The Application of Periodisation Models for Athletes of Different Standards - A Practical Approach

By Craig Abbott, Level 3 - Strength and Conditioning Coach
Level 1 – Sprint Coach
Level 1 – Olympic Lifting Coach

Author's credentials:
I am currently the head fitness advisor for the Box Hill Hawks in the V.F.L and am a tertiary lecturer for Sports Development.
I am also the Director of Ultra-Firm Strength and Conditioning where I develop athletes for a range of sports from endurance based to strength and team sports.

Abstract
The most highly regarded sports scientists claim that programming is not an exact science, and therefore there is no absolute right answer in determining the best approach to planning and organization. However, using the underpinning principles behind periodisation, any coach should be able to adapt the experts' models to the specific needs of their athletes.

The aim of this paper is to provide an insight into the successful application of periodisation models for athletes of different qualification. Coaches will find that the classical model of periodisation will not suit athletes who have surpassed the novice stage and need a higher level of programming to elicit ongoing positive results.

The content presented herein does not simply look at different models in terms of their structure, but also provides useful information for how they are to be applied in the field. It also highlights the fact that the coach needs to take into account the unique characteristics of the athlete or team as well as the distinct sporting, cultural and political environment in which they operate.

Finally, the paper offers practical suggestions for coaches on how to apply the various classifications of periodised models to their training programs. It is my own observation and desire to bring the best out of the athletes that have inspired me to address this topic. Much of the literature regarding this subject is rather technical, and I have attempted to present this in a simplistic and practical way.

Introduction

The main role of a strength and conditioning coach is to physically prepare athletes for the rigours of training, for competition and to succeed and win in those competitions. Istvan Balyi has separated long-term athletic preparation into these three distinct phases – “training to train, training to compete and training to win” (Balyi 1995).

There are many approaches coaches can use to prepare their athletes; the ad hoc approach, guided intuition and a well devised periodised plan. Although it is surprising, it is my observation there are still some coaches that use the ad hoc approach or rely on intuition, albeit mostly at club level. Increasingly however, coaches are utilising periodisation models to carefully plan the training of their athletes and manage the training variables in order to peak them for competition and also attempt to ensure longevity in the athletes’ careers.

Although there are still differing views on periodised training versus non-periodised training, many studies exist that verify that periodised training is more effective and beneficial for athletic performance. Fleck in his critical review of periodised strength training, examined 8 studies investigating the differences between periodised and non-periodised training programs (Baker et al. 1994, Kraemer 1997, McGee et al. 1992, O’Bryant et al. 1988, Stone 1981, Stowers et al. 1983 and Willoughby 1992, 1993). He found that despite the relatively few studies devoted to the long term effects of periodised training that periodised programs can result in greater strength (1RM) than multi-set and single set non-periodised programs. The studies also indicate that periodised programs may result in greater gains in lean body mass, total body weight, cycling power and motor performance and greater decreases in percent body fat (Fleck 1999). The following table summarises the findings from some of these tests comparing periodised and non-periodised plans, and highlights the superior results obtained from periodised training programs.

Table 1 – goes here

Short-term studies (Baker et al. 1994) have shown that similar performance improvements have occurred between periodised and multi-set non-periodised models. Therefore it has been concluded that longer training periods (more than 4 weeks) are necessary to realise the full benefits of periodised training compared with non-periodised training (Willoughby 1993). However, Baker also states that periodisation of strength training with its inherent and methodical manipulations of training variables, is thought to be superior to non-periodised strength training as it allows for greater variation in training and encompasses periods of training directed at emphasising either hypertrophic or neural adaptations (Baker 1993).

Furthermore, due to the fact that a novice will respond favourably to most training protocols (ACSM Position Stand 2002), a tentative conclusion may be that periodised training is not necessary until some level of base strength fitness has been reached (Fleck 1999).

Whilst more coaches are utilising some form of periodisation nowadays in the development of their athletes, many still misapply the models and concepts and hence produce inferior results. One misapplication is the reliance on linear periodisation for all athletes irrespective of the ability, training age and development phase. Athletes of higher qualification require a more complex approach to the planning of their training, whereas a developing athlete needs to spend more time in the multi-faceted development of physical abilities and less time if any in specialisation.

There are many periodisation models that coaches must be aware of in order to get the best out of their athletes. The role of the coach is primarily as a practitioner who is able to comprehend and apply scientific principles to each unique athlete. It requires them to figure out the “how” and only understand the “why”. There are many sport science experts that have researched and tested theories and hypothesis regarding the physical training of athletes. Coaches need not try to re-invent the wheel just roll it in the right direction.

