum speed capacity they are more fatigued by the fast early pace & often waste their finishing advantage in trying to stay with the faster 200m type athletes early in race. This fact suggests that the best type of athlete to be is the 200m type athlete as it presents them with more options in terms of pacing the race.

An important exception to the event favoring 200m type athlete is when the athletes need to race in major championships and endure up to 4 rounds of competition. This situation rewards the athlete with the best ability to back up. Less well conditioned athletes will struggle both in terms of physiological performance deterioration & with having legs that are sore. The best way to avoid these problems is by making sure the athletes have built a bigger base with higher volumes of training. There are many athletes from a 200m background who can run a brilliant single 400m race with minimal training. But if you try to get them to race multiple races in a major championship they are often so sore the day after a fast race that there is no way they can excel in major championships.

There are many varieties of speed endurance training. It is important to train with a balance of the different varieties. It is not near as simple as just running at race pace with short rests until highly fatigued & expecting optimal gains in performance. My preferred method is to improve biomechanics and ease of race speed first. This is done with tempo runs at race pace performed with low levels of accumulated fatigue as well as maximum effort acceleration work over 30-40m. The athletes can then expand how far they can sustain 400m race speed by performing longer repetitions with longer rests. This works at boosting the amount of energy supplied by the Lactic Anaerobic system. Then the athlete can work at maintaining running speed when experiencing high levels of acidosis. This is best done in low key races & with smart use of lactic tolerance work at training. Lactic tolerance training is typically fast short repetitions with short rests. It is often over used with athletes & can produce rapid gains initially but it should be regarded as the icing on the cake.

The next article will include discussion of a variety of sessions performed by some well known 400m athletes.

Training Methods of some Elite 400m Athletes

There are many ways to prepare for the 400m event. This article will outline some of the methods used by some well known Athletes.

Australian Moscow Olympic Silver Medallist Rick Mitchell (44.84s) prepared in a way that was designed to prepare him to cope better with multiple races in major championships. His training was aimed at one peak a year. Early in the year his training included a lap of Melbourne's "Tan" which is a 2.5 mile lap before the main part of his training session. He sometime did 2-3 laps. Rick trained 6 days a week. Some main sessions performed in the first phase of the year were:

- 10 x 400 with short recoveries (building over the months to 57-58s with a 100m walk recovery)
- 2 x 400 2x 300 2 x 200 2 x 300 2 x 400 with short recoveries
- 8 -10 short hills (Hills were performed for the first 6 months of the training year)
- 6 x 400m hills
- 6 x 200m hills
- Time Trials over 2min

Sessions mid year included:

- 3 x (100 - 150 – 180) with walk recoveries and performed at 95% with 400m walk between sets.
- Time Trial 2 x 500m with first 400m in 49s rest 20min
- Time Trial 2 x 300m rest 20min or 3 x 200m rest 20min
- Time Trial 600m
- Fartlek - 2.5mile easy 2.5 mile hard 2.5 mile easy
- Continued with many of the same track sessions as earlier in the year.

Early Competition period included:

- Racing almost every weekend. Rick often raced 15 100m races, 20 200m races, 15-20 400m races & 2-3 800m races in a season. At every meet he would compete in multiple events & relays, he considered this to be his speedwork. Very little training was performed ever at a speed above what would be evident in a 400m race.
- 100-110-120-130-140-150-160-170-180-190-200 with walk recoveries.
- Starting at 350m to go. 60-90-120-150-180-210-240-270 with a walk back to the starting position. This session is great for experiencing the feel of the main part of a 400m race.
- 6-8 x (200-100) with a short rest between reps and a longer rest between sets.
- Some flying start 100m runs.
- Small amount of block starts and rarely maximum speed sprinting during training.

Major Competition preparation period

- Involved performing training simulating the race structure of the 4 rounds of competition.

Sydney Olympic Champion Cathy Freeman's Training is more sprint based than Rick Mitchell's but there is still a great amount of time spent building a base. Cathy's preparation for the Sydney Olympics started 18 months out from the Games in April 1999. She had 2 short periods of Racing 13 & 8 months out from the Olympics.

During a 3 month General Preparation period some of her training consisted of:

- Hypertrophy weight training sessions 3 times a week.
- 2 hill sessions a week.
  - 6 x 140m moderate incline hill on grass with a 4min rest.
  - 4 x 180m steeper hill on bitumen rest 8min then some shorter hills.

- Aerobic training such as
  - 5 x 3 x 200m rest 30s/ 5min between sets or 2 x 4 x 300m rest 100w between reps
- Longer faster reps such as
  - 6 x 400m rest 6min or 500m 3min 2 x 300m 100w 3min 4 x 200m 1min
- Faster shorter reps such as
  - 2 x 4 x 150m rest 3min / 7min between sets 8 x 200m rest 2min
- Pool recovery session

Minor Competition preparation 8 months before Olympics consisted of:

- 2-3 weight training sessions a week – more strength based.
- 1 hill session most weeks of something like 6 x 140m moderate incline hill on grass with a 4min rest.
- Some faster speed development work e.g. 6 x 100m in & outs, 2 x 150m fast relaxed
- Some starts, resisted & assisted work once a week for a month.
- Lactic tolerance e.g.
  6 x 200m with diminishing rests 5-4-3-2-1min or
  300m 1min 150m 10min 200m 1min 120m 8min 200m 1min 120m or
  500m 2min 120m 10min 400m 2min 120m 8min 300m 2min 120m 6min 200m 2min 200m
- Race 3 weeks in 4 in the main month.

Specific Preparation 5-7 months before Olympics consisted of:

- 3 strength based weight training sessions a week
- 2 Hills sessions (same as in General Prep)
- 1 session a week of Plyometrics & Speed
- 1 session a week of faster e.g. 3 x 3 x 120m rest 3min/6min
- Speed Development e.g. 4 x 30m, 2 x flying 30m, 6 x 120 in & outs with full recoveries.
- Longer reps e.g. 500m 8min 400m 6min 300m 4min 200m
- Lactic Tolerance e.g. 3 x (300m 1min 150m) 10min between sets
- Swiss Ball & Pool session once a week

The weekly structure was usually
Sunday- Steeper Hills
Mon - Plyo & Speed then weights
Tue – Faster shorter reps
Wed – Hills then weights
Thu – Speed Development
Fri – Pool session & Swiss Ball
Sat – Long reps or Lactic Tolerance

It is interesting to note above that her speed development & faster speed endurance sessions were conducted the day after a hill session. Hill sessions involve longer ground contacts, lower stride frequencies & therefore less nervous system stress. This should result in hill sessions not producing flatness the next day when conducted in volumes that the athlete performs regularly.

The Early Competition Phase leading into the Olympics tended to follow a pattern something like:
Day 1 Speed Development & weights
Day 2 Fast Lactic Tolerance short reps
Day 3 Faster Tempo or Time Trial e.g. 350m & sometimes weights
Day 4 Easy
Day 5 Warmup
Day 6 Race or Lactic Tolerance e.g. 3 x (300 rest 1min 150m) 12min between sets.
Day 7 Rest

No sessions totaled in this period more than 1500m of reps.
Some examples of sessions performed were:

- 6 x 200m 5-4-3-2-1 in between 24.6 & 26.4s from a slow rolling start.
- 4 x 200 walk 80m flying 100m 10min between sets in about rolling start 23.5 & flying 11.9
- 6 x flying 100m walk back in 10.8-11.3
- 4 x 150m rest 4min in about 17.0 15min then 4 x 120m in about 14.0s
- 2 x 300m 7min 36.6, 37.1 rest 15min 200m 23.9 5min 200m 24.7 2min 200m 26.1 10min 3 x 120m relaxed
- Blocks to 350m in 43.9s

The most specific sessions that a 400m athlete can do that will have a big impact on 400m racing are doing fast short runs in pairs. Darren Clark who was Commonwealth Champion in 1990 & Olympic Finalist in 1984 & 1988 was able to perform sessions such as:

- 300m (35.0s) rest 2min 300m (35.9s) 30min recovery 200m (21.4s) 2min 200m (21.7s)
- 300m 20min 200m 20min 200m in 33.2s, 21.2s, 20.4s from rolling starts
- 3 x 300m full recovery from blocks 32.9s, 33.6s, 33.3s

There are a great variety of sessions and training plans that can be implemented with 400m athletes. It certainly depends very much on the type of athlete. Rick Mitchell might not have been able to back up as well as he did through four rounds of competition if he had been prepared with Cathy Freeman's training program. Cathy may not have developed adequate speed to run as fast as she did if she used a program like Rick Mitchell's. The main thing is that the 400m event should not be prepared for with too big an emphasis on lactic tolerance type training. The athlete needs to develop economy at race speeds, good general conditioning & the strength to be able to maintain good running form when highly fatigued.

