PERIODISATION

planning your training for peak performance

A SPECIAL REPORT FROM

PEAK PERFORMANCE

The research newsletter on stamina, strength and fitness

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From the editor

'Let me simply say that a) for as long as you want to be an effective coach, you have to be well-organised and conduct a well-organised and planned periodised training methodology. And b) if periodised training is ineffective, what is left to us? We either have periodisation or chaos!' These are the words of one of the foremost authorities on training planning and strength development in the world, Tudor Bompa. As a coach or athlete, we need to know that the training we are doing will bring us the results we want. Periodisation is the name given to the placement of training phases in a progressive format that will deliver optimum performance when it is needed. Many coaches find that 'putting it all together', *ie* periodising training for their athletes, is one of the most complicated of all the processes involved in coaching. In this *Peak Performance* special report, we simplify this process whatever your sport and tell you how to 'get it right' on the day and in all the days leading up to the day.

We kick off with Richard Godfrey's article 'Practical Periodisation'. It introduces some of the terminology and themes of the subsequent articles. Top track and field coach Phil Gardiner then addresses strength development. He spells out over four distinct phases how strength can be built up so that the athlete has it when they need it. Next, I provide you with a further overview of periodisation models and explain which are best for selected sports. I then throw in a further practical article dealing specifically with sprint training and the content and organisation of a speed-orientated periodisation plan. And we leave the lasts words to the man who has been called the 'father of periodisation' – Tudor. I had the privilege of interviewing him and his thoughts and comments are extremely, educative, illuminating and entertaining!

Happy training planning.

John Shepherd,
Editor, *Peak Performance Premium*

Practical periodisation

An athlete has to focus on the most important competitions and plan their training so as to be in optimum shape when it matters most. As Richard Godfrey explains, traditional models of periodisation identify these peaks and work backwards…

From a physiological perspective, it is not possible to improve an athlete's level of conditioning in several areas at one time. Training, for example, must be planned so that at certain times of year the emphasis is on improving one parameter, such as strength, while other areas, such as endurance and speed, are simply maintained.

Training phase terminology

Under periodisation models, training phases that help an athlete to progress towards their peak/peaks are termed:

- Microcycles – these last one to 14 days
- Mesocycles – these last two weeks to six months
- Macrocycles – these last one to four years.

Hence the broad focus is 'macro', the more detailed 'meso' and the fine detail 'micro'.

In a macrocycle there are generally (but not exclusively) four distinct phases of training:

1) The conditioning (or preparation) phase
2) The competition-specific preparation phase
3) The pre-competitive preparation phase
4) The competitive phase.

For summer sports such as 5,000m running and javelin throwing, the major conditioning phase occurs in the winter. For winter

Table 1: Example of a periodised year for a 400m swimmer

Preparation		Transition	Pre-competition		Transition	Competition Season	Transition
Base endurance	LT	LT/Speed	Speed	Taper	Taper	Main competition training	Active rest
14 wks	8-10 wks	3 wks	2 wks	2 wks	1-3 wks	1 competition every 14 days for 16 wks	4 wks

sports such as cross-country skiing and ski jumping, the major conditioning phase occurs in the summer.

Regardless of the time of year, the non-competitive period is the time when base endurance is the major focus for endurance sports, and strength training and power the major focus for speed sports. Of course, in some sports there is a demand for a combination of endurance and power (*eg* rowing), so a simultaneous combination of endurance and resistance training is required. This results in very careful training manipulation to develop endurance and power in harmony, or at least in terms of a resultant harmony when it comes to the actual competitive peak.

'Regardless of the time of year, the non-competitive period is the time when base endurance is the major focus for endurance sports, and strength training and power the major focus for speed sports'

Aim for a seamless transition

The transition between mesocycles should be seamless. So, in the transition (pre-competition mesocycles) phase/phases there is an increase in one type of training and a decrease in another. Taking 5,000m and 10,000m running as examples, base endurance work occurs predominantly in the winter. Around mid-January, one session per week of base endurance work would be dropped in favour of a tempo/lactate threshold (LT) session – *ie*, working between 75-85% of maximal heart rate (where exactly within this range is appropriate will be athlete-specific and depends on current levels of conditioning). During the next four to six weeks there would be a gradual decrease in the volume of base endurance work and an increase in the amount of threshold work. In this way a seamless transition between periods of predominant focus is achieved.

Table 2: An example of a non-linear (undulating) resistance-training programme

Monday (strength)	Wednesday (strength-endurance)	Friday (power)
Squat – 3x 3RM, 3m RI	**Squat** – 3x 10RM, 1m RI	**Squat** – 3x 6 @ 12-15RM, 1m RI
Leg curl – 3x 3RM, 3m RI	**Knee ext** – 3x 10RM, 1m RI	**Knee ext** – 3x 6 @ 12-15RM, 1m RI
Bench press – 3x 3RM, 3m RI	**Lower back ext** – 3x 10RM, 1m RI	**Lower back ext** – 3x 6 @ 12-15RM, 1m RI
Seated row – 3x 3RM, 3m RI	**Lat pull-down** – 3x 10RM, 1m RI	**Lat pull-down** – 3x 6 @ 12-15RM, 1m RI
Calf raise – 3 x 3RM, 3m RI	**Leg curl** – 3x 10RM, 1m RI	**Leg curl** – 3x 6 @ 12-15RM, 1m RI
	Calf raise – 3x 10RM, 1m RI	**Calf raise** – 3x 6 @ 12-15RM, 1m RI
	Bench press – 3x 10RM, 1m RI	**Bench press** – 3x 6 @ 12-15RM, 1m RI
	Seated row – 3x 10RM, 1m RI	**Seated row** – 3x 6 @ 12-15RM, 1m RI
	Military press – 3x 10RM, 1m RI	**Military press** – 3x 6 @ 12-15RM, 1m RI
	Abdominal curl – 3x 10RM, 1m RI	**Abdominal curl** – 3x 6 @ 12-15RM, 1m RI
	Arm curl – 3x 10RM, 1m RI	**Arm curl** – 3x 6 @ 12-15RM, 1m RI

NB: 'RM' is 'rep max', so 3-rep max (3RM) is the heaviest weight that can be lifted just three times; 'RI' is 'rest interval', so 3 x 3RM, 1m RI = three sets using the 3-rep max weight, with a one-minute rest between sets

'There are 'transition' phases: these channel the strength and endurance gained in the previous phases into the subsequent one'

Table 1 (*see page 12*) shows an example of a periodised year for a 400m swimmer. This is an annual linear periodised programme with six to eight competitions in a season lasting 16 weeks (LT again refers to lactate threshold training). Note that in the table there are 'transition' phases: the purpose of these is to channel the strength and endurance gained in the previous training phase into the subsequent one. These phases could be

termed pre-competition 1 and pre-competition 2, for example, as distinct mesocycles in their own right.

For winter sports, using cross-country skiing as an example, base endurance work, as noted, occurs in the summer. This usually involves roller skiing, running and cycling, utilising base endurance training such as 30 minutes to two hours of continuous or interval work, at 70%-80% of maximum heart rate.

Likewise, the transition phase between the preparation (conditioning) phase and pre-competitive phase involves a decrease in the base endurance work and a gradual increase in the volume of faster training, such as tempo/LT work. Other training methods are not eliminated but are used occasionally

Real-world periodisation

In the real world, with many sports increasing the amount of competition during their competitive phases, programmes emerge that are a combination of models, with a linear periodised model operating for most of the year and a non-linear (undulating periodisation) model operating during the competitive phase. *See figure 1 for an example of this.* This model would reflect the training required of a middle distance runner, for example, entering a season without an absolute defined peak – perhaps a US runner in a non-Olympic year who wants to run well on the European circuit and continually earn some money from race success!

Figure 1: A combined linear/non-linear model – a linear periodised programme with two-week detail for a non-linear competitive phase where there are one to two competitions per week for 16 weeks

Preparation		Trans	Pre-comp		Trans	Comp season	Trans
Base endurance	LT	LT/Speed	Speed	Speed	Taper	***Non-linear periodised programme***	Active rest
14 wks	8-10 wks	3 wks	2 wks	2 wks	2 wks	1-2 comps per wk for 16 wks	4 wks

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14
LSD	speed	LT	speed	easy	comp	rest	speed	LT	LSD	LT	speed	easy	comp

Note: LSD = long, slow distance work, LT = lactate threshold / tempo work, Trans = transition phase, comp = competitive or competition.

A periodisation programme must have the following training principles at its heart:

- **Progressive overload** – to improve your performance, you have to continually provide the body with a stimulus that will provoke physiological change;
- **Specificity** – training needs to be relevant to your sport: for example, to run faster, you need to train at a faster pace, *etc*;
- **Reversibility** – if you do not continue to provide the same training stimuli, training gains may be lost.

to maintain other aspects of conditioning – for example, there will still be some base endurance work, which may take the form of recovery sessions between the harder, faster ones. The key point is that for individual endurance sports, training organisation is very similar, the only difference being the 'opposite' times of year where types of training occur between summer and winter sports.

'In linear periodisation, the primary aim is preparation for competition'

Linear periodisation

The type of periodisation described above, where a limited number peaks are aimed for, is known as 'linear (or single) periodisation'. In this model, the primary aim is preparation for competition or, more generally, improving the functional capacity (anatomy and physiology) of the individual. However, in sports where there is a long season, such as football and tennis, the time for training is reduced and the number of competitions is increased, and so a different form of periodisation with a different purpose is favoured.

Non-linear (or undulating) periodisation

In professional football, it is quite common for quality of play to decrease towards the end of the season. Clearly, aspects of physiology related to high-intensity performance are retained, thanks to specific stimuli resulting from the game environment. However, those aspects that help to minimise fatigue and

Peaking

Peaking is the Holy Grail of sports performance – who gets it right on the day wins. This relies on having carefully constructed mesocycles (and microcycles) that reduce the quantity of training and emphasise quality. A sprint athlete may drop down to doing just one or two flat-out efforts a couple of times a week in the week or so preceding their 'peak' competition. They need to arrive at the competition fresh and sharp. However, as Bompa, for example, points out (*see article on page 63*), maintaining strength so that speed can still be optimised is a crucial consideration. Consequently, the athlete may perform weight training sessions comprised of one to four lifts on their key exercises, lifting near to maximum to maintain strength, but not develop further strength nor induce physical and mental fatigue.