There are various methods to achieve superior sporting results. A good coach will know when to appropriately match a training method or plan with the current circumstances and long term outlook for the athlete. This paper seeks to discuss the practical application of periodisation and identify the various approaches for organising the training for beginner, intermediate and elite level athletes and develop a practical framework that coaches can appropriately apply.

Periodisation can be viewed in context of training physical abilities or the breakdown of a time frame into preparative, competitive and transitional phases. Each training block should manipulate training variables to achieve this. In a larger context a successful periodisation model must reflect the following:

1. Training age of the athlete
2. Career phase of the athlete (novice, intermediate, advanced)
3. Yearly phase (i.e. pre-season, post-season, competition)
4. Principles of training
5. Athletes current condition/ injuries/ psychological state
6. Physical weak points/technical problems
7. The sport

8. Dominant movement patterns, energy pathways and dominant qualities in the sport or position within the sport.
9. Short, medium and long term objectives

Thus the ultimate aim of periodisation of training is to apply the appropriate stressors and level of stress on the body at appropriate intervals to reach super compensation at the right time for an athlete to peak for competition. These characteristics mentioned above should ultimately determine which approach to the planning of training would be most effective in bringing up the athlete's level of sporting proficiency.

History shows us that the former Eastern bloc countries viewed the obtaining of sporting excellence much differently from Western sporting programs.
The Eastern bloc, namely the former Soviet Union, believed in a longer general preparatory period for developing athletes where a multi-lateral approach was appropriate. Once a novice athlete obtained a wide pool of motor skills and abilities through multi-lateral development, he/she would then have a higher state of readiness to tackle the specialisation phase of training and would compete in high-level competition at a later stage.

In contrast researchers found that the Western coaches applied specialisation to novice athletes a lot earlier before a sufficient base of motor skills, abilities and general physical preparation were developed. Their approach of early specialisation would see sport-specific training being implemented early in the athlete's life without thorough multi-lateral development (Myslinski 2001)

The table below outlines the differences between the two approaches and how it impacts on athletic ability and sporting success in the various stages of an athlete's life (Myslinski 2001).

Table 2 – goes here

The respective philosophies in athletic development in turn influenced how they approached the planning and organisation of training for their athletes. The Eastern sports specialists quickly concluded that one type of periodised planning maybe suitable for an athlete of lower qualification but as the athlete passed into sporting maturity the same model would render below-par results. Therefore the models implemented would differ for the novice, the intermediate and advanced athlete.

Political Ideology and Sport

In the Eastern bloc and Soviet Union, a concept of modelling became the central theme of their training science and research. They basically understood that one model of planning is not sufficient or appropriate for all sports. Therefore, through modelling, they established specific models for each different sport on the basis of careful scientific and practical analysis of the particular fitness, anatomical and psychological profile of each sport (Siff 2003).

Different models are selected for athletes of different ages and levels of sporting proficiency. These coaches simply developed a needs analysis for novice, intermediate and elite athletes as well as the sport and provided a periodised training plan to fit these needs.

Despite the definite success the Soviets had with the planning of athletic training, their sports scientists also found that it may not work as well in other countries. In other regions where systems of government were different or racial and environmental characteristics were more diverse a different approach to planning was required.

Under the rigid Soviet communist system (as well as the other Eastern bloc nations), a sports program was developed from primary school to the elite level where every training and lifestyle variable was strictly controlled by the coaches or state department. The Soviets viewed sporting success in the larger context of ideological and political supremacy. Therefore the complex models for training athletes was very workable from this standpoint due to the level of control they could exert on their athletes. Dr. Verkhoshansky has commented on this fact, saying that the paradigm of periodisation was based heavily upon the philosophies and methodologies of communism (Verkhoshansky 1997).

In the West where such personal control went against the very fabric of the nations belief system, identical models of periodisation were not practical. Secondly, in the West, in many instances coaches only got access to athletes once they were in their teen years and did not have the opportunity to initiate well rounded early stage training that would optimise training in their later years.

This is one point that is severely misunderstood if realised at all by practitioners and coaches. Many renowned Western strength and conditioning coaches have now taken the principles of the Eastern periodised models and adapted them to the training environment of their country, state, or team.

This makes sense as great variations may exist is the sporting and training culture between nations, states and even at club level. Environmental conditions, the budget allocated to sport development, population, and access to facilities are just some of the areas that may vary. Furthermore, genetic pre-dispositions and racial/cultural differences may dictate what type of planning structure is used in physical training.