Alberto Juantorena who won both the 400m & 800m events at the 1976 Olympics and had personal bests of 44s & 1:43. His training consisted of a variety of work with a moderately high volume performed. He like Rick Mitchell was exceptional at being able to backup in major championships. At the 1976 Olympics his performances were as follows:

Friday
800m heat 1:47.14

Saturday
800m semi 1:45.8

Sunday
800m final 1:43.5

Monday
- morning 400m 1st round 47.8
- afternoon 400m 2nd round 45.92

Tue - rest

Wed
400m semi 45.10

Thu
400m final 44.26

Fri
4 x 400m heat 45.8

Sat
4 x 400m final 44.0

For the 1976 Olympics some of his training consisted of:

General Preparation - 8 months before the Olympics
Monday
Warmup plus exercises
Fartlek total 13km

Tuesday
Warmup plus exercises
Weight Training
3 x 5 x 200m in about 23.8s

Wednesday
Warmup plus exercises
3 x 100m accelerations
4 x 1000m in about 2:35

Thursday
Warmup plus exercises
2km cross country then 3 x 3 x 400m then 2km cross country

Friday
Warmup plus exercises
Weight Training
3 x 5 x 200m in about 23.6s

Saturday
Warmup plus exercises
3 x 100m accelerations
1000+500+1000+500
in about 2:41 and 1:04

Alberto Juantorena's strength was the power of his stride reported to be 3.0m which was developed clearly from his use of weights and hill bounding or skipping. His training consisted of a high volume of fast work combined with solid cross country running over relatively (for distance athletes) short distances.

Competitions were spaced 8-20days apart in the 3 months leading up to the Olympics. This was so that intense training could still be maintained. He also spent 4 weeks training at 2400m in Mexico.

Special Preparation - 4 months before the Olympics
Monday
Warmup plus exercises
2km cross country
5 x 350m
6 x 200
5 x 200 skipping or bounding
2km cross country with uphill skipping or bounding

Tuesday
Warmup plus exercises
3 x 100m accelerations
3 x 30m starts from blocks
10 x 200m in about 23.6s

Wednesday
Warmup plus exercises

3 x 100m accelerations
5 x 600m in about 85.6s

Thursday
Warmup plus exercises
9km cross country

Friday
Warmup plus exercises
Special exercises including over hurdle bounces
3 x 100m accelerations
3 x 30m starts from blocks
8 x 200m in about 23.18s

Saturday
Warmup plus exercises
3 x 100m accelerations
3 x 100m from blocks
2 x 600m then 2 x 400m
in about 81.9 and 48.2

Immediately prior to the 1976 Olympics training was as follows:
Tuesday
4km cross country
2 x 10 x 150m
1km cross country

Wednesday
4 x 100m accelerations
3 x 500m in 63-64s

Thursday
Rest

Friday
3km cross country
2 x 10 x 150m
2km cross country

Saturday
1km cross country
4 x 100m accelerations
3 x 600m 91, 81, 79

Sunday
4km cross country

Monday
200m in 21.4s
300m in 34s

Tuesday
Warmup like competition
600m in 79.3s rest 15min then 600m in 75.9s

Wednesday
5km cross country

Thursday
Rest

Friday
1st round of 800m

For Extra Information about Training Methods see the Michael Johnson supplement on page 58

Developing 400m Athletes – A Yearly Plan

400m athletes need to practise all year with good biomechanics at the speeds they reach in a race. The best way to do this is with a double periodized year. This is because it will allow short phases that focus on improvement of a target area without ever staying away from any quality long enough to lose it. What follows is the outline of a yearly plan for what would be a 200m type 400m athlete:

44 weeks
Conditioning Phase A 8 weeks
Every 4th week is recovery.

Weight training
Weight training initially targets hypertrophy & general conditioning. It is usually performed 3 times per week. Interestingly when athletes lift in sets of 8-10 they stay much fresher in terms of their nervous systems than later in the year when they are lifting more intensely with sets of 3-4. This means that during the conditioning phase it is much easier to perform quality running without it being effected by flatness from the weight training sessions. Late in the phase sets should be decreased from maybe 3 sets of 10 to 3 sets of 8. Athletes should lift upward fast & down slow, they should not lift to the same tempo as a body builder even though the aim of this phase is to attain some muscular hypertrophy.

Plyometrics
Plyometrics should aim to develop power with the longer contact varieties. Standing start bounding e.g. 4 alternate leg bounds & a jump into a sandpit can be performed. Standing long jumps & standing triple jumps can also be performed.

Hill training
Hill Training can be performed over distances of 60-200m and some can involve alternate leg bounding. e.g. run 60m bound 20m. A common session could be something like 4 x 5 x 80m hills with 20m bounding 40m run 20m bounding with rests 90s between each and 5min between sets. The bounding sections can be steep. Another good session would be 6 x 140m with a 4min rest performed on a moderate slope. It is a good idea to perform two different hill sessions on alternate weeks.

Easy Tempo
Athletes should perform 1-2 relaxed tempo sessions on grass per week totaling about 2200m in each session. It is essential to keep tempo sessions slow so that they do not effect the quality of training the next day. This means running at no faster than 75% of maximum speed for the distance. A good tempo session may be something like 2 sets of 11 x 100m with a set of pushups & crunches before each rep. Athletes can rest after each run for 30-60s then start the exercises & have 5min between sets.

Aerobic Development
Should consist of moderate to fast paced 4km runs performed after a warm-up & then followed by a warm-down. This could be extended to 8km occasionally. These runs could be performed 4 days a week & sometimes be combined with a hill session.

Speed development
Speed development initially focuses on improving performance over 30m from a 3 point start. Usually athletes will find that improvements in strength, bounding & 30m times will happen concurrently throughout the phase.

Speed Endurance
Speed endurance should mostly consist of sessions of longer moderate paced sessions (total volume up to 2000m) e.g. 500m-400m-300m-200m with 5min rests or aerobic development sessions (total volume up to 3000m) such as 3 x 3 x 300m rest 1min with 5min between sets.

The week may look something like this:
Mon
– Speed Development
- weights
Tue
– Relaxed Tempo
- 4km run
Wed
– Speed Endurance – longer reps
- weights
Thu
- 4km run
Fri
–Relaxed Tempo
- weights
Sat
- Plyometrics , Hills & 4km run
Sun
- rest

Strength Phase A 6 weeks

Weight Training

Weight training changes to smaller sets e.g. 3-5 sets of 3-6 reps to target the development of maximum strength. This move can easily negatively effect the quality of running that can be performed the next day. It is ideal to be able to do fast track sessions in the morning & then weight training straight afterward. In this way it is easier to balance the recovery in the week to maintain quality in faster track sessions. Weights should be continued 3 times a week.

Speed Development

Speed Development work should be expanded to include as well as the 30m runs longer ones where the athlete is relaxing & surging (in & outs) at 400m race speeds over 80m-100m. It is important to aim to do only as many sprints as they can perform with quality at maximum effort. Make sure the athlete can back-up from the session to the next one & still perform with good quality. If the athlete is finding that they can't back-up for the next session then do less volume , do the runs sub-maximally or do less stressful weight training sessions. Balancing this area is one of the biggest challenges when coaching 400m athletes.

Plyometrics

Plyometrics should progress toward varieties that have shorter duration ground contacts. A good way to do this is by performing running start bounding. e.g. 10m running start then 4 alternate leg bounds & a jump into a pit. They should continue to do longer contact bounding as well. Plyometrics should be done once a week.

Hill training

Hill training should stay the same as in the previous phase at once a week. It's a good idea to have two different sessions that can be performed.

Easy Tempo Sessions

Athletes should continue performing 1-2 simple tempo sessions on grass per week & total about 2200m in each session.

Aerobic Development

Should continue to consist of moderate to fast paced 4km runs performed after a warm-up & then followed by a warm-down. These runs could be performed 4 days a week & sometimes be combined with a hill session.