So, the relationship between the amount of reduction in volume and the amount of time over which that reduction takes place is critical. If the reduction occurs too fast then there will be an insufficient stimulus to prevent detraining. If the reduction is too slow, then recovery will be inadequate and performance will be sub-optimal.

Peaking and different peaking protocols

Exponential tapers are generally considered best and are of two types: fast and slow decay. Exponential tapers involve a 'relative reduction' in volume – *ie*, successive percentage decreases – whereas linear tapers reduce the volume by absolute amounts. A fast decaying exponential taper (larger percentage decreases), is used with very well conditioned (*ie* 'fitter') individuals or those with less available time between required peaks. A slow decay (smaller percentage decreases) is used with those who are less well conditioned (*eg* where time off due to illness or injury has been required).

ensure good recovery are being lost because of a lack of base fitness maintenance work – and the opportunity to achieve this is much more limited in-season. Likewise, speed and power may decrease as a player becomes less strong and less able to exert maximum force.

Steps should therefore be taken to avoid a reduction in endurance and speed, and this can be achieved by adding one or two training sessions into each microcycle to maintain those

aspects, which might otherwise be lost. Regular weight training workouts and power work should therefore be included to maintain speed and power.

The primary aim of non-linear periodisation is the maintenance of previously hard-won physiological advances. Table 2 (*page 13*) shows a simple example of a non-linear model reflecting resistance training. Strength, strength-endurance and power are required by strength and sprint athletes and, to ensure that at certain times of year all are maintained, training must encompass all of these *every* week. Note that undulating periodisation can be constructed differently to allow for optimised performance across sports with long playing seasons, such as rugby and football.

'The primary aim of non-linear periodisation is the maintenance of previously hard-won physiological advances'

Conclusion

Non-linear or undulating periodisation is increasingly used in sports training, but rather than linear or non-linear models presenting an either/or choice, it can be most effective when both linear and non-linear models are merged within the same macrocycle. This is particularly so when the sport has a long, intense competition season. We shall also see that there are other models of periodisation, such as double or triple methods that can also be adapted by a coach to bring about optimum performance when it matters, for their respective sport.

Peaking relies on a huge range of variables and it is widely acknowledged that, as well as the physical aspect, the mental factor cannot be overlooked. A peak can be conjured up by an athlete who is in the right frame of mind (and maybe not in the best physical condition), but it is all the more likely to occur when they are in the best possible physical shape. Psychological periodisation must thus go hand in hand with physical, to cover all aspects of performance peaking (*reference to this is made in John Shepherd's article on page 51*).

PERIODISATION FOR STRENGTH

In this series of four articles, Phil Gardiner explains in practical terms how to use periodisation to plan and implement a strength-training programme. He identifies four distinct phases:

1) The strength preparation phase
2) The strength build-up phase
3) The strength transition phase
4) The strength maintenance/competitive phase.

Phil's thoughts can be applied to most sports, and he provides numerous examples of relevant exercises and programmes, for use during the training phases.

Phase 1:
The preparation phase

The need for strength in sports is now generally accepted. I have witnessed mediocre teams and individuals in field sports and other events improve quite dramatically by adopting a structured strength-training programme. Whether at elite or recreational level, a strength-training programme should be planned and implemented according to sound principles to optimise the athlete's performance capabilities.

The aim of this series is to give you an insight into the type of work that can be included in a progressive strength programme and inform you on how to plan such a programme. We start with the strength preparation phase.

The strength preparation phase is extremely important. It is during this period that the framework of physical, technical and psychological preparation is developed prior to the competition phase. Inadequate training performed during this period will create problems during the competitive phase, which will be very difficult – if not impossible – to rectify. During this phase a

relatively high volume of training is required in order to prepare the body for the higher-intensity training* and competitions that follow, where the ability to recover quickly is important. It is also essential as it can provide the basis for injury prevention. This is because strong, flexible muscles can withstand the rigours of competitive sport much better than the non-strength trained.

* Higher-intensity training refers to sport-specific training, speed training and plyometrics (jumping-type exercises) and heavy weight (over 85% of 1-rep maximum – 1RM) training.

How long should a strength preparation phase be?

This will vary according to the type of sport. For sports with clearly defined, relatively short competition phases:

- Single-competition phase (*eg*, track and field athletes and swimmers preparing for one major event in the training year): 32 weeks plus
- Double-competition phase (*eg*, track and field athletes or gymnasts, preparing for two peaks, perhaps in the winter and summer seasons): 13 weeks plus
- Triple-competition phase (*eg*, sprinters going for three peaks, indoor season, mid and late summer outdoor seasons): eight weeks plus.

'Strong, flexible muscles can withstand the rigours of competitive sport much better than the non-strength trained'

Sports with multiple competitions require a different approach. Coaches in charge of football and rugby teams, for example, tend to adopt a single periodised plan. The drawback is that, unlike track and field or rowing, their competitive seasons are normally several months longer (with one or two matches weekly), so preparation time is at a premium. And in tennis, for example, because of indoor facilities, there are competitive opportunities throughout the year. For these sports, fitting in a strength preparation phase can be difficult. Coach and athlete may have to fit in short preparatory phases before less important tournaments and select their competition schedule accordingly.

In sports such as triathlon and marathon running, long periods of recovery and preparation are necessary to allow the

Further information is provided on different models of periodisation on page 41.
Note: Coaches do vary in their beliefs about periodisation – for example, some endurance runners will not follow a double or triple periodisation programme, favouring a single peak, which allows for a considerable period of base building.

athletes ample time to prepare and recover from their efforts. These athletes are more likely to benefit from a double or triple competition year. This would allow enough time to develop the required strength (and other qualities) in the 'gaps' between competitions.

Strength-endurance training is crucial

Irrespective of whether your sport requires great endurance or is predominately speed-based, the foundation period must contain strength-endurance training at relatively low intensity, but with a fairly high training volume (in terms of repetitions and sets). This will allow the muscles to build up the endurance necessary to withstand and recover from the more intensive work that will be demanded of them in the subsequent training and competition phases.

'Irrespective of whether your sport is endurance- or speed-based, the foundation period must include strength-endurance training at quite low intensity, but with a fairly high training volume'

In terms of strength, intensity is measured by the 1RM that the athlete is capable of lifting at the time of doing the training (as opposed to their lifetime best lift). I advocate this as being around 65-75% of 1RM during this phase.

Note: More experienced athletes should spend less time on lower-intensity strength training than novice athletes, before moving onto higher-intensity workloads – *eg*, six as opposed to eight weeks for sports with a triple-competition year.

The best strength preparation phase exercises

It is important to utilise multi-joint free weight exercises, such as the squat or dead-lift, as opposed to isolated (single joint) exercises, such as biceps curls or leg extensions. This is because multi-joint free weight exercises have a systemic effect that

reaches beyond the muscle fibres recruited in their execution. This means that they activate the neuromuscular system, which in turn improves coordination. In simple terms, they improve the body's ability to move fast, change direction and employ all the various movements and skills used in sports. They also release greater quantities of the androgen (growth) hormones – testosterone and growth hormone – which, among many positive functions, can contribute to the increased growth of stronger, more powerful muscle fibre.

'Multi-joint free weight exercises… improve the body's ability to move fast, change direction and employ all the various movements and skills used in sports'

Certain fixed-weight machines can serve a useful sports strength preparatory role – for example, the low pulley row, or leg press – but multi-joint free weight exercises usually have a better transfer to athleticism.

Designing the preparatory strength phase

Preparation is the foundation of success, and a well-designed training plan is key. Take into account:

1) Tempo and load – movements should be controlled and should be made through the full available range of motion.

2) Do not exercise to failure, only to fatigue – the aim is to gradually progress condition and avoid excess muscle soreness (and, in worse case scenarios, injury).

3) Do not attempt unrealistic loads – begin with two or three workouts per week, using six to eight exercises over two or three sets of eight to 12 repetitions, and allowing two to three minutes' rest between sets. The loads should be between 65% and 75% of 1RM and performed in circuit format.

4) It is not necessary to endure prolonged workouts in the gym to achieve progress – 30-45 minutes will normally suffice.

5) It is not necessary to lift weights more than three times per week to achieve success – lifting more frequently will not allow the body sufficient time for recovery and adaptation. It can take 48 hours to recover from strength training. Moreover, it

is not when you are training that adaptation occurs, but when you are not training (*this is explained further on page 27*).

6) When training for sports such as football and tennis, you should take into consideration the time and effort being put into your sport-specific training and allow for recovery time – you need to follow a balanced, inclusive training programme.

Circuit and stage circuit training methods

Circuit format: Exercises are performed consecutively with minimal rest between each. Two to three minutes' recovery is then taken at the end of the circuit. All major muscle groups should be worked. It is the best format to use when working at lower intensities and for training less mature athletes.

Stage format: I believe this method is best for achieving strength gains, when the loads lifted increase in intensity beyond the 75% limit of the strength preparation phase. It's a more advanced system and should be used only by appropriately experienced athletes. The athlete completes, say, three sets of each exercise before moving on to the next exercise.

'It is always good to commence the strength preparation phase with body-weight exercises before progressing to weight training workouts'

Body-weight exercises and strength preparation

It is always good to commence the strength preparation phase with body-weight exercises, before progressing to weight training workouts. These are usually performed in circuit format, although the intensity can be increased by using the stage method. Try it and you'll feel how much tougher it is to do four sets of 20 press-ups, with a short recovery between each set, before moving on to the next (different) exercise.

Sample strength preparation phase workouts

The following workouts will provide a solid strength-endurance base for numerous sports. Note that as the loads (intensity) increase, the number of exercises and repetitions decreases proportionally. If necessary, the number of sets can be reduced to one or two when the intensity is increased, before building

back up to three as the body adapts.

I have included exercises for the glutes and the lower back – *eg*, dead-lifts and the bent-over row. These exercises play a vital part in the prevention of injuries to the legs and lower back and improve the body's ability to sprint, jump, kick, *etc*.

Note: You should vary the core exercises to ensure that all 'ab' and back areas and muscles are targeted.

Strength preparation workout 1

Circuit style – suitable for most sports, and for those sportsmen and sportswomen who are new to circuit training

	Sets	Reps	% of 1RM	Recovery
Squat	3	12	65	1 min.
Bench press	3	12	65	1 min.
Dead-lift	3	12	65	1 min.
Calf raise	3	12	65	1 min.
Ab exercise	3	20	-	1 min.
Front pull-down	3	12	65	1 min.
Hyper-extensions	3	20	-	1 min.