Dr Verkhoshansky explains that very successful African athletes, particularly Kenyans who train in mountainous terrain and have genetic and cultural predispositions, have never implemented periodisation in their training. He adds that African and European athletes should not imitate one another, even if impressive results may tempt athletes to do so (Verkhoshansy 1997). He stresses that Soviet runners did not improve world records in running middle distances and the British runners who used the Russian concept of periodisation did not gain gold medals in Olympic Games over the last 30 years, but produced great achievements before they used such concepts (Verkhoshansy 1997).

Therefore careful consideration should be given to all these points when planning the training regimen for an athlete or team. As we will see in the following sections some modes of periodisation are suitable for certain types of athletes and certain sports.

As far as planning goes, coaches must ensure that the athlete has the necessary level of development for all physical traits that will lead to proficiency in technical skill. Furthermore there must be continuity between periodised stages, whether they are micro-cycles, meso-cycles, macro-cycles or yearly plans. In other words, the level of development of the physical traits or bio-motor abilities developed in one cycle should be the basis for the next cycle where these qualities are built on.

We should not forget that the aim of long-term planning is to not only ensure sporting success but also longevity of high level performance. If there is insufficient, ineffective or even no linkage between training stages then results will definitely be compromised.

Types of Periodisation

The American College of Sports Medicine (ACSM) endorses the use of periodisation models not only for elite athletes or advanced trainers, but also for all individuals with a diverse background and fitness level. Furthermore, they state that in addition to sport-specific training, periodised training has been shown to be effective for recreational and rehabilitative training goals (ACSM Position Stand 2002).

There are numerous variations of periodisation models but they can generally be classified under three broad methods. The appropriateness of each application varies according to the different classes of athlete and various training goals.

The three basic methods of planning and organisation of training are:

1. The sequential method
2. The concurrent method
3. The conjugate method

All of these main methods can and have been combined to create hybrid models suitable for particular athletes or situations. These models can be further augmented or modified through load distribution variations such as linear, wave-like, step-like, pyramid-style, asymmetric pyramid or equal distribution.

The Sequential Method

The Sequential Method is characterised by sequenced uni-directional loading of each motor-ability. The Metveyev model of so-called linear periodisation is the classic example. The sequential method is generally applied to the macro cycle but can be used in short or long time frames. It involves the rotational, uni-directional separation of the motor abilities, with each being focused on in separate phases during the macro-cycle.

For speed-strength and strength sports the usual format used in the classical sequential periodisation scheme and programs, is that yearly training starts with building muscular endurance followed by hypertrophy, maximal strength and conversion to power, until the start of competition where maintenance loads are used in sports with a long season. In sports with specific event style competitions such as a weightlifting meet then a peaking cycle is used. Then there is a transitional phase after competition where recovery and active rest take place.

A scheme for endurance sports may entail aerobic endurance being developed in the first block, a mixture of aerobic and specific endurance in the second and specific endurance in the pre-competitive and competitive phases.

A sequential plan for speed development could comprise the training of aerobic and anaerobic endurance, alactic speed and anaerobic endurance, specific speed and specific speed/agility/reaction time in chronological blocks.

Linear Periodisation

The model Metveyev developed is much more extensive than the model most coaches now use. Matveyev also included technical skill as a variable in his model and not just volume and intensity of loads. As stated in the introduction Western coaches have tended to place a heavy reliance on the early periodisation model, attributed to Leonid Metveyev, as the method for all athletes, at all levels and in all circumstances.

Metveyev, the Soviet sports scientist, advocated a model in which the macro-cycle begins with a large volume of low intensity training with a small emphasis on technical training. Gradually the emphasis changes to a low volume of high intensity training that places great emphasis on technical skills. The Metveyev model and the Western spin-offs that have eventuated in the last 30 years basically make the point that volume and intensity are inversely proportional. Therefore, his model has also been known as linear periodisation, Western periodisation and progressive overload.

The breakdown of training phases in a strength-training plan would then necessitate that when volume is high and intensity is low then functional adaptation and hypertrophy will be the abilities developed. Then as the volume decreases and the loads increase then strength and power will be developed (Figure 1).

This basic model can be applicable to the untrained person or the novice athlete, as any training influence will leave significant traces in an untrained person. According to Siff, it is important to realise that this type of model is suitable for some sports or less qualified athletes but it is neither the only periodisation model nor the most applicable (Siff 2003).

Figure 1 - goes here

The main advantage of using this method of planning is that beginners are able to utilise easy loads to develop exercise technique and sports skill. In terms of strength training it will allow the development of ligament and tendon strength and work capacity, as the volume is high. From phase to phase the novice can build upon the sub-quality developed in the previous block of training by taking advantage of the adaptation that occurred in that particular period. There are several disadvantages with this model however that may make it impractical once the athlete matures.