Speed Endurance

Speed endurance should consist of some sessions of

- Longer moderate reps (total volume up to 2000m) e.g. 5 x 400m rest 5min

- lower intensity lactic tolerance sessions (total volume up to 2000m) such as 8 x 200m rest 3min with 5min between sets or 3 x 3 x 200m rest 1min/5min
- Some faster work over 100-150m (total volume up to 1000m) e.g. 6 x 100m rest 3min between.

The week may look something like this:
Mon
– Speed Development & faster 100m reps
- weights
Tue
– Relaxed Tempo
- 4km run
Wed
– Speed Endurance – longer reps
- weights
Thu
- Lactic Tolerance lower intensity
Fri
–Relaxed Tempo
- weights
Sat
- Plyometrics , Hills & 4km run
Sun
- rest or 4km run

Power Phase A 4 weeks

Weight Training

Weight training 2 times a week moves toward a power focus. A small volume of strength lifts are maintained. One gym session a week is aimed at developing power with exercises such as:
- stiff legged bounces with a light weight e.g. 20kg
- jump up onto a box with less than 30% of 1RM half squat.
- stomping step ups with less than 30% of 1RM half squat.
- power cleans

These are often done in a circuit type situation with some heavy ¼ squats includes for a contrast effect.

Plyometrics

Plyometrics should progress toward even quicker ground contacts. This is done with the performance of alternate leg speed bounding. These are done with a 10m running start and the aim is to get as much power into the track as quickly as possible e.g. taking the minimum number of strides to go 30m but also in a minimum time. The athlete needs to aim to strike the ground well underneath the body.

Hill training

Hill Training is replaced with small volume fast speed endurance sessions e.g. 150m rest 8min 150min rest 8min 150m rest 2min 150m.

Speed Development

Speed Development sessions should be expanded to include sprints of up to 60m.

Easy Tempo

Athletes should continue performing two simple tempo sessions on grass per week & total between 1200m-2200m in each session. They should do minimal continuous running.

Competition

Some competition without disruption to the training plan.

Speed Endurance
Speed endurance should consist of some sessions of

- Highest intensity Lactic Tolerance sessions (total volume up to 1200m) such as 3 x (300m rest 1min 100m) with 5min between sets.
- Very Fast work with longer rests (total volume up to 1000m) e.g. 6 x 100m rest 3min between progressing to sessions like 3 x 200m rest 10min between with flying starts.
- Low volume sessions with longer reps or a Race

The week may look something like this:
Mon
– Fast speed endurance work with shorter reps.
- weights bouncy session
Tue
– Relaxed Tempo
- 4km run
Wed
– Speed Development & Technical
Thu
- Lactic Tolerance high intensity
Fri
–Relaxed Tempo
- weights
Sat
- Plyometrics & low volume longer reps e.g. 2 x 450m rest 12min or a competition
Sun
- rest or 4km run

Competition Phase A 3 weeks
Weight training sessions can be performed once a week with a very small amount of a complex lifts just to maintain strength e.g. power cleans as well as ¼ squats are performed to maintain strength.
Plyometrics are stopped to enhance the athlete's nervous system freshness.
Maximum speed sessions are performed of the same variety as the power phase but the emphasis needs to be on racing. The 72hrs leading into the race need to be free of anything that could effect the nervous system on the day of the race. This means almost no intense high cadence training, plyometrics or heavy lifting.
Tempo sessions are performed once to twice a week with 800m-1600m in each.
Speed endurance sessions need to be carefully selected & should never take away from the competitions that will be performed that week.
Competition.- A mini peak of 3 weeks because the main emphasis should be on the extended peak in Competition Phase B. Competition Phase A may coincide with the indoor season.

The week may look something like this:
Mon
– Speed Development & Technical
- Weights - bouncy session
Tue
– Relaxed Tempo
Wed
- Fast speed endurance work.
Thu
- Relaxed Tempo or rest
- Massage
Fri
- Warmup & drills
Sat
- Competition
Sun
- Rest

Conditioning Phase B 6 weeks
Similar to Conditioning B
Main time to focus on longer reps with longer rests & aerobic work

Strength Phase B 6 weeks
Similar to Strength A.
Increase intensity of sustained speed.

Power Phase B 8 weeks
Similar to Power A
Emphasis on speed endurance & repeatable high speed.

Competition Phase B 8 weeks
Mental & physical freshness for races is the highest priority.
Gym once a week should focus on maintenance of strength with a small range of complex lifts.
Speed sessions should focus on technical aspects.
Speed Endurance should be enhanced from appropriate amounts of racing.
Tempo sessions of 800m-1600m should be continued once to twice a week.

Summary
The aim is to perform the following simultaneously as the competition phase approaches during each half of the year:
- decreasing contact times of plyometric activities.
- decreasing total volume of weights & aim finally for improvement in power.
- extending the distance of sprints from blocks.
- decreasing the distance of speed endurance while increasing intensity.
- performing a smart balance of Anaerobic Training.
- decreasing the volume of relaxed tempo sessions.
- decreasing total volume of all training for major races
- build confidence & mentally preparedness for racing with block starts, reaction drills etc.

Tactical Ideas for Racing 400m

The 400m is a sustained sprint. But sprinting at maximum velocity is an energy costly exercise. The key to the 400m event is being able to sustain a high speed for the full distance of the event. This means that running fast while economical is of paramount importance. 400m athletes do this by developing good rhythm at race speed, this means they can run at the pace they want with minimal perceived effort. If an athlete has a great mid-torso strength, endurance & control then they are able to maintain good balance at high speeds with a minimized arm action. This can save energy. They can also save energy by being more relaxed everywhere that is not required for propulsion. Practicing relaxation is essential but it is easy to forget to do when the athlete is more interested in running hard & fast in every training session. The coaches job needs to be to create many opportunities for the athlete to relax & develop good race rhythm throughout the training year.

The best way to pace a 400m race depends on the qualities of the athlete as well as the weather conditions & the competitors. Generally for 200m type athletes it is best to go out fast for the first 200m (but not too fast), maintain as much speed as possible on the bend & hang on as well as possible in the final 50m. The 800m type athletes are best to aim to run more within themselves for about the first 150m & then make a sustained drive all the way to the line. When two athletes of different types race use their best pacing strategy the 800m athlete can easily be so far behind that they lose self belief & run a below par race as a consequence. So it is essential to recognize that psychology needs to be as big a part of race strategy as physiology.

If a 200m type athlete starts slowly & aims to make a sustained drive for the line often they will be less able to make as good a use of the conservative strategy as an athlete with superior endurance. If the 800m athlete races too aggressively in the first 200m they will run too close to their 200m maximum speed & face high levels of fatigue causing them to fade badly in the final straight even though they may have great endurance.

Michael Johnson had great success racing his back straight very fast relaxed & maintaining much higher levels of speed relative to his competitors on the second bend. Many athletes slow down as they enter the curve near the 200m point. They can benefit greatly from practicing accelerating as they enter the bend & staying up high on their left hip on the bend. This is a skill that can be developed which will provide improvements in race performance.

Some athletes approach the 400m with the plan to make a number of periods of smooth surges & floats during the race. This is possibly a good way to ensure good biomechanics & economy at the right time. Training sessions should as often as possible be performed in away that helps simulate racing e.g. different lanes, winds, places on the track. I have also heard about the idea of accelerating at the start of the back straight, start of the bend & finish of final bend.

Athletes should also aim for lots of experience at maintaining as good a running form as they can when fatigued. In the final 50m races can easily be lost by athletes who have poor concentration & lose form under high fatigue. Some athletes also throw their races away in the final few metres. So it is also worth always making sure the athletes maintain perfect position right through the finish line. It is a good idea to place a cone a couple of metres past the line to signal where the athlete should race to. Maintaining good running form is discussed in detail in my other e-book Maintaining Form . There are a great range of activities that can be done to improve it.

An athlete should aim to run their first 200m of the event 1s-3s faster than their second. On rare occasions in Elite Athletes it may be better to run with a smaller differential. Any more than 3s means the athlete has run the first 200m too fast or given up late in the race.

Some of the pacing data collected at the Seville World Championships in 1999 is presented & discussed below.