Strength preparation workout 2

Stage format – suitable for intermediate to advanced trainers

	Sets	10 reps	% of 1RM	Recovery
Squat	3	10	70	2 min. 30 sec.
Bench press	3	10	70	2 min. 30 sec.
Leg curl (concentrate on the lowering phase)	3	10	70	2 min. 30 sec.
Seated row	3	15	70	2 min. 30 sec.
Ab exercise		20	-	2 min. 30 sec.
Calf raise	3	15	70	2 min. 30 sec.
Lateral dumbbell raise	3	10	70	2 min. 30 sec.

Phase 2:
Powering up your sports performance with weights – the strength build-up phase

Following the strength preparation phase, most athletes will move into a training phase designed to increase muscular strength – which, if planned and executed properly, will improve the body's ability to express acquired strength quickly. In short, they will be developing power, which will improve their sports performance. Power is an area of training where the amateur player can make big improvements to their game.

Examples of an expression of power include a rugby player accelerating past an opponent, a footballer kicking a football hard, jumping and striking a volleyball and leaping for a slam dunk in basketball.

I recommend that at least eight weeks be devoted to the strength build-up phase. This phase should be positioned in the training plan prior to the commencement of the playing/competition season and after the strength preparation phase. However, this is not always possible due to the requirements of particular sports such as football, with their multiple competitions. In sports such as these, strength will be developed pre-season and then maintained in-season or during breaks. For sports with more clearly defined playing/competition seasons I believe that is acceptable to carry on with the strength build-up phase into the early part of the competition season, providing it does not affect the athlete's ability to develop sport-specific skills and/or play matches.

Increase intensity but allow sufficient rest

A good way to schedule the strength build-up phase is to increase intensity over a three-week period, with two to three sessions a

week. I recommend that this should be followed by one week of lower-intensity work. This will allow the body to recover from the accumulation of what is an intense period of training, before increasing intensity again over a further three-week period. Another single recovery week is then used to recover prior to either a further increase in intensity or a change in training emphasis to in-season strength training (*this will be covered in Phase 3 – see page 31*). The single recovery weeks are often referred to as 'de-load weeks'.

De-load weeks are not meant to be rest weeks. Training should continue but at lower intensities. Total cessation should only occur if the player is unwell or injury prevents them from training.

What constitutes the strength build-up phase?

The key here is maximum strength training. This should be completed with limited work volume, particularly if performed in conjunction with speed/skill training. The emphasis is therefore on quality. To develop maximum strength and power the athlete should lift at the following percentages of 1RM:

- Core lifts: 80-90% of 1RM

Core lifts work major muscle groups over numerous joints: *eg*, squats, dead-lifts and cleans

- Auxiliary (isolation) lifts: 65-75% of 1RM

Auxiliary lifts usually target smaller muscles/muscle groups over single joints: *eg*, lat pull-downs and calf raises.

'Strength training exercises should be tailored to improve the specific muscles and movement patterns associated with the player's particular sport – they should be "specific"'

To develop maximum strength and power I recommend that the 'stage' format of exercise progression be followed. Here the player performs all their sets on one particular exercise before moving on to the next. A full recovery (90 seconds plus) should be allowed between reps and sets to permit for maximum effort (*see sample workouts on pages 29-30*).

Exercises should be specific

Strength training exercises should be tailored to improve the specific muscles and movement patterns associated with the player's particular sport – they should be 'specific'. For example,

exercises such as the squat involve triple extension – of the ankles, knees and hips. This (posterior chain) movement pattern is essential to many sports.

Specificity in training is important, but less specific exercises such as the bench press do have relevance in terms of improving overall strength, which can then be 'translated' into more sport-specific strength through channelling exercises (*examples of this are given in Phase 3 – see page 31*).

To lift heavier weights and increase maximum strength, you need to:

1. Reduce volume – the number of lifts performed in each session must be reduced. Reps should be between one and six and sets should be equally low, between one and three. A full recovery must be taken to allow for optimum lifting.

'Adaptation occurs when the body repairs itself following the breakdown of muscle tissue during strength training'

2. Increase rest – between lifts and sets; for example, allow at least 90 seconds between sets.

3. Increase recovery between workouts – leave at least 48 hours between strength training workouts to allow for adaptation. Adaptation occurs when the body repairs itself following the breakdown of muscle tissue during strength training. This results in the body becoming stronger.

4. Vary the exercises used – when a new exercise is introduced, time should be allowed to learn its technique. Consequentially, loads should be kept light. Adaptation will still take place due to a new movement pattern being learned and muscles being used in different ways.

Strength building tips

1) Focus on the glutes, calf muscles, hamstrings and the muscles of the lower back, as strength in the posterior chain provides the foundation for athletic function.

2) Some upper body work needs to be carried out; in particular, the shoulders, triceps and abdominal muscles should not be

neglected (obviously, if your sport requires great upper body strength – say, if you are a shot putter – then work should be done specifically on this area, with relevant weights exercises). **3)** Strengthening the area around the shoulder joint helps to prevent injuries – for example, to the rotator cuff. Dislocations of the shoulder are fairly common in contact sports, particularly among amateur rugby players, and this is often a reflection of poor conditioning.

Strength-building exercises and their relevance to sport

Muscles	Sports relevance	Selected exercises
Glutes and hamstrings	Sprinting and jumping	Dead-lift, lunge, squat, leg curl
Quadriceps	Kicking a ball, acceleration	Front squat, lunge, leg press
Lower back and glutes	Most activities	Bent row, good mornings
Triceps	Throwing, racquet sports, volleyball spike	Triceps extension, triceps dip

Avoid imbalances

'It is important not to overwork certain muscle groups at the expense of others – muscle imbalances are often the cause of injuries'

It is important not to overwork certain muscle groups at the expense of others – muscle imbalances are often the cause of injuries, particularly hamstring strains and tears. For example, footballers are usually strong in the quadriceps muscles (due to the amount of time they spend kicking the ball and making quick accelerations and turns), but often have weak and tight hamstrings, due to inadequate strength and flexibility training. This is a recipe for injury.

The planning of exercises to strengthen the muscles around the shoulder joint also requires great care. It is quite common for weight-training enthusiasts to end up with a rounded upper back, as a result of an over emphasis on exercises for the chest and front shoulder muscles, and insufficient attention to the rear upper body muscles. Players risk shoulder injuries if the muscles strengthened are on only one side of the joint. The

synergistic muscles work the protagonist muscles to support a movement. Though the former tend to get little stimulation, it is important to strengthen them along with the protagonist muscles, to maintain muscular balance and so minimise the risk of joint and strain injuries.

Suggested maximum-strength, power-building workouts

Workout 1:

Suitable for experienced weightlifters and all sports returning to autumn/winter training

Exercise	Sets	Reps	% of 1RM	Recovery
Squat	3	6	80	3-4 min.
Incline press	3	6	80	3-4 min.
Leg curl	3	6 (each leg)	75	3-4 min.
Lat pull-down	3	12	65	2 min.
Dumbbell side-bend	3	12 (each side)	65	2 min.

Workout 2a:

Suitable for intermediate weightlifters and all sports

Exercise	Sets	Reps	% of 1RM	Recovery
Lunge	3	8	75	3 min.
Bench press	3	8	75	3 min.
Dead-lift	3	8	75	3 min.
Front pull-down	3	12	65	2 min.
Sit-up	3	30 sec.		2 min.

This could be progressed to Workout 2b (*next page*)

Workout 2b:
A progression from Workout 2a, for intermediate weightlifters and all sports

Exercise	Sets	Reps	% of 1RM	Recovery
Squat	3	5	85	3-5 min.
Dead-lift	3	5	85	3-5 min.
Seated row	3	12	65	2 min.
Triceps dip	3	30 sec.		2 min.
Weighted crunch	3	20	5-10kg weight	3 min.

Workout 3:
Suitable for advanced weightlifters and all sports

Exercise	Sets	Reps	% of 1RM	Recovery
Power clean	4	4	85	4-5 min.
Dead-lift	4	4	85	4-5 min.
Bench press	4	4	85	4-5 min.
Shoulder press	3	12	65	3 min.

The above workouts should be seen as suggestions.

Phase 3:
The strength transition phase

Running fast, jumping high and throwing far and fast are all related to the ability to develop and impart forces quickly – *ie*, they are expressions of power. Following Phase 2, when the athlete should have built up good levels of strength and power, it is now time to enhance and channel that power into applying speed to the movements used in specific sports situations.

Developing and training different types of strength for power

It is important to select the most appropriate methods for the chosen sport for the development and refinement of power, and allow enough time for the training to take effect.

Remember that this type of training is the icing on the cake and that it should follow the basic preparation and strength development phases – failure to do so will result in less than optimised sports performance. The components that need to be improved in this phase are:

- **Starting strength** – the ability to exert maximal force instantly.
- **Explosive strength** – the rate at which the player develops force.
- **Reactive strength** – the ability to move from a yielding, accelerating, decelerating or maximal muscle contraction and into another one as powerfully as possible. The combination of eccentric and concentric muscular action strength can be measured in the time it takes to reverse direction from an eccentric (braking) contraction to a concentric (accelerating) contraction. Examples of this are a rebound jump in basketball or volleyball, or foot contact when sprinting.

This combination of eccentric and concentric contractions is

Rate of muscular force tension versus rate of muscular force production

If an athlete trained only for maximal strength development, they would be capable of expressing large amounts of the rate of muscular force tension but would not improve the rate of muscular force produced. Being bulky and strong is no guarantee of sporting success – unless you happen to be a Sumo wrestler.

The activities or exercises used during this training phase must relate closely to the demands of the sport or event. Medicine-ball throws and plyometric drills are examples of activities that closely mimic movements associated with sport.

known as the stretch-shortening cycle (SSC). An eccentric contraction occurs when a muscle lengthens as it contracts – as during the lowering phase of a biceps curl. A concentric contraction occurs when a muscle shortens as it contracts as during the curling phase of the biceps curl. This eccentric-concentric contraction is key to the stretch-shortening cycle and to plyometric (jumping) exercises.