It must be stated from the outset, whilst linear periodisation is criticised it also not fully understood either. As Siff notes “a fairly cursory examination of the Metveyev model reveals some noteworthy weaknesses and problems in training logic, many of which have to do with limited Western access to the author’s original material than with the model itself” (Siff 2003, p 317).

First, there is an assumption that this model represents all components of the overall programme such as strength, speed and endurance. Whilst this may not affect the beginner, it has serious implications for the more advanced. For the elite athlete completing high intensity sprints, distance work and high intensity strength training during the same period can cause a large degree of interference.

Siff (2003) states that the extensive use of general heavy resistance exercises during specialised training phases can diminish speed and explosiveness. An elite level athlete will spend more time in specialised training and therefore high intensity training of multiple physical qualities and sub-qualities may decrease performance before competition. Scientists agree that the subtle merging of training sessions and

training blocks with one another, which is characteristic of the Metveyev model, is highly suitable for novices but not for advanced athletes.

Secondly, the scheme is a percentage-based system, which cause serious drawbacks for athletes in strength sports such as power lifting, weightlifting or power based events where there is a large carryover between strength and sports performance. The loads used in each phase are calculated as a percentage of a repetition maximum. If a power lifter's last competitive squat was 700 pounds and he takes 4 weeks off in the transitional phase then the 1 rep max for the squat will more than likely decrease.

Strength performance in general is readily maintained for up to 4 weeks of inactivity, but highly trained athletes' eccentric force and sport-specific power, and recently acquired isokinetic strength, may decline significantly (Mujika and Padilla).

Vladimir Zatsiorsky states that long breaks (from working at percentages close to your 1RM) can ruin physical fitness. This is where a percentage-based system has many problems. Vladimir asks: If a mountaineer wants to climb to the summit, will he climb halfway up then back down to go back up again? These long breaks are detrimental because motor abilities are built and retained at different rates that are fairly specific to each individual. Some may be lost very quickly while others will be held (Zatsiorski 1995).

When the power lifter starts the next macro-cycle of training he will then be calculating the training percentages on his 700lb squat when in fact it may have decreased to below 630lbs. This in turn will make all the training percentages too high. Whilst in the early stages of the first micro-cycles problems may not be apparent, he will begin to miss lifts in the strength cycle or peaking cycle. This would be disastrous before a competitive meet.

The second problem with the reliance on load percentages is that if the athlete is injured, especially during the pre-competitive phase then all the training load schedules are thrown out of kilter. Because the loads are also worked out according to the number of training weeks before a meet, then how does the athlete re-adjust the loading schedule to peak for the competition?

This also gives rise to another failing of this system of planning – that this method implies that there is only one peak in a season. Most individual and team sports rarely have only one major competition a year. For example in European soccer, teams must peak for several competitions within one season i.e. National League title, Football Association Cup title and European Champions League title. Similarly a tennis player needs to peak several times in a year to be ready for the four Grand Slam tournaments, Davis Cup ties and other important tournaments.

Obviously this problem can be overcome by devising a multi-peak linear model where numerous competitions are scheduled. However, being a percentage-based program it does not take into account the physiological and psychological state of the athlete nor their injury status or potential. If the athlete suffers from any injuries, illness or the accumulation of general physiological and psychological stress then once again the training loads may be thrown out of kilter.

Verkhoshansky (1997) in his critical analysis of this simplistic form of periodisation states that plans to produce high results should not be based on training to achieve “notorious peaks of sports form” but should meet the ongoing demands of events distributed throughout a competitive season and not simply to produce performance peaks for a very few years.

A further problem with this system is that using high volumes of training, even with low intensities may not necessarily be the most efficient way of introducing a novice to a training programme, because this is also likely to cause post-exercise soreness, impaired adaptation and reduced motivation (Siff 2003). Furthermore, it is suggested that the model does not address the concept of exercise order and their interaction. One may easily imply from the model, without thorough investigation, that the effects of volume and intensity at any given time are independent of the structure and content of the training session.

Another important drawback with traditional linear periodisation is that due to a continual increase in intensity, an accumulation of stress results, promoting overtraining. In a typical progressive overload program, in the power phase and subsequent peaking phase there maybe over four weeks of lifting loads greater than 90% of the 1RM. Zatsiorski (1995) concedes that you cannot train with weights above 90 percent of a 1RM for much longer than three weeks before the nervous system begins to weaken. When this happens strength will begin to diminish.

Linear periodisation is also criticised for being ineffective in the development and maintenance of hypertrophy. It has limitations in regards to increasing lean body mass, the principle mechanism by which strength is enhanced. It is thought that long periods of low volume, high intensity training characterised by linear periodisation models resulted in less favourable hypertrophic adaptations and may induce neural fatigue (Baker 1993).