Michael Johnson WR 43.18s
Each 50m interval time was
6.14 4.96 5.00 5.12 5.20 5.24 5.52 6.00
His back straight was run in 10.12 in a relaxed way.
The second bend was run aggressively in 10.44 which was typically 0.5s faster than most of the other finalists. Most of whom ran under 45s.
His final 50m was almost 0.5s slower than the second last 50m. Most of the other finalist were 0.6s of a s slower in their final 50m.
Michael Johnson's first 200m was only 0.74s of a second faster than his second. The other competitors had differentials between 1.7s & 2.7s

The Womens race was won by Cathy Freeman in 49.67s
Each of her 50m interval times were:
6.56 5.63 5.68 5.92 6.08 6.10 6.53 7.17
Her back straight was run in 11.60s & she was in third place at 200m.
The second bend was run in 12.18s which was the equal fastest of all the competitors & putting her 0.02s from the lead.
Her final 100m was run in 13.70s which was second fastest off all competitors which the last 50m in 7.17s. The final 50m for the other competitors ranged from 7.08s to 7.49s.
Cathy Freeman's differential between the first 200m & second 200m was 2.09, the other finalists had differentials between 1.7s & 2.7s interestingly the same as the Mens race.

Some athlete reaction times to the gun in a 400m race can be lousy. The data from Seville showed athletes reacting to gun between 0.133s which is good to a sleepy 0.284s with an average of 0.181s which is slower than the average reaction in the 100m races of 0.137s by 0.044s which is interestingly & maybe explained by it being the time it takes for sound to travel 14m.

Young 400m Athletes. What do we do with them?

The 400m is a very intense event & elite athletes have limited careers at the top. This is often because of accumulated injuries & illness problems. The idea of identifying athletes who will be superstars in the 400m & then training them specifically for the 400m event from age 11 is almost certainly a flawed idea.

It is probably much better to develop excellent running technique in these athletes & have them participate in events much longer than 400m like Cross Country or predominantly in the 100m & 200m. The main thing to stay away from is any significant volume of Lactic Tolerance or other exhausting training. By doing this the athlete will be able to avoid the massive form loss that is evident in any athlete who has not been conditioned to maintain good form when fatigued. This form loss when it happens frequently can easily habituate bad running habits. These bad habits will be apparent eventually even when the athlete is not fatigued. They are evidence of decreased efficiency & can lead to many injuries later. It is better to improve running technique first while at the same time developing strength & conditioning using other means. This will lead to the athlete sooner being able to maintain good running form whilst fatigued. However the process of doing this optimally will likely take 3-6 years.

A plan I have designed for young & very talented 400m athletes is summarized below:

General Preparation First half of the year
Cross country training e.g. 15-25min & some competition (but not frequent)
Strength training with appropriate resistance – aim for variety
Low intensity plyometrics – standing start bounding
Sprints to 30m – maybe just 3-4 reps once a week
Every 4th week a very light week
Some Rhythm runs at up to 400m race pace with plenty of rest between e.g. 6 x 100m rest 5min aiming for good technique & relaxation
Exercise tempo sessions e.g. 4 x 4 x 60m with exercises before each run. All runs very easy at less than 75% of maximum speed for the distance.
Hill training – e.g. 3 x 3 x 60m with some hill bounding
Some slower endurance training on grass e.g. 8 x 400m reps with rest 1min at XC paces only.

This half of the year maybe culminates in some major cross country & a small number of races down to 800m

Special Preparation second half of the year
Minimal jogging – just perform exercise tempo sessions to maintain basic conditioning.
More emphasis on strength training
Sprints to 60m but mostly to 40m from blocks
Plenty of relaxed tempo sessions e.g. 8 x 200m rest 3min – making sure last 2 reps are the best.
Low volume speed endurance sessions e.g. 150m rest 8min 150m rest 8min 150m rest 2min 150m. Aim not to do hard speed endurance sessions that create fatigue that slows the athlete down below the average speed of their best 400m. This means keeping distances short enough that quality can be maintained.
If longer slower reps are performed they must be done with great running form.
More plyometrics conducted in a fun way. Lots of variety & measurable if at all possible.

This half of the year should emphasize racing over 100m & 200m with some 400m races & even maybe some 800m races early in the half year.

An effect of the above plan is that the athlete should be able to perform well at a great range of distances throughout the year. They will be stimulating gains in general conditioning for the first half of each year & then gains in maximum speed in the second half of the year. There is

a great opportunity for variety over the year as the athlete is essentially training for cross country for half the year & then as a sprinter for the second half.

The plan is easily sidetracked if the athlete (or parents or the coach) becomes too keen to target the 400m & then does lots of training which is simulating race like fatigue. The effect of this would be to produce a short term gain at the expense of gains in general conditioning and/or speed & technique. It could also shorten their athletics career. I have seen a 13 yr old girl produce 4:38 at 1500m & 25/57s at 200m, 400m in the same year following a program similar to the yearly plan outlined above.

Nutrition & Recovery Ideas For 400m

There are many things that can be done to help an athlete recover better from training. The quicker they can recover the earlier they can train again & the faster they can improve. It is also very important that athletes recover well so that they avoid injury. Training with high speeds combined with high levels of fatigue is a recipe for disaster. So it is essential that athletes are able to prevent soreness & certainly take appropriate risks when training with any soreness.

Avoiding or Minimizing Soreness

- Maintain good fluid status. Drink steadily.
- Massage may help prevent tight muscles which can then become sore when trained on. Research has tended to not support the idea that massage speeds up the removal of Delayed Onset Muscle soreness.
- Warmup well & Warmdown well.
- Pre-exercise trigger point treatment.
- Post-training Protein in liquid form may help.
- Be extra careful with anything new i.e. spikes, tracks, hills, exercises, speeds etc.
- Don't sprint at 100% maximum when it's a bad day.
- Eccentric impacts are main culprit.
- Change the session to something less structurally demanding of already sore.
- Optimize Dynamic Flexibility, enlist a physiotherapist to identify areas of deficiency & design a plan.
- Optimize Running Biomechanics e.g. Athletes who "sit" tend to over-stress hamstrings. Minimize over-striding.
- Sleep well aim for 9hrs.
- Elevating legs may help.
- Contrast Baths i.e. 3min in a warm shower then 30s in a cold bath repeated 3 times. I believe this is better than a massage.
- Plunge Pool & Spa if available (similar protocol as above)
- Ensure adequate food intake especially protein.

Nutritional Ideas

- The athlete needs to maintain a healthy diet especially with enough protein (at least 1.3g/kg body weight).
- Creatine is helpful with 400m athletes. It increases the muscles stores of creatine which can improve the athletes ability to perform repetitive sprints. It may also improve the athletes ability to cope with acidosis by increasing the level of buffering in the blood. Some have claimed that Creatine is effective at lower doses of 2-4g/day. As an amino acid Creatine is simply another form of protein supplementation. It is important if the athletes uses a loading regime of creatine (15-20g/day for 5 days) that they maintain good levels of fluid intake to prevent muscle injuries from slight de-hydration.
- Powerdrive made by Biotest is a product that contains all legal supplements. It claims to be able to enhance nervous system performance & is taken just before training or racing. It is worth examing.
- Athletes need to be very careful with any form of supplementation. Impurities can be introduced to what are legal supplements intentionally or by accident. This is particularly a risk with any protein powders. Some pro-hormones (steroid like substances) have been known to get into some protein supplements & probably have caused the majority of Nandrolone positive tests over recent years. It is important to only buy supplements from highly reputable manufacturers. (some would say if at all)

Supplementary Ideas of Training Sessions

Medicine Ball

There are new varieties of bouncy rubber medicine balls that are the size of a volleyball or basketball. These can be used to do a large variety of conditioning exercises. Athletes can perform some exercises very fast and develop power especially in the mid-torso and arms. In addition, the experience of being able to train at coping with impact forces is also beneficial. They will improve the ability of an athlete to cope with rough races and have a better chance of staying on their feet when bumped. Many of the exercises are great for overall co-ordination and balance.

There are great range of exercises available at www.faccioni.com
Athletes can do one set of 10 of each of the exercises in any of the four sessions.
http://www.faccioni.com/fcubed.html

Medicine Balls can also be used in Throws for maximum distance.
There are a range of throws that can performed in training that can also be measured as indicators of increases in full body power.