'Being bulky and strong is no guarantee of sporting success – unless you happen to be a Sumo wrestler'

Starting strength

As with the strength development phase, it is important to use multi-joint dynamic weightlifting exercises that employ triple extension of the leg joints (ankle, knee, hip). Suitable exercises would include: cleans, the snatch, jump squats and lunges.

Note: If the athlete has not mastered the technique of the Olympic lifts, the next best option is to adopt the squat and dead-lift exercises, as they are also multi-joint exercises involving triple extension and they don't require anywhere near as much skill to master.

Plyometric exercise

There are many plyometric drills that are easy to learn and which can be performed within the confines of the weights room – these are normally performed 'on the spot'. One such

drill is the box jump, where the athlete leaps upward onto a box (usually two to three foot high). A double-footed jump is used. Once on the box, the athlete steps back down and repeats the jump. At least 30 seconds' recovery should be allowed between jumps.
Do: 3 x 6.

Explosive strength

As well as via weight training, explosive strength can also be developed by ballistic exercises, such as medicine ball throwing and explosive (plyometric) jumps with one to three ground contacts – for example, hops and bounds.
Do: 4 x 3 reps of each exercise – recovery as above.

Bounds are exaggerated running strides, like the step phase in the triple jump. The athlete steps from one foot to the other as dynamically as possible, trying to remain in the air for as long as possible.

'Reactive strength is trained by using fast, explosive jumps with repeated ground contacts'

Reactive strength

Reactive strength is trained by using fast, explosive jumps with repeated ground contacts – for example, two-footed jumps over small hurdles (the plyometric training tip below is useful to bear in mind while doing this), or fast, repeated medicine-ball chest passes against a wall.
Do: 4 x 12 reps – recovery as above.

Plyometric training tip

Contact with the ground should be light and quick – time spent with the feet in contact with the ground is time wasted when a player is sprinting or jumping.

An elite male sprinter's foot will be in contact with the ground for less than 0.9 sec. Athletes need to train fast to be fast.

How to plan the strength transition phase – power combination training

An effective way to develop power in the strength transition phase is to include ballistic and/or plyometric exercises in the same training session as weight training. This is known as power combination training (*or complex or contrast training – see session examples beginning on opposite page*).

This method, while being effective, is highly intensive and requires a reduction in exercises performed and volume of repetitions per session. Coach and athlete must always emphasise quality.

I tend to advocate performing a set of lifts, followed by a set of ballistic/ plyometric drills (this is the contrast method of power combination training).

A maximum of two sessions of this type of training per week is strongly recommended.

Ensure adequate rest

It is extremely important to allow adequate rest between sets of lifts and drills. This should be as long as three to five minutes. The central nervous system (CNS) and the anaerobic energy systems responsible for generating fast, powerful movements fatigue relatively quickly and require sufficient time to recover. Without this amount of recovery time, quality of movement cannot be repeated.

The key to improving explosive power is quality of movement, not quantity of exercises or repetitions completed: 'Less is more'.

Using speed training to develop power

For the highly conditioned player, it is possible to include sprint training over very short distances within a power development session. This is highly demanding and should only be used by athletes with at least a couple of years' background of specific strength-conditioning training.

The format for such a session would be:

1) Weights
2) Plyometrics/ballistic drills
3) Sprints.

I would recommend no more than 300m total volume of sprint work – over distances of 15-30m in such a session.

This type of workout is very much a short-term method for improving power and speed and should not become a main feature of the overall training programme. I recommend a three-week period of this type of training – performed twice per week. After this phase the athlete should have a recovery period of a week to 10 days.

A further three-week cycle followed by another short recovery period can be used if necessary. To continue the training sessions for longer and/or not incorporate suitable rest sessions would result in the player becoming overtrained, which would obviously be counter-productive.

Examples of sessions

1) Basic contrast session

Performed as a contrast session – you do one set of each pairing, for example, leg press, then tuck jump, then bench press and clap push-up, and so on (completing all pairings) to complete one circuit, then start again with the first pairing. Repeat this process until you've completed all pairings two to three times.

Weights all 80% of 1RM x 5 reps	Power drills – 5 reps	Sets 2-3	Recovery between pairings	Recovery between exercises within pairing
Leg press	Tuck jump		5 min.	30 sec.
Bench press	Clap push-up		5 min.	30 sec.
Squat	Standing long jump		5 min.	30 sec.

2) Medium complex session

Performed in complex fashion – all sets of each exercise pairing are completed before moving onto the next pairing – following the recovery guideline provided. Thus you would do all sets of bench presses, before doing all your sets of clap push-ups,

before moving onto the next complex (exercise pairing).

Weights all 80% of 1RM x 5 reps	Power drills – 5 reps	Sets 2-3	Recovery between pairings	Recovery between exercises in each complex
Power clean	Tuck jump		4 min.	30 sec.
Bench press	Med-ball chest pass against wall		4 min.	30 sec.
Squat	Box jump		4 min.	30 sec.

3) Advanced complex session with speed work

Weights all 85% of 1RM x 4 reps	Power drills – 6 reps	Circuits x 2	Recoveries between sets	Recoveries between pairings
Power clean	Hurdle jump		5 min.	1 min.
Bench press	Medicine-ball chest pass		5 min.	1 min.
Split snatch	Split jump		5 min.	1 min.

Allow 10-15 minutes' recovery following the last circuit, before performing sprints.

Perform sprints after completion of all complexes.

Example of suitable sprint component:
2 x 4 x 20m from standing start with two minutes' rest between each sprint and 10 minutes between sets.

Phase 4:
The strength maintenance/ competitive phase

Hopefully, by now the athlete will have successfully followed the training guidance noted in the three prior training phases. Now they face the most important phase of all – the competition season. Often, weights (and other strength-developing aids and methods) are discarded at this time and an emphasis – not surprisingly – is placed on competing and sport-specific training. But is this best practice?

No, not unless you want your hard-earned strength and power to deteriorate during the season and experience a tail-off in performance. So often, amateur sportspeople neglect to maintain their strength levels in pre-season and in-season. This neglect can lead to injury, as the body's resilience declines (weight training develops and maintains the strength of soft tissue – muscles, ligaments and tendons). And equally crucially, not continuing weight training can lead to a drop in form as the athlete begins to lose their ability to utilise the strength, power and pace that was evident earlier in the season. Skill can also deteriorate as a result.

In the competitive season, you must train for both weight and strength.

How to maintain strength and power in-season

So how do we go about maintaining strength and power levels when much of the athlete's energy needs to be channelled into matches and their sport-specific training?

Power expression should hopefully be taken care of by frequent matches and by sport-specific training (*see Phase 3*). But now there must also be a focus on maintaining maximum and general strength levels in the weights room.

If it is felt that lack of specific power is becoming an issue,

How often and how much?

It is advisable to include a strength training session once every seven to 10 days, depending upon competitions in the athlete's training.

This can be a weights session on its own, or it can be a very low volume unit following a planned speed or sport specific session. The latter allows for greater recovery time (further into the training week) as it removes an extra high intensity (weights session) day from the weekly training programme.

It is advisable to cease high-intensity weight training (80% plus of 1RM) seven to 10 days before an important competition, and low-intensity (less than 75% of 1RM) at least five days before an important competition, to avoid fatigue that could impair competitive performance.

A situation may arise because of competition demands that weight training has to be dropped from the training programme for a period lasting more than 10 days. That is OK – it's performing well that matters, and being fresh for competition is paramount. However, just make sure to get back to lifting as soon as possible when a break from intense competition occurs.

Note: Less effort is required to maintain strength, than build it. For example, one set of six lifts completed at 80-85% of 1RM can maintain acquired strength.

To make the best use of your time in the weights room, it is advisable to use the core triple extensor lifts whenever possible.

it can be a very good idea to include a short period of training as outlined in Phase 3 (*ie*, power combination training). But this phase should be of very low volume, particularly if the athlete has been involved in matches/competitions, as recovery will be a crucial factor following such high-intensity training. Additionally, the athlete has only so much central nervous system (CNS)* energy to expend, and factoring this in becomes a crucial consideration. Expend too much CNS energy and the athlete's performance will deteriorate.

* Central nervous system (CNS) – the largest part of the nervous system, including the brain and the spinal cord, which processes information from other parts of the body.

Which exercises?

Remember, core lifts work the major muscle groups. Great examples are: squats, dead-lifts, cleans – all involve the ankle, knee and hip joints (triple extension). As a large number of muscle fibres are involved in completing these lifts, only a small number of exercises, sets and reps are needed in the maintenance programme, especially when the loads are high-intensity. I prefer lifts to be performed at 80% of maximum during this phase.

The auxiliary lifts – *eg*, the lat pull-down – targets smaller muscle groups over single joints and have a lower overall motor unit recruitment and are performed at lower intensities. These lifts can still be valuable during the maintenance phase, particularly near a major competition when it is advisable to reduce training intensity.

Examples of in-season weights workouts

1. Single-unit session (no major competition within 14 days)

Lifts	Sets	Reps	% of 1RM	Recovery
Squats	2-3	6	80	5 min.
Dead-lifts	2-3	6	80	5 min.
Seated row	2-3	12	65	3 min.
Dumb-bell press	2-3	12	65	3 min.

Reduce the number of exercises to two to three and the sets to two nearer to a major competition

2. Strength unit following speed/competition-specific unit

Lifts	Sets	Reps	%1RM	Recovery
Bench press	2	6	80	5 min.
Bent-over row	2	6	80	5 min.

This unit is limited to the upper body (one pushing movement, one pulling movement) as the athlete's central nervous system will be taxed following high-intensity work and this crucial contributor to top performance does not want to be drained.

3. Strength endurance unit – to maintain general fitness

Lifts	Sets	Reps	% of 1RM	Recovery
Lunge	3	10	65	2 min.
Bench press	3	10	65	2 min.
Dead-lift	3	10	65	2 min.
Front pull-down	3	12	60	2 min.
Ab exercise	3	30 sec.		3 min.

This workout could be substituted with body-weight circuit training, which could be performed on recovery days. This is because the intensity is low. It could also be combined with low-intensity tempo running to aid recovery from high intensity sessions and maintain general fitness.

IMPORTANT NOTE: DO NOT ATTEMPT TO FIT MORE THAN TWO STRENGTH SESSIONS INTO A WEEKLY PROGRAMME DURING THE COMPETITION SEASON.