Finally, and what may be the most heavily criticised aspect of the basic linear periodisation model, is that as there is a rotational sequencing in the training of separate physical traits, that abilities are not maintained. As mentioned earlier, sports scientists have concluded that physical qualities can diminish in as little as four weeks. If an athlete developed hypertrophy in one meso-cycle then in the next one or two meso-cycles that physical quality will be diminished if specific hypertrophy training is ceased. Poliquin (1988) in his research suggested that the hypertrophy gained from the first month of training would plummet over the next several months of strength/power phases, which involved higher intensities, and decreasing volumes (both of which are not conducive to hypertrophy), rendering the first month of traditional periodisation training practically worthless.

Undulating Periodisation

The undulating method of sequencing avoids some of the pitfalls of the straight linear method whilst maintaining others. It addresses the problems associated with the system based on load percentages such as overtraining, decrease in ability after the transition period and lack of contingencies if injury occurs. It does so through using a

“wave” approach in load progression, where volume and intensity are varied during the macro-cycle.

The undulating method uses alternating periods, usually two weeks in duration, of high volume training to stimulate hypertrophy and high intensity training to develop neural adaptations (Baker 1993). It follows from this that in each 2-week cycle a different strength quality is being developed. Referring to Poliquins advised parameters (Table 3), it maybe deduced that hypertrophy is being developed in weeks 1-2, 5-6 and 8-10 and strength/power is the objective in weeks 3-4, 7-8 and 11-12 (Poliquin 1988).

Table 3 – goes here

Poliquins rationale for this quick switch in volume and intensity is because his research concluded that strength programs lost their efficiency after only two weeks (Kulesza & Poliquin, 1985). Thus, it was deduced that if a stimulus were provided in exactly the same way, results would diminish quickly. This is in accord with the biological law of accommodation, which states that the response of an organism to the same given stimulus decreases over time (Kulesza, A & Poliquin 1985). Frequent changing of exercise selection and exercise order would prevent this stagnation and diminishing results. In this regard this system can also avoid the accumulation of stress on the body and also fatigue of the neural system. It can also prevent boredom and keep motivation levels higher by fluctuating the main variables.

One benefit of this scheme is that abilities developed in one two-week cycle maybe maintained and built upon further by re-introducing it within a four-week period before the effects are lost. However in attempting to overcome the problem of detraining physical traits developed early in the cycle of a traditional periodised plan, it may eventuate that not enough time is spent on developing a specific bio-motor ability. When these program variables are arranged to suit hypertrophy development, they are then changed within a fortnight to suit maximal strength or power

development, Even though it may eventuate that many blocks of hypertrophy, strength and power training occur in the meso-cycle, they may be too sporadic to solidify gains made in each targeted phase. Two weeks may be not enough to elicit progress in beginners who need repetitious regimes to practice the exercise technique and as well for the elite athlete who requires concentrated loading to obtain a higher level of special fitness.

The American College of Sports Medicine (ACSM) states that the rate of muscular strength increases approximately 40% in untrained individuals, 20% in the moderately trained, 16% in the trained, 10% in the advanced and 2% in the elite athlete over periods ranging from four weeks to two years (ACSM Position Stand 2002). The ACSM have classified trained or intermediate individuals as those who have approximately 6 months of consistent resistance training. Advanced individuals are those with years of resistance training experience who have also attained significant improvements in muscular fitness. Elite status is given to those athletes who are highly trained and achieved a high level of competition. Therefore it is a reasonable assumption that the shorter time frame of four weeks represents the strength increases in untrained or novice athletes and the large range of two years would apply to the strength increases of trained, advanced and elite athletes.

This supports the contention that a two-week training cycle maybe insufficient to elicit any type of meaningful strength gains, especially with the advanced and elite athlete. Since it also takes around four weeks for the effects of de-training to set in, then a three-week alternating cycle maybe more appropriate or at least a happy medium.

Baker in his 1994 study on undulating periodisation found that whilst there was no significant difference between the group of subjects using undulating periodisation and the subjects using a non-periodised multi-set program, those undertaking the undulating periodised program had a significantly greater change in the variables used in terms of percentages over the course of the study (Baker 1994). Furthermore, Ivanov found that undulating periodised models are more successful in increasing squat and bench press strength than the non-periodised hypertrophy or neural methods alone (Ivanov et al. 1980).

There are also variations of undulating periodisation models that mainly differ in the length of the macro-cycles, micro-cycles and meso-cycles, and also in the degree of undulation or sharpness in variation of intensity.