Medicine Ball Testing Activity A (start with a 2kg ball progress to 3kg)
4 attempts at each
-standing underhand forward throw
-standing over the head backwards
-chest pass lunge and throw
-sideways twist and throw to the left
-sideways twist and throw to the right

It is a good idea with Foundation Squads to do at least one session a week all year of an ever changing variety of medicine ball exercises.

Larger volume sessions can be done with Med Balls with advanced athletes. Charlie Francis describes some large volume sessions done with Medicine Balls in his book Training for Speed. He writes that some athletes do 6-10 exercises sometimes totalling 800-1200 throws in a single workout.

Plyometrics - each activity may be part of a larger session.
Plyo Activity A
Alternate leg bounds
5 x 4 alternate leg bounds and jump into a sandpit- measure the total distance in each. rest between 3-5min

Plyo Activity B - perform as major part of the session combine with tempo training or technical drills. Measure total distance in each
Plyo Testing
3 x 4 hops left leg
3 x 4 hops right leg
3 x standing triple jump starting from the left leg
3 x standing triple jump starting from the right leg
6 x standing long jump
3 x hop-step-hop-step-jump

Plyo Activity C - best performed at the end of a session.
Sandpit Plyo
Perform in sandpit barefoot - more of an ankle conditioning activity than pure plyometrics. Safe to do quite large amounts of jumping in sand.
4 x 10 double leg hops - short rests
4 x 10 hops left leg
4 x 10 hops right leg

Plyo Activity D - perform early in a bigger session.
Hill Bounding
1-5 sets of 3 x 20m hill bounding rest between each 3min/longer between sets

Plyo Activity E
Hill Bound & Run
1-4 sets of 3 x (20m hill bounding +20m run) rest between each 3min/longer between sets

Plyo Activity F
Running start alternate leg bounding
Progress from standing start alternate leg bounds to running start bounds. It is best to start with a short run up and as skill/power improves to extend the run up.
5 x 5m run up and then 4 alternate leg bounds and jump into a sandpit - measure the total distance in each. rest between 3-5min
or
4 x 10m or more runup then 4 bounds & a jump into the pit
or
4 x 10m or more run-up then 9 Bounds & a jump into the pit.

Plyo Activity G
Hurdle Hops - 6-8 x 3 hurdles double leg bouncing in between. Make sure ground contacts are very quick and this means keeping the hurdles very low. Initially maybe as low as 30cm. Do not progress with the height so fast that it lengthens contacts times.

Plyo Activity H
Speed Bound Index
The athletes do alternate bounds from a 10min running start for 30m. The number of steps taken is counted and rounded up to the nearest half. The time is also recorded from the athletes first movement to the nearest tenth of a second. The Speed Bound Index is calculated by multiplying the number of steps by the time taken. The lower the score the better. Improvement in this score is indicative of higher levels of sprint specific power. In a session an athlete should have no more than 5 attempts. It is important in speed bounding that the athlete does not reach and overstride. They need to aim to contact the ground

actively underneath the body.

Dedicated Plyo Session
Warmup (Mixed)
Speed Drills
6 x 3 hurdle bounces double leg (alternating with a light weighted vest 3kg & using no weight)
3 x Hops with 2 strides between over 4 hurdles each leg
3 x 25m speed hops
Warmdown

Swiss Ball

The swiss ball can be used as a multipurpose bench, which has the training advantages of being an unstable environment. Any kind of training in an unstable environment is great for strengthening stabilizer muscles. The shape of the ball also allows for multi-angle training and allows greater range of motion on some exercises. These are important factors in properly training certain muscle groups e.g. the swiss ball crunch. It can be performed starting from a hyper-extended position over the ball. It is recommended that athletes learn the correct techniques. The best way to do this would be to attend Swiss Ball classes which are increasingly becoming a regular fixture at many fitness centres. Alternatively, there are a number of very good video workouts, which explain carefully the finer points of technique and present planned sessions. I have found videos to be very effective and enjoyable for the athletes in my squad. It is important to recognize Swiss Ball training as a way of improving functional strength and not just a toy for improving balance etc.

Many athletes enjoy doing exercises on Swiss Balls - choose a range of exercises, learn to do them properly and perform just 10 exercises of each.

I have found swiss balls great for helping athletes to improve posture and stabilization. But it is important to do more intense activities in the Gym to increase strength levels to a higher extent in the mid-torso. Swiss Ball training or un-resisted mid-torso training alone is not enough.

Pilates

The Pilates variety of exercises have been an integral part of ballet training for many years. The basic principles of Pilates conditioning are to make people more aware of their bodies as single integrated units, to improve alignment and breathing, and to increase efficiency of body movement. The method consists of a sequence of carefully performed movements with some carried out on specially designed equipment. Each exercise is designed to stretch and strengthen the muscles involved accompanied by a high level of focus on learning to relax. Athletes in my squad that have done a significant amount of pilates have exhibited improved body awareness and control . I have noticed that they are able to learn to do drills much easier than other athletes. I also believe this area of training is exceptionally good for enhancing hip mobility and mid-torso strength.

Pilates can be done at studios where it is common to have personal tuition or there are a variety of good video workouts of floor exercises. My squad do Pilates video workouts at least once a week all year, one good one combines Pilates with some yoga stretching it is called a Mat Workout Based on the Work of J.H. Pilates by Denise Austin.

Weight Training

It is worth finding a good weights room and getting good instruction from a trainer who is specialized in weight lifting. Perfect technique is very important.

A few extra ideas for weight training are included in this section.
Some exercises I have found good are:

Step-Ups. There is a distinctive way to perform Step-ups that is a good test of stabilization ability. They are performed on alternate legs with the lower leg kept close to vertical throughout the movement. Executed this way they target the glutes more than when the knee is allowed to move forward and are a good specific hip extension exercise. Often when Athletes start training with this exercise they have great difficulty in staying tall and maintaining level hips. There is a great tendency to 'wobble' or 'twist' on the way up. This indicates that they have weak stabilizers. Athlete progress is clearly limited by their ability to stabilize the weight. So this is a good way to measure improvements in stabilization strength. Athletes usually display the gains from other training methods that impact upon stabilization by improving in the perfect execution of this exercise more rapidly.

Developing athletes can start step ups on a low box without a weight progressing to a box that is not so high that it causes their upper leg to be lifted above parallel. Then add a barbell weight and progress within the obvious limits of the athletes stability. Do 3 sets of 8 each leg.

Standing Vertical Dumbell Presses - The athletes stand tall with good posture and have to focus on maintaining this position throughout each set. If they cannot stand tall they are lifting too heavy. Do 3 sets of 6 -10.

Chin-ups - Athletes develop the ability to do 3 sets of chinups for as many as they can do. If they can't do any then they can do standing lateral pulldowns on a machine that uses a cable.(3 sets of 6-10). They can also during the power phase of training aim to do as many as they can in a given period of time e.g. How many can the athlete complete in 6s.

Standing Upright Rows - The Athletes stand tall with good posture and hold a barbell near the middle and lift it to the height of the base of their neck. If they cannot maintain their ability to stand tall they are lifting to heavy. Do 3 sets of 6-10

Exercise choice - There are many other exercises that can be used that are good. I have read some research that recommends against using isolation exercises like hamstring curls, knee extension or leg press. The argument is that these exercises are training muscles in a way that is not the way the muscles function when moving. Some even consider that these exercises may increase the risk of injury. I consider them appropriate for rehabilitation or at best for basic general conditioning. My squad rarely ever do these exercises.

(See the Strength Training Section for some more advanced ideas)

Theraband exercises

Therabands are thick flat rubber bands that can be purchased in a roll. They exist in a number of resistance grades. Many stabilizer muscle groups can be specifically strengthened using them.

A few examples are:
1. Cut a 90cm length, and tie the ends. Get the athlete to step into the theraband circle (band around ankles) and get them to do a series of sumo type walks (squat position with wide legs). Get them to walk sideways, forwards and backwards lifting each leg up (like sumo wrestlers do) and not allowing the theraband to pull their legs together. It is recommended to do one set of 15-25 steps.
2. The athlete lays face down with the theraband around their ankles. They then get into a hyperextended position and abduct their legs. It is recommended to do 1-2 sets of 20.
3. Hip Rotators can be strengthened by having the athlete lay face down, knees together with the lower legs held vertically and placing the Theraband around their ankles. The athlete should then maintain the knees together and rotate their hips so that their ankles move outward. A similar exercise can be devised to strengthen rotation in the opposite direction.