Different models of periodisation

In this article, John Shepherd puts periodisation under the microscope, considers its application to a wide range of sports and specifically addresses its relationship with competition and skill acquisition

The Soviet sports scientist Leonid Matveyev was one of the pioneers of modern periodisation theory in the Sixties (along with Romanian Tudor Bompa – see next article). His work and that of others has subsequently been reinterpreted and modified to produce different periodisation models for different sports – but all aim to achieve the optimum conditions for peak performance.

Under the 'classic' Matveyev model, the training year is divided into distinct training phases. As Richard Godfrey pointed out in his 'Practical periodisation' article, dependent on their duration these are termed, 'macro', 'meso' and 'micro' cycles. As a rough guide, macrocycles normally last months, mesocycles weeks, and microcycles days. Within each cycle, the key training variables of volume, intensity and specificity are manipulated to create the desired training effect.

Sports such as track and field, and swimming, tend to lend themselves more to Matveyev's original thoughts on periodisation, unlike those such as judo, football, cricket, rugby and tennis. Two key reasons can be identified:

- The former's performance outcomes in training and competition can be easily measured. For example, the enhancement of CV ability can be intrinsically linked to heart rate and VO_2 max (the maximum amount of oxygen the body can process, or percentages of this) and the development

of strength and power – for example as percentages of 1RM, the maximum.
- These sports have a relatively low skill component.

This means that a highly quantifiable periodisation programme can be established and worked toward. This is not the same for the more 'qualitative sports', such as football with their much greater and diverse skill requirements.

Periodisation for high skill-dependent sports

Let's take a closer look at one of these sports, judo. Even though judo players will condition themselves with weights and anaerobic/aerobic activity, in a quantifiable way, they will also need to spend a great deal of time progressing to a more tactical, intuitive and more combative competitive peak.

'Coaches in the more qualitative sports can and do often also construct specific quantitative measures to assist the periodisation of their performers'

This has led coaches in judo and similar sports to devise their own periodisation approaches. For example, judo coaches equate time on the mat – *ie,* time spent doing judo – as the key element of the training variable volume [1]. As the competition macrocycle approaches, more time is spent practising the sport and less on general conditioning, in order to develop peak performance. Although this may seem an obvious pathway, it is surprising how many coaches and athletes (whatever their sport) overlook this and become overly preoccupied with developing strength and power, at the expense of skill. This can result in impaired performance, despite improved condition.

It should be noted that coaches in the more qualitative sports can and do often also construct specific quantitative measures to assist the periodisation of their performers. Again from the world of judo, the Polish sports scientist Sikorski devised 11 general and 23 judo-specific drills, for the national team, based on lactate* production and heart rate response. These are used to shape the training cycles.

* Lactate is a body chemical involved in energy production, and its level in the blood rises as a consequence of intense exercise. Basically, the more lactate that the body produces, the harder a

muscle/muscles (and therefore the athlete) has to work.

Team sports

Periodisation can be difficult to apply to team sports, such as football and rugby. Like judo, these often have a high skill component and extremely long and highly competitive playing seasons. Let's consider a real-world sporting example – the 2001 British Lions rugby tour to Australia. The players arrived 'down under' after a tough domestic and international season. They also had a very tough tour itinerary. Yet for reasons best known to the coaching and management staff, they were subjected to a highly demanding training programme. It was as if, within a very short space of time, a mini periodisation programme was being implemented – with too much emphasis on general and specific and, in particular, contact training. The latter resulted in injuries to key players, such as Dan Luger and Mike Catt. Many players commented on the tough regime and the fact that it left them tired before games [2].

'It appears that for team sports and individual sports with long seasons, pre-season or in-season breaks are the best times to improve physical condition'

So what could the Lions' management have done, fitness-wise? Maintaining condition from the previous long season, rather than attempting to lift it might have been the solution. It appears that for team sports and individual sports with long seasons (such as tennis), pre-season or in-season breaks are the best times to improve physical condition. Trying to develop more endurance or strength in-season (or very close to the end of a long season), when players are fatigued, can lead to staleness and injury.

Sports and periodisation focus

Rugby League – can specific physical qualities be lifted in-season?

Researchers studied 14 professional and 15 college-aged rugby league players over 29 weeks in-season, in an attempt to determine whether maximum strength and power could be increased commensurately within the demands of playing and recovery [3]. All players performed concurrent training aimed at increasing strength, power, speed, and energy-system fitness,

as well as skill and team practice sessions.

The college-aged players showed a significant improvement in 1RM bench press, but not bench throw, or jump squat maximum power. The professional players' performances remained unchanged in all tests across the season.

In attempting to explain these findings, the researchers believed that the fact that no reductions in any of the tests for either group occurred reflected prioritisation, sequencing and the timing of training sessions. Secondly, it was postulated that the better conditioned an athlete is, the lesser the potential there is for the interference effect to occur. (The interference effect describes physiological difficulties that are encountered when attempting to train different energy systems at the same time, for example endurance and power – something that rugby league players have to do.)

'The specific physiological requirements of a sport are equally important considerations for successful team sport periodisation'

Volleyball

The specific physiological requirements of a sport are therefore equally important considerations for successful team sport periodisation. Researchers [4] looked at volleyball. It was discovered that it was possible to improve the jump performance of elite players, during pre and in-season training.

So how was this achieved? With volleyball, there is a very strong 'match' between what the players do in training and what the players do on court. The sport relies more on anaerobic energy – and in particular the immediate anaerobic (less than 10-second) energy pathway – than do sports such as rugby and football. This means that plyometric jump training (as used in the research study) is much more likely to 'fit' and complement the actual physiology of the match situation. This will reduce the interference effect and can allow for the enhancement of physical performance.

Though not the specific topic of this article, coaches and athletes must always be on the lookout for ways in which they can devise specific training drills that fit their sports' playing requirements as closely as possible. These drills should then be utilised throughout the entire periodisation programme, but

particularly in phases 2 and 3 of the strength training phases (*see Phil Gardiner's articles, pages 19-40*).

Squad rotation

Squad rotation offers a further means of maximising team performance. Elite football and rugby sides often perm their starting line-ups from their squads, in order to rest players and maintain and develop their condition. Both the fitness coach and manager must be in harmony if this approach is used. Chairmen, fans, player injuries and the overall success of the team can of course throw a spanner in the works.

'Developing different training plans for different players is also a must for successful team periodisation'

Different training plans for different playing positions

Developing different training plans for different players is also a must for successful team periodisation. Rugby forwards have different physiological requirements from backs, so they need to train differently – *eg*, forwards, particularly the 'tight five', expend more immediate anaerobic energy than back and loose forwards, who are more short-term anaerobic (making speedy and powerful efforts of up to 90 seconds' duration).

I am also aware of how US national soccer squads have utilised specific training programmes, based on highly detailed physiological data that reflects the requirements of each playing position. For example, a mid-fielder will have to do more running on the pitch than a defender or a striker. In consequence, their periodisation plans are designed to reflect this and maintain pre-determined VO_2 max and lactate threshold levels throughout the season. Strikers also make more turns than the other playing positions and their training should also reflect this.

Undulating periodisation

Undulating periodisation (UP) is probably the best option for the team sports coach in-season.

(Note: Richard Godfrey also suggests the use of a varied linear and undulating periodisation combination, which suits sports with a long build-up phase and, for example, a 16-week multiple

competition phase.) In the UP model, much shorter training phases (days/weeks) are combined with different modes of exercise and exercise intensities. Basically, the various ingredients in the training mix are cooked up at the same time. One day the emphasis could be on speed and power, the next on endurance and the next on skill and agility. This type of training should also reduce the interference effect, especially if it is closely allied to the needs of the playing season and the recovery needs of players.

Double periodisation

Double periodisation can elevate all markers of performance, but only for those involved in certain sports, particularly the power and speed track and field events. This follows from the original work of Matveyev. Matveyev believed that significantly greater gains in performance could be achieved on a year in, year out basis when two competitive peaks were being trained for. It was estimated that a 100m sprinter could expect a 1.55% improvement in performance following a double periodisation year and only a 0.96% one with single periodisation. The figures for a high jump athlete make even more impressive reading, with a 5.05% versus 2.40% return ratio. It's believed that two competitive periods and their preparation allow for the continuance of higher and more specific training intensities, with little disruption to technical proficiency (skill acquisition).

'Double periodisation can elevate all markers of performance, but only for those involved in certain sports, particularly power and speed track and field events'

Note: Due to the different physiological processes involved in developing a substantial and lasting endurance base, double periodisation is not recommended for those involved in endurance sports. Nor is it suited to multi-competition sports, unless in-season breaks are scheduled (as in the Scandinavian and Russian football seasons), to allow for a return to more general conditioning (base building). Additionally, for those sports that allow it, it is not recommended that double periodisation be practised year in, year out. Every third or fourth year, the athlete should return to a single periodisation plan, to enable foundation condition to be re-established.

Periodising skill

Many technical event track and field athletes spend a great deal of time getting stronger and faster, only to find that their performances have not improved on last years when they start competing. This is often the result of them not spending enough time, commensurately applying their new-found physical abilities to the skill requirements of their event. A long jump athlete may find that increased sprinting speed does not produce longer jumps, when it should, because they are unable to convert it into increased distance at take-off. The immediate reaction in the mind of coach and athlete is often that more strength is required, but it's often the case that the answer is more skill. Optimum timing and technical performance can only be achieved by marrying the application of strength, power and speed to the sport's skill. Periodisation must account for this and must not allow the development of physical condition to outpace technical requirements.

This has led to the development of 'skill strength' periodisation models (SSP). Utilised by the Easter Europeans initially this method emphasises the development of sport skill at the beginning of the training year, before more 'power' is added in subsequent training cycles. Skill is then continually topped up throughout the periodisation programme and this should result in a state of affairs where the athlete is always able to maximise their performance through the harmonious expression of physical and technical proficiency.

Note that it is also possible to construct triple periodisation programmes, whereby a power athlete, such as a sprinter or weightlifter, is preparing for a winter, early summer and late summer peak. The aim must be to achieve peak performance at the most important time – which for most athletes would be late summer, when world and Olympic games take place.