Similar to the undulating model is the “Accumulation/Intensification” model and the “Wave Like” model. Whilst both of these models display undulation in volume and intensity, there are subtle differences that are noteworthy.

Accumulation/intensification proposed by Zeinlov in 1976, has the volume increasing over a micro-cycle, which is not always the case with the undulating model. Specifically, the accumulation cycle according to Zeinov has volume increasing whilst intensity is maintained at 80%. In the following cycle, the intensification phase reverses this by decreasing the volume whilst increasing the intensity up to 100%. This has the advantage of allowing the athlete to develop hypertrophy during the accumulation phase. Due to the relatively high intensity of 80% used in this phase,

neural adaptations are also maintained. The neural adaptations will be further improved in the intensification phase where volume is decreased and intensity increased (Baker 1993).

It is obvious that this particular method maybe suitable for experienced athletes who have built up their work capacity to be able to handle relatively high intensities with a large volume. Novices would most likely struggle with the intensities used in the accumulation phase and would be better of using a simpler program plan.

The wave-like periodisation structure differs from the above-mentioned models in that it generally contains more pronounced variation within a meso-cycle compared to the more subtle variations used in the undulating method. The wave-like plan maybe implemented over a three, four or five week meso-cycle compared to the four-week cycle characterized in an undulating scheme (Baker 1995).

A study done by Baker on the effect of a wave-like periodised training cycle on maximal strength and lean body mass found that it produced significant increases in 1RM squat and bench press strength in previously trained males (Baker 1995). The same investigation found that wave-like models were more applicable to bench press strength, which due to the simplistic nature of the required technique could withstand sharp increases in intensity. It was found less suitable for squats due to the relative technical difficulty in performance. Baker advised it maybe more suitable to use more subtle variations in intensity when training with squats because squatting technique may be compromised with high intensities. In fact he suggests using a more linear approach when using the squat to develop lower body strength (Baker 1995)

One may conclude that the appropriateness of the undulating, accumulation/intensification and wave-like periodisation models, although proven to be effective, depends on the experience of the athlete and the objectives of the training phase. The coach must be very judicious in implementing any of these strategies and ensure they are matched to the level of athlete.

Baker advises that for intermediate athletes, the greatest emphasis should be placed upon high volume training, of an adequate intensity, to facilitate increases in lean body mass with brief but regular exposures to higher intensities to ensure neural adaptations. He definitely concludes that for advanced athletes the undulating, accumulation/intensification and wave-like periodised models maybe more suitable than linear models (Baker 1993). These three methods may also be classified as concurrent methods of planning as various physical abilities are trained within one meso-cycle. However as pure concurrent models utilize the parallel training of bio-motor abilities or sub-qualities over the training week, for the purposes of this paper they have been classified as sequential.

The model of undulating periodisation suggested by Rhea (Rhea et al. 2003) where the volume and intensity is varied in every workout within the training week does fall under the category of pure concurrent training because muscular endurance, hypertrophy and strength are being stimulated in the same micro-cycle. Rhea has termed this form of undulating training as Daily Undulating Periodisation or D.U.P for short. He suggests that a solid D.U.P program would be 12-15 repetitions on Monday, 8-10 on Wednesday, and 3-5 on Friday, then, start over on Monday. Rhea’s

research found that a program consisting of 8 RM on Monday, a 6 RM on Wednesday, and a 4 RM on Friday, every week, for 12 weeks in total, produced significant increases in leg press and bench press strength (Rhea et al. 2003). It should be noted that such a program seemed to result in staleness after 6 weeks. Therefore when implementing this method it should not be for longer than 6 weeks before the program is changed or a de-loading phase is scheduled.

Kraemer has suggested a D.U.P program of 4 sets of 12-15 reps on Monday, 4 sets of 8-10 reps on Wednesday, and 3-4 sets of 4-6 reps on Friday, then, start over again on Monday. Additionally, he proposed that the athlete could slightly adjust this, and perform 4-5 sets of 1-3 reps on Monday, and then start over. This may be of interest if strength and power are the dominant goals (Haff 2004).

Therefore, if it is accepted that Poliquins version of undulating periodisation, or the accumulation/intensification and wave-like models are not appropriate then the D.U.P style of undulation can be used as a way to concurrently develop various sub-qualities of strength. In fact Siff (2003) suggests two main systems of organising long-term training: The concurrent system and the conjugate sequence system. Both of these types of periodisation models will now be analysed in context of applying the most appropriate model for the athlete and sport.