Often there are big differences in the strength of outward movement and the inward movement. Strengthening and equalizing hip rotator strength should improve stability and improve running form especially when fatigued.

Hill Training

Hills can be used in a variety of ways. They are good for developing strength in the running action. Athletes can do starts running up slight hills, they could bound 20m or they could do longer runs up hill for endurance. The most pleasant type of hill is to use a hill that varies in slope and winds slightly as it climbs in a natural setting.

A few example are:

Hill Training Acceleration Activity A
4-8 x 20m starts - full recovery

Hill Training Power Activity B
4-8 x 20m alternate leg bounding - full recovery

Hill Training Endurance Activity C
4-10 x 80m rest between 2min

Hill Training Endurance Activity D
2-3 x 800m hill on slight slope gradually going faster - walk down recovery

Hill Training Strength Endurance Activity E (Advanced)
2-4 sets of 3 x (20m bound + 20m run + 20m bound) recovery 90s and 8min between sets.

Downhill Training

Running down very slight slopes is also a good way to practise good technique. When running downhill it is very obvious to the athlete when they are overstriding. The goal should be to run with a smooth action and to do this the athlete has to practise maintaining dorsiflexion and making ground contact well underneath the body.

Downhill Training
4-6 x 60m relaxed with smooth impacts on a very slight smooth grassy slope. recover between 3min

Combined Hill Training

3-5 laps of (hill run up gentle slope - 30-50m bound up a steeper hill - 100m slow jog - walk down steep hill - fast smooth running on gentle downhill - jog across to bottom of hill)
Do these continuously at a manageable intensity. Aim for quality bounding on each lap.

Sprinting Technique Development Activities

Sprint Drills

Drills aim to specifically strengthen the muscles in postures and actions that are similar to those that occur during the sprint action. They are posture drills, specific strength drills and functional flexibility drills all at the same time (Gambetta et al.). It is very important that correct execution of the drill be trained carefully with coach feedback essential. This is because drills performed incorrectly can ingrain bad habits that will result in the opposite of the intended effect. Bad drills are much worst than not doing drills at all. Athletes should never perform them as relaxed warm-up activities unless they are done perfectly. They are as serious a business as a concert pianist practising piano.

I have the athletes in my squad simply concentrate on two drills:
1. Ankling - circular movements of the lower leg maintaining dorsiflexion, striking with a backward moving (active) foot. They do 6-8 of these over 6-8s every time they warm-up.
2. Quick Recovery High Knee Running - they catch their leg early bring it rapidly up underneath stepping over the height of the other knee. They keep their pelvis stable lift their knees as high as they can without 'sitting'. They do these aiming to perform them with perfect form. This means maintaining constant lumbar curve, avoiding 'sitting' or losing dorsiflexion before impact. The positive cues are to stay high, step over opposite knee and land flat footed. They do about 6-8 of these over 6-8s at varying tempos and transition out of them into the normal sprint action for about 15m.

Sprinting - Maximum Speed Development

Athletes perform all runs in these sessions one by one. This is so that they can practise thinking about their movement by themselves without distraction. It is too easy for athletes when they have someone else near them in another lane to compete and not think about how they are moving.

Just choose one kind of session to perform on a given maximum speed training day from something similar to the following.

Max Speed Activity A
30 - 40m sprints from a 3 point start. Aim to do up to 6 with 3-8min rests in between. Only do as many as the athlete can perform with absolute best times. (We time them starting the watch from their first movement). As soon as they have become significantly slower this part of the entire training session should end. It is possible to do 2 sets of 3 with 3-8min rest between sprints and a longer but active break between sets.

Max Speed Activity B
Flying start sprints the athletes should accelerate gently for about 25m then sprints maximally across a 15-30m zone. The goal is to create the highest speeds possible over what will be about a 2-3s duration. Aim to do 2 sets of 3 with 3-5min rest in between and an active recovery in between sets.

Max Speed Activity C
in's and out's the athletes should accelerate gently for about 25m then sprint maximally across a 15m zone this is called the "in" then they should freewheel maintaining stride frequency for 15m this is the "out" before performing another 15m "in". Aim to do 4 with a 5min rest in between.

More advanced athletes can do in & outs over longer distances e.g. 40m max acceleration zone then 20m "out" , 20m "in", 20m "out" and finishing with 20m "in".

Max Speed Activity D
Sprint Conditioning
40m sprints at 95% effort - practising good form and relaxation. Do 2-3 sets of 4-5 with a

recovery of 90s between reps and a longer active recovery between sets. Important to do no running at maximum effort. This type of session is thought to increase the storage of CP.

Ideas and possible variations are:

- always have the athletes do maximum speed sprints with the wind. Running against the wind is a strength activity.
- have the athletes do some sprinting on a bend where they focus on keeping their left hip high.
- occasionally do a small amount of plyometrics between each sprint.

Starts & Acceleration

Many young or older developing athletes are not strong enough to start properly but it is still important for their performance to be able to react to the gun and accelerate with as good a technique as possible.

Acceleration Activity A
Block starts
Perform 4-6 x block starts over 15m. rest between 3min
Focus on keeping eyes looking down at track head down, using a big arm action and pushing. The goal is to have an entire body that is leaning forward significantly and being held up by the strong forces being exerted from the legs as a pushing action. These are best done with competition. It is important for the starter to vary the pause and deter athletes from guessing the gun. Athletes can prevent "popping up" vertical too early by keeping their eyes looking at the track more closely - this will keep their head from leading the body up.

Acceleration Activity B
Resisted acceleration.
The coach or an able assistant faces the athlete and resists them as they try to accelerate by pushing against their shoulders. It is important to have the athlete leaning forward through their whole body as they do this. It is also fun and effective to have the resisting partner release tension on the athlete which allows them to display a subsequent brief burst of speed.

Another way to resist is to use a harness and resist using a long length of stretchable rubber tubing and some rope. This is what my squad uses and the athlete is able to accelerate maximally for 20m. We would plan to do this 3 times then 1 unresisted for a contrast effect and may do two sets of this.

Acceleration Activity C
Gun Reaction Drill
The athletes should get down on all fours and practise moving their arms like they will when the gun is fired. e.g. If an athletes has their left foot forward in the blocks then their left arm should swing forward and their right arm backwards. Athletes should practise this so that it becomes automatic that they react to the gun without having to think about it as much.

Acceleration Activity D
Plyo then accelerate
Athletes do 4 alternate bounds then sprint 20m. Repeat maybe 4 times with 3-8min in between.

Speed Endurance Activities

Endurance Drills

Once athletes are capable of performing sprint drills technically well they can then perform them over longer durations as a way of improving the endurance of holding good body position. The athletes in my squad do our version of the high knees drill in segments totalling up to 200m. They only go as far as they can hold good technique in each segment. I have seen great gains in the ability of the athletes to hold good form come from this area of training. The caution is never to have an athlete use drills in this way until they technically proficient at them or they will be practising bad habits. I have heard of athletes doing up to 400m of certain drills in a single effort. If done properly this would be a superb way to develop maintenance of a good body position.

Technical Practise

Baton changes - It is fun for athletes to work in pairs to improve their confidence and effectiveness in relay baton changes. Many athletes first taste of success is in relays so it is worth practising.

Hurdle Drills - Hurdle Drills are very good for improving hip mobility and stabilization of the trunk. Young athletes find it fun to learn how to do them and practise. Short hurdle races are also fun for athletes to do in training.

Hurdle Walking

The athlete walks over six or eight low hurdles setup at about one metre spacings. Stand just before the first hurdle, lift the lead knee up very high and place the lead leg vertically down on the other side of the hurdle. The lower part of the leg should not reach out in front of the body. Bring the knee of the trail leg out to the side to above hip height with the foot pointed outward to clear the hurdle. Bring the trail knee across the hurdle and as the trail knee clears the hurdle bring the knee up and to the front centre of the body. Move the trail leg vertically down on the other side of the hurdle. The lower part of the leg should not reach out in front of the body. It is important to maintain high hips throughout the action and use a good range of arm movement. These drills can also be done with the extra challenge of holding a ball with straight arms above the head.