Periodising psychological preparation

The application of sport psychology to periodisation has received scant attention. Gloria Balagué is one of the few (at the time of writing) to have addressed this[5]. She has developed a model in which a performer's mental preparation is progressed, in keeping with their physical preparation, throughout the various training cycles. It makes sense that different mental strategies should be employed during the different training phases, to maximise the

athlete's performance and bolster competitive readiness. Thus, during the strength build-up phase, for example, the sport psychologist could be working with a hammer thrower on developing the mental fortitude and belief that he can lift heavier and heavier weights, and move heavy weights as quickly as possible. It is no coincidence that one of Team GB's most successful teams, *ie* the cycling team, attributes a great deal of its success to mental preparation and the help of psychiatrist Dr Steve Peters.

'The culmination of months of prior periodisation can come down to a matter of seconds, so the coach and athlete must now focus sharply on performance readiness'

Competition

The culmination of months of periodisation can come down to a matter of seconds, so the coach and athlete must now focus sharply on performance readiness. It's no use devising the greatest, most detailed and systematic training plan, if the athlete is unable to 'perform'. According to top coach Frank Dick [6], for the track and field athlete (and some individual sports participants), the nature of the competition macrocycle is determined by:

- The number of competitions an athlete will require to stabilise best performance
- Competition dates
- How much recovery the athlete requires between competitions
- Any specific adaptations that may be needed for optimising major competition performance, such as time zone and temperature acclimatisation.

As Dick states, 'Competition is the only means of adapting to the stressor of competition, and to avoid its particular stress simply increases the stress potential of the next one.' This, incidentally, throws up a further reason for the use of progressive psychological strategies to be implemented in harmony with the athlete's physiological preparation – namely, the development of the competitive psyche.

Coaches need to be well aware of when and where they intend to put the conditioning of their charges on the line –

again, this will be easier to ascertain for those in certain sports than others. For example, individual sport athletes, with designated competitive seasons, can use low-key competitions as build-ups to major ones. Their competition meso and micro cycles can also be designed around the athlete's ability to remain in peak condition. Team sports will pose greater challenges in this respect – but they may also profit from the fact that more peaks may be possible for these players.

'Very careful consideration needs to be given to recovery, especially during the competition phase'

Recovery

Very careful consideration also needs to be given to recovery, especially during the competition phase, as the physical and, crucially, the mental drain is so much greater. Indeed, it has been suggested that athletes have only a limited amount of neural energy.

Conclusions

Designing the ultimate training plan is no easy task; there are so many variables to consider. Hopefully, with the information provided in this and the rest of this *Peak Performance* special, you'll be armed with the knowledge and tools to do just this.

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See page 69 for a schematic of single and double periodisation models.

The long and short of it: should sprint athletes turn sprint training convention on its head?

The traditional training approach has been to progress speed athletes from slower, aerobic work through to anaerobic speed work as the season progresses. But it can be argued that this methodology is outdated and that convention should be turned on its head. John Shepherd explores the reasons why…

Until quite recently, the prevailing methodology in sprint athlete training has used a 'long-to-short' training approach. Basically, for this periodisation model, the sprinter performs slower aerobic and anaerobic work at the beginning of the training year and then progresses to faster and faster anaerobic work as the season approaches and in-season. Intensity is increased, training volume reduced, and specificity of training increasing accordingly.

However, more recently a 'short-to-long' approach has become more popular. Coaches such as Charlie Francis (*see box on page 53*) have been at the forefront of such a shift in thinking. The short-to-long approach emphasises speed all year round. Sprint workouts, for example, take place in what would normally be the 'slow, slog' preliminary mesocycles of training, when an athlete is supposedly building sprint condition (using slower speed conditioning methods). Under the short-to-long approach, the athlete never moves more than a few percentage points, as it were, from the ability to move his or her limbs at 100% effort. This, it is claimed, will:

1) Maximise physical speed development

2) Optimally stimulate the central nervous system (CNS), which processes information – so the faster its response, the better for the athlete's performance
3) Reduce injuries (athletes training with the conventional approach can pick up injuries when attempting to sprint after months of much slower work)
4) Allow for more speed peaks
5) Minimise the negative effects (slowing) of de-training of fast-twitch muscle fibre. (*For an explanation of the different types of muscle fibre, see page 56.*)

'Too much emphasis on aerobic work can blunt speed [because] intensive aerobic training causes an unnecessary increase in the oxygen-processing capabilities of endurance-favouring slow-twitch muscle fibre'

The short-to-long approach to sprint training can be seen to reflect the undulating periodisation (UP) theory of training planning (*see pages 15 and 45 if you need a recap on UP*).

How much of an aerobic base does a sprint athlete need?

Aerobic fitness underpins the development of most other types of fitness. The more efficient an athlete's body is at processing oxygen, the quicker it will be able to recover between efforts. In the past, it was reasoned that developing good aerobic condition in a sprint athlete would boost speed development. Thus it was not unknown for rugby and football players to go on 10-mile runs, or sprinters to run continuously for up to 30 minutes!

The logic of this approach is questionable, however, when you consider the actual aerobic/anaerobic content of these sports (*see table 1, page 55*). Most of the work done by field sport players and, more obviously, by the sprinters, is anaerobic (*see table 2, page 56*), and we now know that too much emphasis on aerobic work will blunt speed – the reason being that intensive aerobic training causes an unnecessary increase in the oxygen-processing capabilities of endurance-favouring slow-twitch muscle fibre, and a 'blunting' of the speed- and power-generating capabilities of type IIa and type IIb fast-twitch fibre muscle fibre (*see page 56*).

Prolonged training with a specific emphasis (here, speed) can change fibre types I and II (*see Table 2, page 56*). Sprint

Charlie Francis – sprint guru or sprint devil?

Charlie Francis coached Ben Johnson, the then-fastest man in the world, to the world record and Olympic title in Seoul in 1988. Johnson, as we know, was subsequently stripped of this and other titles for a doping offence. However, it would be erroneous for us to assume that Francis' athletes only won because they were drug-fuelled. The 'Francis sprint training methods' did add that something extra to the performances of those he coached, and one of these was the 'short to long' approach. Among his many other coaching accomplishments was the fact that at the 1984 Olympics, of the 14 Canadian medals, eight were won by Francis-coached athletes. Not surprisingly, his techniques and thoughts are still in demand today.

'A top-class sprinter's leg muscles will comprise 70-80% fast-twitch fibres'

athletes obviously require a proliferation of fast-twitch muscle fibres – a top-class sprinter's leg muscles will comprise 70-80% of fast-twitch fibres – and the short-to-long approach never loses sight of this, as it maximises the opportunity of changing muscle fibre type in the 'right' way so as to optimise speed.

So how much aerobic training is actually necessary in a speed/sprint training programme? Charlie Francis recommends that for training a 'mature' 100m, 200m or 400m runner, the development of base fitness with an aerobic element requires relatively little attention. He advocates only a short (six-week) mesocycle where this conditioning element is given any kind of ascendancy, at the beginning of the training year.

Training immature athletes (*ie*, who have had less than five years of consistent sprint training experience) will require a greater (but still relatively limited) aerobic conditioning emphasis. For such athletes, Francis identifies an eight- to 12-week mesocycle development phase, likewise at the beginning of the training year. Both these durations should allow sufficient time for the coach to plan a double or even a triple periodisation sprint programme, using much more

specific training (of which, more later). Tempo running is used as a much more appropriate, specific base builder. These runs therefor provide a more relevant anaerobic base of fitness, while improving aerobic condition.

A typical workout would be: 100m, 200m, 100m x 3, with 50m walk recovery between each run and 300m walk between sets. The runs would be performed at 75% of maximum speed and the recovery periods.

In the light of this, it is interesting to consider the American approach to pre-season conditioning for field sports such as American football. Here, the emphasis is placed on developing speed and power and much less emphasis is placed on general aerobic conditioning. The reasoning is that in pre-season (where the rigours of competition and travelling between fixtures are absent), proper attention can be given to developing the playing ingredients that will have the most effect on developing peak playing power. In-season training can then concentrate on topping up speed and power levels. This again reflects the short-to-long approach to developing speed (and undulating periodisation). Speed is built prior to the season and maintained throughout.

'Undulating periodisation (UP) is probably the sprint and field coach's most effective way to maximise the playing condition of his or her athletes'

Maintaining speed in-season for speed athletes

Undulating periodisation (UP) is probably the sprint and field sports coach's most effective way to maximise the playing condition of his or her athletes. As we have seen, UP basically mixes and matches all the relevant training ingredients into one training mix. Strength, power, agility, endurance, speed, specific individual and collective playing skills and flexibility are all carefully overlapped and fused together to keep the athlete in peak playing condition.

This requires careful and consistent athlete appraisal on the part of the coach (something that Francis emphasises with his sprint training) and it is crucial that coaches are aware that no two athletes will have exactly the same training needs and that individual training programmes will therefore have to be produced (although this may be more difficult for those

involved in team games). So coaches should realise that one periodisation programme does not fit all.

It should also be noted that even within team sports, some athletes will need greater levels of aerobic conditioning than others, to allow them to cope with the energy pathway demands of their games (looking at football, for example, a midfielder – who does more running over a greater area – will need more aerobic work than a striker, who spends more time around one location). However, even then, anaerobic training is the most important element (*see table 1, below*).

Table 1: Selected track events and sports and their aerobic/anaerobic energy pathway contributions

Event	Aerobic energy pathway contribution	Anaerobic energy pathway contribution
200m	5%	95%
800m	34%	66%
1500m	50%	50%
10,000m	80%	20%
Marathon	98%	2%
Baseball		100%
Basketball		100%
Football		
Goalkeeper		100%
Forward		100%
Midfielder	20%	80%
Field hockey	20%	80%

Adapted from Dintiman, *Sports Speed* (3rd edition) page 149

Table 2: Work performed by sprinters and selected other speed athletes, and energy pathways

Energy pathway	Duration/comments	Sprint activity relevance – selected examples
Immediate anaerobic	6-8 seconds Type IIb fibre emphasis Targeted by sprint and plyometric (jumping) activities	100/200m sprinters – very significant 400m sprinters – significant Football goalkeepers and strikers – significant Racquket sport players significant
Short-term anaerobic	8-90 seconds Type IIa and IIb fibre emphasis Targeted by sprinting, plyometrics and weight training	100-400m sprinters – very significant Field sport players – very significant Racquet sport players – very significant
Aerobic	90 seconds onwards Type I (slow-twitch) fibre emphasis Targeted by steady-paced running	Minimal

Fast-twitch muscle fibre

Type IIa are intermediate fibres that possess a potentially significant power capability if trained appropriately.
Type IIb fast-twitch fibres are the out-and-out power-producing muscle fibres.