The Concurrent Method

The concurrent method of periodisation is characterised by the parallel training of all motor abilities such as strength, speed and endurance, during the same stage to promote multi-lateral or multi-faceted development. This can be applied to the macro-cycle, meso-cycle, micro-cycle or even an individual workout. The concurrent system also allows for emphasis to be placed on certain physical traits through volume and load manipulations, but the time spent on training each ability is kept constant.

Training abilities of different types in the same stage not only produces multi-faceted physical fitness but also produced a synergistic effect where the development of one quality contributes to the development of the other qualities. It shows that multi-lateral loading was superior to sequential unidirectional loading in improving strength, speed of movement and endurance.

Over time concurrent periodisation became the preferred approach as it became clear that prolonged uni-directional work dedicated to a single fitness factor, caused the body to adapt to loading with the dominant involvement of only some of the physiological mechanisms and does not create conditions for specific adaptation to competition activities. Parallel loading of various physical abilities was shown to simultaneously improve different physiological functions in the necessary balance for various sports Metveyev (1970).

In utilising this method one must be aware of the interaction between training different physical qualities and different training means so that interference is minimised and training variables can be integrated so that physical preparedness for the sport will be enhanced and not retarded. For example, if strength and power exercises are included in a single session they should be performed early in the training session. This ensures that they will be completed before the lifter has been

too taxed. If the lifter is fatigued prior to performing the power exercises the power development objective will remain elusive (Fleck and Kraemer 1996).

This method is most applicable to athletes of average standard or those that matured past the novice stage and the disadvantages of this method generally refer to unsuitability of the planning approach to elite athletes. According to Verkhoshansky (1977), there generally appears to be little advantage for high-level athletes to use the concurrent system of training.

Major deficiencies of the system are:

- To raise the special physical preparedness of highly qualified athletes and improve sports proficiency, the athlete must use strong and prolonged training influences of appropriate emphasis. Concurrent training uses a distribution of volume that is not able to promote sufficient adaptation of the necessary physical ability.
- The multi-faceted nature of the concurrent method cannot create the physiological conditions necessary for producing specific physical preparedness that is required for sporting mastery.
- Concurrent training inevitably leads to general fatigue that precludes the athlete's ability to perform the sporting activity in the competitive environment with precise control.

In other words, advanced athletes are unable to adapt to a large number of stimuli and need some concentrated blocks of a particular ability to progress while maintaining all other abilities. Unlike novices and intermediate athletes, whose bodies do not differentiate between the possible conflicting influences of large number varied stimuli, the advanced athlete is sensitive to such influences and must receive phases of unidirectional loading to achieve high-levels of special fitness that will make them competition ready.

To summarise the application of the concurrent method of long-term athletic planning, it must be repeated that whilst research has corroborated the effectiveness of this system, the subjects used in the studies were usually athletes of lower qualification. Although the negative influence of the concurrent system is not apparent with less advanced athletes, it becomes very noticeable with elite athletes in whom it produces only average results (Siff 2003). To evoke a more powerful training effect in athletes who have already accommodated to high levels of simulation, it becomes necessary to impose intense phases of uni-directional loading. This is precisely the purpose of the conjugate sequence system.

The Conjugate Method

The conjugate sequence system does not reject or oppose the concurrent system as the most general principle of training, but only extends it so it meets the requirements of conditioning highly qualified athletes (Siff 2003). In fact when analysed closely, it is apparent that it combines the rationale of unidirectional loading and sequencing (characterised in linear periodisation), whilst maintaining all the advantages of the parallel training of all bio-motor abilities (characterised in concurrent periodisation).

This system is used throughout the annual cycle for organising the loading of different physical abilities and during separate stages for organising the loading of a single primary physical ability or sub-quality. Therefore not only does it preserve the advantage of the concurrent method of planning, but it also accentuates the specific training effects of concentrating on a given physical ability.

In simple language the conjugate method prioritises the development of one specific required physical ability whilst training all other relevant abilities with maintenance loads. The athlete essentially adapts to one strong and prolonged stimulus and maintains others, whilst preventing stagnation, overtraining and fatigue. Therefore conjugate training does not only combine physical abilities in the same stage, but also sequences a coupling of training means for the emphasised ability.

To provide a clear example of this, an athlete competing in a power-endurance team sport may train hypertrophy, maximal strength and specific speed at maintenance loads in a single phase of training. The coach may then introduce a specialised block of concentrated training for power development for improvement in the athlete's vertical leap, where 4 weeks are dedicated to improving this specific quality through the means of jumps, barbell exercises, weighted jumps and depth jumps. As mentioned earlier uni-directional loading for more than four weeks may cause diminishing results or stagnation, and the heavy concentration on this specific ability may lead to overtraining and fatigue. The conjugate method suggests that in training this single primary emphasis, a diverse complex of means and training methods are coupled sequentially to prevent stagnation and physiological and psychological fatigue (See figure 2).