Mobility Drills

Leg swing drills

1. Leg Swings. Stand holding onto a wall for balance with one hand. Swing a leg forward and backward 10-15 times. Repeat with the other leg.
2. Inward and Outward - Place both hands on a wall for support. Swing a leg out away from the body and back across the body 10-15 times. Repeat with the other leg.

Hurdle drills

Lateral Leg Lifts. Stand at the end of a hurdle, with our body slightly to the left of the hurdle. Keeping your right leg straight, lift it up

and over the hurdle. When your right foot hits the ground, lift your left leg and circle it over the top of the hurdle. Pause and step back across the hurdle with your left foot first. Start with 3 sets of 5 reps in each direction and build to 3-5 sets of 10. There is a variation of this drill where the athletes does the same action with legs that are bent. This creates a situation where there is a higher knee lift.

A more advanced activity is to set up 5 hurdles.
Then start by moving laterally over one hurdle and then back one,then over two and back two,over three and back three,over four and back four,over five and back five, over four and back four, over three and back three, over two and back two, over one and back one.
This a total of

Lower leg conditioning

Many athletes have trouble with lower leg inujuries as they mature and especially if they are training really hard at any stage in the future. It is a good investment of time to perform as much pre-habilitation exercises as possible. The muscles of the shin, foot, ankle and calf can all be conditioned in a variety of ways to make them more resilient.

One simple way to condition the lower legs is to do heel/toe walking at the end of most training sessions. For all but the most important competition part of the year. My squad twice weekly do 2 sets of:
30m walk on toes as high as possible
30m walk on heels with toes pulled upward toward shin as high as possible.
30m walk on toes as high as possible with toes pointed outward.
30m walk on heels with toes pulled upward toward shin as high as possible with toes pointed outward.
30m walk on toes as high as possible with toes pointed inward.
30m walk on heels with toes pulled upward toward shin as high as possible with toes pointed inward
30m on the outside of the feet.

These are best done barefoot where possible. Barefoot walking & play is a good way to condition the feet. Staying in shoes all the time allows condition of the feet to deteriorate and will likely eventually in foot/lower leg injury such as plantar fasciitis.

Stretching

I believe it is best for all athletes at any age to follow a personalized stretching program designed by a physiotherapist but teaching some important stretches is also valuable in training. It is important that athletes know how to do it properly. Combinations of some dynamic stretches and static stretches are appropriate. Muscle Physiology researchers now believe that static stretching does not decrease the risk of injury pre-competition or pre-training. Some research has shown a slight increase in injuries among athletes that stretch statically pre-event. My squad do loosening up activities involving the use of accupressure and then a mixed movement warm-up. They do static stretching mostly at home that is designed for them personally and a small amount after training.

Advance Technique
Overspeed Training

Overspeed Training is very effective in some athletes at increasing maximum speed. However it is a dangerous activity and must be conducted very carefully. Athletes should not do overspeed training unless they have a high level of postural control and are not athletes with a pronounced anterior tilt (butt out postition). Overspeed towing will pull the athlete into a position of even more lumbar curve and will very likely result in hamstring or back injury.

It is probably not worth the risk to perform overspeed training with 400m athletes. Overspeed training improves the nervous systems capacity to co-ordinate a faster cadence movement &

increases maximum speed. It will likely have negligible if any positive effect on 400m performance.

There are a number of forms of overspeed training:

Surgical Tubing
We used to use surgical tubing and have one athlete tow walk foward to pre-stretch the tubing and then run at a pace that provided the right amount of resistance. We found that the athlete had a large amount of assistance early but the overspeed effect was difficult to control.

Using a Pulley Mechanism - Ultra Speed Pacer
We have been using this method of overspeed training with good effects. The athlete is assisted by a partner towing them using the multiplying effect of the pulley. The assisting athlete only need to run about half as fast as the athlete being assisted and the force delivery can be smooth. To use the ultra speed pacer requires at least 2 people as well as the athlete. One athlete to wear a harness which has the pulley mechanism immediately behind them. One coach to hold the handle at the end of the cable (or a pole to fix it to) and someone to time the performance of each run and monitor the athletes form.

A typical overspeed session we have performed is detailed below:

Warmup (Mixed)
Speed Drills
40m sprint from 3 point start
4 x 40m assisted tows using speed pacer
1-2 x flying 80m rest 3min at 100%
Warmdown

This session is a combination of overspeed and speed endurance straight afterward. An example of the data collected for a sub12.00 100m Female is the 40m from 3pt in 5.00s from first movement and the assisted runs are in 4.34-4.54 , the fastest flying 80m recorded has been 8.68

I would not recommend doing assisted sprinting with surgical tubing or an ultra speed pacer on a grass track. It is difficult enough turning muscles on & off faster with overspeed let alone adding the difficulty of stabilizing on an unreliable surface. Overspeed can often make the athletes sore from the increased forces experienced. I would recommend starting with just 2-3 assisted runs and repeating once a week on a fresh day and at least 4 days before any competitions. Never do this form of training when the athlete is sore. Also I would only do this form of training with an athlete who has done regular maximum speed sprinting and is close to a speed plateau. It is best done during the late power phase and conversion/maintenance phase of training.

I have read that it is also valuable to do overspeed while wearing a lightly weighted belt e.g. 2kg. This increases vertical forces and trains the athlete to stay up higher. I have not yet used this method of training with my squad.

It is also possible to do slight overspeed sessions using downhill running or with talwind. Both of these methods may help but are not near as effective as overspeed towing.

Acceleration/Complex Training
There are special low resistance disk sleds available that have a mechanism that causes the sled to drop off the back of an accelerating athlete after a set distance. We have used this equipment to cause a recruitment overspeed effect. The contrast effect of having the athlete sprint maximally while resisted causes recruitment of a greater amount of muscle and then when the resistance is released the athlete experiences a surge of speed. This is a great way to train the nervous system to allow the athlete to run faster. It is just like when someone throws a medicine ball repeatedly and then picks up and throws a basketball.

There are many other ways to use complex training:

- Lifting weight and then bounding or bouncing e.g. quarter squats then bounce over hurdles.
- Lifting weights and then sprinting eg squats fast then a block start.
- Running arms with weight then unresisted running arms
- Uphill Training then sprint on the flat
- Resisted starts then unresisted starts
- Weighted belt sprints then unweighted
- plyo bounces with a light weight then without weight

All of these methods function by impacting on the nervous system in a different way than conventional training. A big part of sprint training when an athlete is already strong and has reached a plateau is to work on more conversion of strength to power and power into the specifics of sprinting.

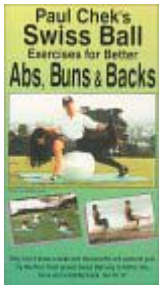
The book Explosive Power & Strength by Donald Chu covers complex training in detail.

Recommended Resources

Training Kids for Speed - Video on CD
Includes footage of many of the ideas presented in this book.

http://www.oztrack.com/kidspeedcd.htm

Paul Cheks Swiss Ball Video 'Better abs,buns & backs'
http://www.amazon.com/exec/obidos/ASIN/B00004TQ18/sydney2000trac00

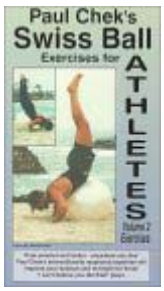


My squad do this Swiss ball workout 2-3 times a week for most of the year.