Intensity, not volume, is the key to improved sprint performance

Although nearly all athletes increase the volume of their training as they progress year to year, for sprint athletes it is

training intensity that must have the ascendancy. Intensity should increase, while volume will often decrease. The coach needs to carefully monitor the volume of intense work being performed by the athlete and the recovery that is needed to allow progression and reduce injury. The short-to-long approach allows the athlete to never be too far away from absolute sprint condition at any time in the training year.

This is why, for sprint athletes, double and even triple periodisation is advocated (*see figure 1, overleaf*). A triple-periodised training programme allows an elite sprint athlete to peak for the indoor season, mid outdoor season and late outdoor season for Olympic or world championships. Each peak should elicit a higher level of performance than the previous one, whereas the conventional long-to-short approach may fail to provide a real opportunity to achieve three optimum speed peaks, as too much time will be lost in 'returning' to previous speed levels rather than building on them. An exacting sprint coach should attempt to blend all the ingredients of perfect sprint performance into the third peak (acceleration, absolute speed and speed endurance – *see figure 1*).

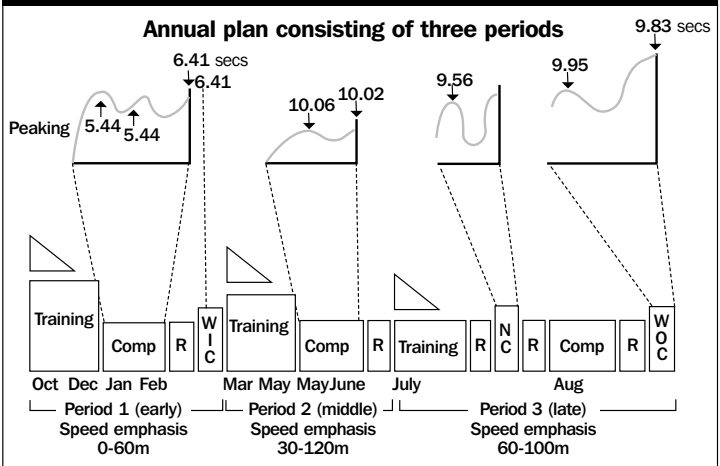
'An exacting sprint coach should attempt to blend all the ingredients of perfect sprint performance into the third peak'

This plan (reflecting Ben Johnson's training) shows how Charlie Francis always saw speed as the key training goal, not an overall or peripheral condition. Progressively quicker times are earmarked for each phase and the training is designed to bring these about. The long-to-short method would literally lag behind developing speed, as the athlete would be taking (sprint) steps backwards to go forwards.

The importance of power

Power is also crucial for the sprinter and the short-to-long periodisation method keeps this on the boil. Francis ensures that complementary training takes place at all time, *eg* by maximum strength work in the gym during tempo running phases and even workouts. He does not advocate combining flat-out sprint work with near-maximum weightlifting, due to the contraindications of the two training methods and the 'strain' that this would place on the CNS. Interestingly, neither

Figure 1: Example of a triple periodisation programme for a sprint athlete (Ben Johnson)



This plan (reflecting Ben Johnson's training) shows how Francis always saw speed as the key training goal, not an overall or peripheral condition. Progressively quicker times are earmarked for each phase and the training designed to bring these about.

Source: *The Charlie Francis Training System* (p101)

does he recommend a weight-training 'channelling' phase. Channelling uses more sport-specific weights exercises performed with increasing speed, after general strength is developed with more general, slower, strength-developing exercises (for example, in channelling training phases, the more sport-specific single-leg squat would follow the more general double-leg squat exercise). Instead, Francis sees sprinting, plus plyometric exercises, as the ultimate 'channeller'.

Sprint speeds as conditioning ingredients

In order to develop optimum speed, the coach and athlete need to carefully blend sprint speeds. We have noted, for example, that aerobic conditioning becomes much less of a concern for nearly all power athletes as they become more mature. In terms of absolute speed, it is generally recommended that running intensities never fall below 75% of maximum speed. Speeds slower than this will not produce a sufficiently strong

Table 3: Sprint speeds as a percentage of maximum speed

Name of speed	Description and comments	Typical workout
Tempo runs	75-85% of max speed, run over 100-300m distances on the track (Francis recommends total weekly distances of 2000-2400m)	6 x 200m at 75% effort (speed) concentrating on form; 5 minutes' recovery between runs
Speed-endurance speed	Sprints over 60-120m designed to improve the sprinter's ability to maintain flat out speed. This type of training is very intense and should be used with caution, due to its stress on the CNS. Regeneration of the athlete is paramount	2 x 120m 100% sprints – full recovery
95% effort speed	These runs are performed just below flat-out. They will groove in flawless technique without over-stressing the athlete and, in particular, their CNS	3 x 120m with 7 minutes' recovery between runs
Out-and-out speed	These runs are performed at 100% effort, they are intense and will stress the CNS	2 sets of 4 x 40m sprints from block start – full recovery between runs
Over-speed speed	These runs are performed at 105% of top speed, using downhill methods or bungees to achieve this. High level of CNS strain	4 x 30m downhill runs with full recovery

stimulatory effect on fast-twitch muscle fibre. Many coaches fail to divide up (in terms of their effects) the percentages of speed that can be generated between 75% and 105% of maximum speed (105% refers to the speed that can be generated through the use of overspeed techniques, such as downhill running and the use of bungees). Various terms have been applied to sprint running speeds based on percentages of effort, such as tempo runs, speed endurance, lactate endurance and maximum speed and over-speed runs. Table 3 (*above*) defines the key types.

Table 4: Eight-week speed-endurance programme

Week 1	Workout	Routine and distance	Repetitions	Rest interval
1	1	Jog 15yd, stride 15yd (75% speed), jog 15yd, walk 15yd	5	No rest between reps; the 15yd walk acts as the recovery phase
2	3	Jog 20yd, stride 20yd 90% speed), jog 2 yd, walk 20yd	5	As above
3	9	Jog 25yd, stride 25yd, sprint 25yd, walk 25yd.	7	As above
4	11	Sprint 20yd, jog 20yd, sprint 20yd, walk 20yd	7	As above
5	14	Sprint 20yd 300yd sprint Run on the spot to exhaustion	10 1 2	Walk 10-30 sec. 2-3 min. 1 min.
6	15	Sprint 40yd 300yd sprint Distance-hop to exhaustion	8 2 1 each leg	Walk 10-30 sec. 2-3 min. 1 min.
7	19	Sprint 20yd, jog 20yd, sprint 20yd, walk 20yd, 300yd sprint	15 3	Walk is the recovery phase 2.5 min.
8	21	440yd sprint	4	4-5 min.

Adapted from Dintiman, *Sports Speed* (3rd edition) page 151/152

Speed-endurance training

Speed endurance is crucial to a multitude of athletes, and a lack of it will result in reduced sports capability. A rugby player short of speed endurance may be intercepted and hauled to the ground after making a 60m break for the line, while a 200m runner may have built up a seemingly victorious lead off the

bend, only to be reeled in and passed in the last five metres of the race. Whereas in field sports, players make repeated short-lived but intense efforts, the athlete with a high level of speed endurance will experience less 'fade' during a match or workout and will be able to maintain high power outputs. Speed endurance workouts are therefore crucial to their training.

The short-to-long approach should be used when developing speed endurance as well as out and out speed. How much of an emphasis the coach places on this will be dependent on the training maturity of the athlete, the point in the playing/training season and the specific playing requirements of the athlete's sport. For example, a midfield football player will require greater speed-endurance capability than a goalkeeper, who needs more 'immediate anaerobic pathway' conditioning. George Dintiman is another one of the world's leading experts on speed training, and he has devised an eight-week speed-endurance training programme designed to increase both immediate and short-term anaerobic fitness. Table 4 (*opposite page*) provides some sample workouts from this programme and shows how it is in keeping with the short-to-long theory of speed development.

'The athlete with a high level of speed-endurance will experience less "fade" during a match or workout and will be able to maintain high power outputs'

The short-to-long approach, as stressed, never loses sight of the need to move at maximum speed. It is totally focused on developing this quality. It strips out (or at least minimises) all the intensities and exercises and energy pathway training that is seen to be detrimental to achieving this goal. And it is very carefully constructed to allow the athlete – and, crucially, their CNS – to optimally adapt.

References

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Tudor Bompa – the 'father of periodisation'

John Shepherd writes: Tudor Bompa has been called the father of periodisation (training planning) and I bet there are few athletes in the world who don't owe their successes (even if they don't realise it) to his theories in some way or another. Bompa has had his detractors (maybe because he advised 'drugs cheat sprinter' Ben Johnson and his coach Charlie Francis in the Eighties), but I believe he is the genuine article. He did the research, proved the theory by coaching Olympic and world champions and should be hailed as one of the greatest practical sports scientists of all time. I was privileged to interview him for our website, and our talk is reprinted here…

JS: How did you get involved in sport?

TB: Like almost every kid in Romania I started to play football. Track and field also captivated me, so much so that during my mid-teens I was very busy training and competing in both sports. I quickly realised the athleticism I gained from track and field greatly helped my football. I was the fastest and the strongest in our junior football league and by the time I was 17 I was selected for the Romanian national under-18 side. And I was still training for track. I won a silver and two bronze medals in the under-18 national championships. These were in the sprints and the pentathlon, so I was busy! However, an unfortunate ankle injury terminated my football career.

Some of my best friends were rowers and due to my injury I found myself turning to this sport. Since I was genetically equipped for speed and power, I had to struggle to achieve a decent

performance level in a sport where endurance is crucial. But somehow I managed and kept going to such an extent that I won a silver medal in the 'four' at the 1958 European Championships.

Professionally, I feel that I owe a great deal to my own sports involvement. I think that without the knowledge I gained from tens of thousands of hours of training and coaching, I would have never reached my best as a professor, a sports training specialist and author.

'Without the knowledge I gained from tens of thousands of hours of training and coaching, I would never have reached my best as a professor, a sports training specialist and author'

Why and how did you get involved in sports science?

I realised that I lacked a great deal of scientific training knowledge. Therefore, for several years I read everything I could put my hands on. And this was in a Communist society where access to information was available to only a selected few. I was coaching rowing and track and field. I was having success with the javelin in particular. I was also invited to coach the national rowing team. From that point on I had access to everything I wanted, including the chance to research many of the training elements that captivated me, for example, strength training as it applies to different sports and the development of endurance. This was in the 1960s, and those were the years that really shaped my professional training philosophy.

You are widely acknowledged as one of the fathers (if not the father) of periodisation. Do you accept this tag, and what made you interested in this field?

Your statement greatly honours me, but it is slightly exaggerated. Let me share with your readers the evolution of periodisation. From the early years of the ancient Olympics, athletes have followed a very simple but logical method of training. They train to compete; compete in pre-Olympic and Olympic Games and then rest and relax. This is periodisation – the athlete follows training phases (now called –'preparatory, competitive and transition' phases). A Russian professor, Leonid Matveyev, was the first to use the term periodisation, in terms of planning the phases of an athlete's training. He borrowed the term from history – where periodisation describes the phases of human

history, for example, antiquity, middle ages and so on.

Matveyev was the first author to really analyse statistically what the Soviet athletes used in training for the 1952 Olympic Games. His work validated the concept of periodisation …… that the annual training plan should be divided into phases of training with each phase having a specific training objective. And that the phases themselves should be subdivided into even smaller training phases called 'macro-cycles' (of two to six weeks' duration) and 'micro-cycles' (a week of training).

How did you get on with the Russians?

It's funny looking back on my time then, as the Russians wanted to steal everything that had been successful in any of the Eastern European countries. So much so, that in the West it's often thought that the Russians discovered everything in training!

'With research and through the efforts of top coaches we constantly discover/ produce better information that enriches the science of training'

What's the difference between the periodisation methods that evolved in the Fifties and those of the present day?

The difference between periodisation in the 1950s and nowadays is that 1) we have created several variations of periodisation and 2) in our planning and periodised training we apply sports science more effectively. With research and through the efforts of top coaches we constantly discover/produce better information that enriches the science of training.

How did you and your colleagues determine if periodisation actually worked?

As I indicated, many elements of periodisation have evolved as a result of a better understanding of sports science or through research, for example, at the Romanian Olympic training centres in Bucharest and Timisoara. It started when we tried to work out why our athletes failed to reach peak performances at the most important competitions!

We are particularly interested in your work on the development of sport-specific strength – where did this interest develop?

In 1963, Mihaela Penes, a junior javelin thrower from Romania,

was left without a coach when she moved to another city. I was approached to help her. I applied what is now known as the 'periodisation of strength' to her training. At that time nobody regarded maximum strength ('MxS') as a key determinant of power.

The logic of the time – and one that is still held by many coaches today – was that since power is the dominant ability in javelin, for example, it (power) has to be trained all the time. However, my logic was different. Since power is a function of MxS, you have to develop MxS first and then convert it into power, prior to participating in major competitions. Many coaches ridiculed me for training MxS. They said that 'MxS will make you slow'!

However, the knowledge we now have in exercise physiology justifies what I believed and believe in. That is, the scope of MxS to recruit more fast-twitch (speed- and power-producing) muscle fibres. This contrasts with power training, which increases the discharge (firing) rate of muscle fibres.

During my first winter with Mihaela I tested my theory and realised that levels of power were much higher following the periodisation of strength. This was in contrast to other athletes who followed the standard training methodology of year-round power training. This was further vindicated by practice, as Mihaela achieved outstanding testing results and a national senior record.

'Mihaela was an unknown athlete outside of Romania… and with her first throw she threw an Olympic record'

Mihaela won the 1964 Javelin Olympic gold…

Yes… since Mihaela was an unknown athlete outside of Romania, I wanted to surprise all her competitors at the Tokyo Olympics. I added another different ingredient into the training plan. This was that her first attempt had to be the best of the day when throwing and strength/power training! We did this in training for almost two years. In Tokyo none of the other throwers were looking out for her and with her first throw she threw an Olympic record. Shock! All the other throwers had long faces. And they still had them by the end of the competition as she climbed the podium to collect her gold medal.

Why the emphasis on weight training for power (if there are

still those that need convincing)?
The best way to answer this question is to show the relationship between strength and other motor abilities.

During an athletic action such as sprinting, the athlete recruits a certain number of fast-twitch muscle fibres – the higher the number, the greater the ability to display both strength and power. Let's assume that athlete 'A' can recruit 60% of all their fast-twitch fibres and athlete B only 55%. Who will display the higher level of power?

But it should be remembered that according to the periodisation of strength, maximum levels of power can only be reached after the MxS phase.

'I finally realised that for sports where a coach has to plan at least two peaks per season, he/she has to use a plan I called double-peak periodisation'

So, how do you organise the periodisation of strength?
The periodisation of strength is organised in this sequence and through these phases:
1. Anatomical adaptation: three to six weeks
2. MxS: six weeks
3. Conversion to power: five to six weeks.

You said there are different periodisation models…
Yes, double (two peaks), and triple (three peaks) periodisation models resulted from detailed studies (*See page 69 for a detailed overview of single and double periodisation*). In the 1960s, most athletes used a mono-cycle, or one-peak annual plan – this used to be a typical plan in track and field. I also used it in rowing. It soon became apparent that the best performance was achieved in early summer (June) and could not be replicated in the late summer (August) during the world championships, for example, with these methods. This failure made me critically analyse what I was doing with my athletes. More testing and research followed and I finally realised that for sports where a coach has to plan at least two peaks per season, he/she has to use a plan I called, at that time, 'double-peak periodisation'.

Between the first peak in June and the second in August, as examples, I had to put in a mini-preparatory phase (involving mostly MxS and power training). A very short transition period

was also included in June, at the end of the first peak – this lasted for two weeks. The result was two world champions in the next year in rowing.

'In order to develop optimum speed, the coach and athlete need to carefully blend sprint speeds'

This variation of periodisation evolved into what I now call a 'bi-cycle or a double peak annual plan'.

You've had your detractors…

Yes, despite the success of my methods I have my detractors, especially in the USA. Several sports scientists have claimed that I didn't really create all the elements of periodisation I have described in my books. They claim that the Russians developed them! And that I 'just' brought them to the West! My reaction: show me a Russian book or article written from 1960-1980 that discusses periodisation of strength/power! The periodisation of endurance! The periodisation of speed and agility! And so on. In fact, two books of mine have been translated into... Russian!

Has periodisation theory changed significantly? There have been a number of articles recently, touting 'the end of periodisation'. These, to me, just supplant linear periodisation with undulating periodisation (UP)….

I read such an article and was very disappointed to realise the author confused loading patterns with the periodisation of training! Anyway, for those who claim the end of periodisation I have two questions/comments to make: a) do they really understand periodisation? I regret to say this, but the more a person questions periodisation, the more I question his/her understanding of sports science and training in general. Let me simply say that for as long as you want to be an effective coach you have to be well organised and conduct a well-organised and planned periodised training methodology. And b) if periodised training is ineffective, what is left to us? We either have periodisation or chaos! Choose what you want.

And… undulating periodisation?

So-called undulating periodisation is nothing but changes to

Schematic of single and double periodisation models

Double		1				2		2		1		
Single												
Month	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct

Key

Reference is made to the phases identified in Phil Gardiner's articles

= preparation macrocycle 1 – would equate to strength preparation phase 1 and strength build-up phase

= specific preparation – would equate to strength transition phase

= competition-specific macrocycle – would equate to competition macrocycle

= rest/recovery macrocycle

Note: The exact training balance would not remain the same in each macrcocyle. The dark to light colouring has been used to graphically illustrate that the training should evolve across the training year, from training phase to training phase

Single periodisation model

This example of a single periodisation plan could apply to a sprint or field event athlete, who is aiming to achieve peak performance for a major championship in August/September. Despite the advantages of double periodisation for certain sports (*see page 46*), following a single periodisation plan every fourth year, for example, is often recommended to aid recovery and build greater base condition.

Double periodisation model

The example of a double periodisation model would suite a sprinter, for example, who is aiming to achieve near peak 60m form in March for the indoor season and then a second maximum competitive peak in Aug/September for 100m championship running.

As indicated, double periodisation may have more advantages over single periodisation for achieving enhanced performance for speed and power sports with clearly defined competitive seasons. Triple periodisation models also exist that would place an ultimate peak in August, for example for the Olympic Games, with the two prior ones occurring in June (perhaps for national trials) and March for important indoor competitions.

General comment

Each phase of preparation in both periodisation models would largely reflect the percentage of general, specific and competition-specific training performed by the athlete. Each would build upon its predecessor.

Each macrocycle would contain specific meso and micro cycles designed to further the athlete's preparation and peaking. These would be planned in great detail as they approached.

the patterns and magnitude of training loads during a week of training. Olympic weightlifting athletes have used variations of loading patterns for generations. Since the Sixties, the variation of loading magnitude per week has also been used in most sports, matching strength-training intensities to the intensities planned for specific training days (days with low, medium or high intensity, for instance). This is better expressed as alternating training loads as a percentage of 1RM.

Is there truly a 'key' weight lift for a power athlete, such as a sprinter? Recently I read an article where the dead-lift was identified by one coach…

For sprinting and any sports that desire quickness, maximum speed and agility, the triple extensor muscles – gastrocnemius and soleus, quadriceps, and gluteus maximus – are determinant for ultimate performance. The propulsion phase (the push-off against the ground) when sprinting is crucial. Weak propulsion potential will increase the duration of the contact phase, making the athlete slower. The stronger the triple extensor muscles, the shorter the duration of the contact phase. A short-duration contact phase means improved speed. Now, the dead-lift does not strengthen the calf muscles! Period! It strengthens the hamstrings – which are essential in terms of power and strength in terms of shortening the recovery phase of the running step (bringing the heels up toward the buttocks).

'Experience as many methods as possible to realise what works best'

I recommend these exercises for sprinters and any athletes that want to become faster and more agile (in this order):

a) Calf (heel) raise
b) Squats
c) A suitable hamstring exercise.

What makes a successful coach?

A few simple comments… have an inquisitive mind! Experience as many methods as possible to realise what works best. Beware of salesmen! Always challenge instructors promoting 'novelties'! Read, read! and read again! You'll find out what is good and what is… trash!

Notes

Notes