Paul Check's Swiss Ball Exercises for Athletes Vol 1 – VHS
http://www.amazon.com/exec/obidos/ASIN/B00004TQ19/sydney2000trac00

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
http://www.amazon.com/exec/obidos/ASIN/B00004TQ1A/sydney2000trac00



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

Denise Austin - Mat Workout Based on J.H. Pilates (2000)
http://www.amazon.com/exec/obidos/ASIN/0784018235/sydney2000trac00

This video contains 2 x 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%20Speed%20Presentation%202000.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

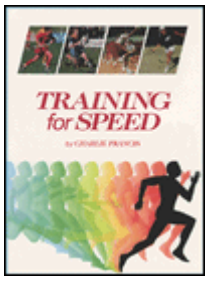
'Run-Play' Training
Some Creative training ideas
http://www.pponline.co.uk/encyc/0272.htm

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

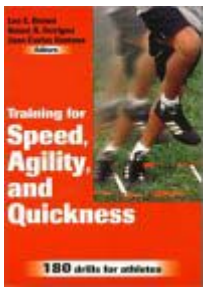
The Simple Secrets of Developing Great High School Sprinters
by Bryan E. Hoddle
Some useful ideas and explanation
http://www.watfxc.com/TF/TF%20Education/Hoddle1.htm

Training for Speed by Charlie Francis



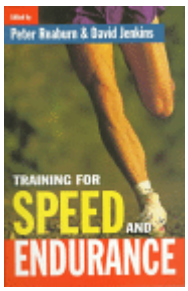
A recommended book on Sprinting. Contains plenty of great sprint training ideas. Written by the coach of Ben Johnson who ran 9.79 for 100m in the Seoul Olympics.
More information at http://www.oztrack.com/Francis.htm

Speed Agility and Quickness
by Brown, Ferrigno and Santana
http://www.amazon.com/exec/obidos/ASIN/0736002391/sydney2000trac00



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

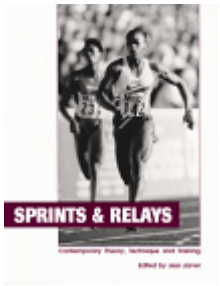
Training for Speed and Endurance
by Peter Reaburn (Editor), David Jenkins (Contributor)
http://www.amazon.com/exec/obidos/ASIN/186448120X/sydney2000trac00



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
http://www.amazon.com/exec/obidos/ASIN/0911521429/sydney2000trac00



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

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Any application of the techniques, ideas, and suggestions in this e-book is at the reader's sole discretion and risk.

The Training & Values Of Michael Johnson

Consistency
Strived primarily to be consistent, it was his number one priority.
Program designed to create this.
Did not believe in peaking
Built a base and then did not "milk" it too much, kept topping it up
Consistency of coach , training environment, everything - nothing ever changed much.

Goals
Setting goals - big goals with small goals to lead to it.
Maintaining work ethic required reminding self of the goals
100% perfect training, following instructions not going faster or slower than planned.

Coach-Athlete
Coach learns from Athlete, Athlete learns from Coach – feelings of athlete shaped the work that was done. Athlete had superior mental understanding of program but Coach made decisions.
Athlete-Coach rely on one another

Strategy
Initial College strategy was : Slow as possible for first 200m then go hard, this strategegy was shaped and tuned over the years to be – reach race speed as early as possible in first 50m cruise to 200m then accelerate steadily next 100m and hold form for last 100m
Workouts done to rehearse strategy called EVENT workouts
eg 3 x (350m in 46s rest 1min 100) 5min rest
or
Event 300s
Which were run with first 50m very quick but then relaxing to go through first 200m in 28s and then the last 100 sub12s rest 10min between (in College) shorter later to maybe 5min

Technique
Aimed to have consistent stride frequency and length for duration of race – not a longer stride at end, Allow a shorter stride to just happen but maintain cadence.
Technique was not taught or shaped. It just developed and was later found to be efficient.

Holding Form
Improved by Strength Endurance
Upper body strength from exercises like running arms with good form 5 x 15 each arm with 30s rest.

200m Training
Did mostly 400m training even though he ran 200m in 19.32.

Aerobic Running
Offseason did two aerobic runs a week 20-45min max. This was for firsrtv 3 weeks mostly but offseason was usually 6 weeks.
Longer reps 2 x 800m or 3 x 600m rest 15min

Common key workout
In pre-season
3 x 350m rest 5min in College , later it became 3 x 350m rest 3min , each 50m at same speed.

One Speed workout was called 60 -40m
2 sets of 2 laps of 60m at 95% slow down 40m then pitter-patter jog 40m then 60m at 95% 40m slow down – pitter patter jog 40m. rest between sets 5min

Pure Speed work
often was
30, 40, 50, 60, 70 on bend with full recoveries

Faster Speed endurance
6 x 100m at 95% non-timed from standing start rest 5min

Weight Training
3 Gym sessions a week usually in morning
from about 9am till 10am – over in an hour
On any day sometime done Mon-Tue-Wed or spread out in week.

Track is at 3pm & was usually over within 1hr45min

Weights is general all body work with short recoveries and usually 3 sets of 10 rest less than 1min maybe 30s
No squats , no Olympic lifts, Also did good variety of core work eg 3 x 30m situps 1min rest
Gym did not change in format throughout the season
Did not ever lift really heavy , he did lunges

Normal Warmup
4 laps jog straight – run bends
Stretch 30min
Drills 4-5 x 30m over a speed ladder with fast cadence. This Michael believed was significant effect on his turnover. These were done with a flatish footed contact not with feet pointing down and a quick recovery.
Buildups sometimes for example 3 x 150m with each 50m quicker
Then workout

Comp Warmup
4 laps as usual
Stretch 30min
3 x 100m – first moderate, harder, fast with full recoveries
a few pre-race drills

Time Trials
Did not like Time Trials rather use a key session and base of ease of pace and recovery.
Typically when 2 x 350m rest 3min in 46s was feeling great – race form was great.

At Competition
Expect the unexpected. Don't complain, just be ready for anything.

Visualization
Train the mind to control the body in competition in the way that is wanted.

Sustained Speed work
60m & over was at 95% – never 100%.
Longer work was done for stimulus not for race pace rehearsal, so nearly all was at paces slower than race pace.

Plyometrics
Almost never did plyometrics

Overtrain – Undertrain
Better to undertrain than overtrain

Going into Championship
More taper (already doing less volume anyway)

Workout Accuracy
- Cones every 50m – beeper sounded at set intervals – athlete ran each 50m at same speed. – Be on the buzzer
- Standing starts
- Workouts done at times planned not faster – not slower. Important not to go faster than predetermined targets even with 200s in 32s !!

Refreshing Base
Coach needs to decide when to refresh base by going back slightly from quality to quantity even if just for a week or two mid season , important not to take too much from base.

Athletes rewarded
Athletes rewarded with fun things – more speed , less reps by doing well at quantity stuff and proving they are ready to do less with more quality. Coach decides timing.

The Program

Off season
Pre season
Early season
Late Season

Off season 6 weeks – "preparation for training"
First 3 weeks all on grass

Mon 12 x 200 @ 32s rest 3min

Tue 2 x 800m near 2min rest 15min
Wed 4 x 350m in 55s rest 10min

Thu 20min run and 3 x 200-250m on long hill or 3 x 3 x 200m up and down hill with each set within a predetermined total time

Fri 30min

Off season second 3 weeks
Mon 10 x 200m in 29-30s rest 2min

Tue 2 x 600m in 90s with 15min rest

Wed 3-4 x 350m in 52 rest 10min (maybe down to 3)

Thu 20min run and 3 x 200m on long hill or 3 x 3 x 200m up and down hill with each set within a predetermined total time or maybe 10 x 100m rest 3-5min

Fri 30min

Pre season
Mon 8 x 200m in 28s rest 2min

Tue 2 x 500m with 50s through 400m rest 10min

Wed 3 x 350m in 49s rest 8min

Thu speed makers 60-40 session or event 300s (3 x 300m with last 100m sub12s and first 200m in 28s after a fast first 50m) rest between usually 5min

Fri 10 x 100m with 3min rest

Sat – another session like Thu or Fri

Early Season
Mon 6 x 200m in 26s rest 90s

Tue 2 x 450m rest 7.5min

Wed 3 x 350m in 49s rest 3min or 2 x 350m rest 5min in 47s or 2 x 350m in 46 with 2min rest (indicated great form)

Thu – event 300s

Fri – 10 x 100m or 60-40m session

Sat – similar to Thu or Fri

If Competing (maybe something like)
Mon 6 x 200m in 26s rest 90s

Tue 1 x 450m

Wed 2 x 350m in 47s rest 5min

Thu – 1 set of 60-40 session

Fri – warmup only

Sat – competition

Late Season (Main Season)
Mon 7 x 200m in 27s rest 90s or 6 x 200m in 25s rest 90s or down to 3 x 200m 3min in 25-24-23

Tue 2 x 450m 48s through 400m rest 7.5min

Wed 3 x 350m 200 in 27s through 450m in 47 then last rep fast all the way in 45 with a 5min rest between

Thu 3 x 30m starts , 1 x 40-50-60 maybe 70 with full recoveries 5min+ then maybe 5 x 100m short hills

Fri – event 300s

Sat – something similar to Thu or Fri