The uni-directional approach to explosive power training and specific vertical leap regimes will enhance the athlete's special physical preparedness and special fitness. The synergistic and summated effect of the training of the other relevant physical abilities will assist in the development of explosive power and vertical leap.

In the next four-week meso-cycle if the coach still feels it necessary to continue with emphasis on explosive power and vertical leap ability, the training means will be changed. On the other hand if it is felt that that by emphasising another ability, the specific preparedness for the sport will further increase then explosive power will be trained at maintenance levels and another trait such as specific speed may be concentrated on.

Depicted below is a four week micro-cycle based on Conjugate periodisation - with primary emphasis on explosive power development to improve vertical leap ability in a power team sport, where:
a = jumping exercises **b** = barbell exercises **c** = weighted jumps **d** = depth jumps

The dashed lines in the explosive power quadrant highlights where one training means is changed to the next training means with a progressively stronger training effect for the development of explosive power and vertical leap.

Figure 2 – goes here

The graph depicts that hypertrophy; maximal strength, specific speed and explosive power are being trained over the same four-week meso-cycle. Maintenance loads are utilised for all the abilities, except explosive power, where a concentrated loading is used.

This model of periodisation involves phases of sharp or concentrated loading to achieve a specific training purpose or to shock the body out of a state of stagnation or habituation. The scientists advocating this method are well aware that sudden increases in the rate of loading are potentially more risky, but they never recommend such regimes without careful considerations of the state of preparedness of each individual athlete (Siff 2003).

Research determined as long as there was a simultaneous, sequential development of required specific traits with frequent changes in training targets, and non-targeted specific traits were maintained with retaining loads, there was a linear increase in technical skill, strength, and speed. This positive correlation between motor abilities or means was observed during the unloading phase, rather than the loading period signifying an adaptive reconstruction, or a positive "transfer of trainedness" (Zatsiorski 1995).

Likewise, the linear periodisation approach, or the rotational, uni-directional separation of these motor abilities did not exhibit the same effect, due to the time and efforts spent focusing on a specific direction while the concurrent development of other traits are ignored. Over time, this resulted in de-adaptation or a detraining effect, with the level of non-targeted traits diminishing considerably (Zatsiorski 1995).

This simultaneous, uni-directional system of multiple targets, prescribed through specific means, permits the competitive sporting form to be obtained two to three times a year instead of the one peak characterised by sequential/linear methods. This model maybe the most practical for keeping the athlete in optimal physical fitness for most part of a year and hence the athlete can compete in many competitions or tournaments.

This leads to the main disadvantage of this particular system, which is the danger of overtraining if the correct exercise selection and sequence is not used. Furthermore, the levels of fatigue may necessitate an unloading period that the coach must factor in the entire training scheme.

It is definitely not a scheme suitable for the novice who needs to spend more time in multi-faceted development or a long preparatory phase. A novice would not benefit from such a program that was modified to cater for the elite athlete who is more involved in specialised forms of training.

The Conjugate sequence system can be summarized with the work from N.G. Ozolin (1971):
Below are presented the tasks that must be accomplished over the course of multi-year training.
1. “To achieve the super-compensation effect (restoration of the body and raising its functional potentials to a level higher than the pre-existing level).”
2. “To strengthen the functional potentials and the morphological and biological changes at the athlete’s achievement level.”
3. “To acquire motor abilities and skills in sports techniques and tactics.”
4. “To strengthen motor skills in sports techniques and tactics.”
5. “To actively recover from physical exercises, training sessions, and competitions (active rest).”

Conclusion

As the athlete passes through physical and performance maturity, the stimulus required to raise their level of special strength, specialised fitness and specific preparedness for sport drastically changes and so does the method of program prescription. Misapplication of periodisation models will produce sub-standard results, impair the athlete’s ability to perform to the highest potential and may be the cause of injuries or illness. It seems that instead of debating which periodisation scheme is the best, the question should be – which model of planning and organization is most suitable for my athlete?

A beginner in almost all instances can get away with a basic program emphasizing progressive overload from session to session, as well as a concurrent training plan devoting time to multiple motor abilities. As the athlete passes to the advanced stage, the ability to emphasize multiple motor qualities at the same time will diminish. To overcome this, a few specific types of training session should be emphasized, with the goal being to improve from week to week. The remaining qualities are maintained with light retaining loads.

It has been shown that the conjugate sequence system produces the best results for advanced athletes. This is likely because of the amount of work devoted towards a specific goal is very high, and there are no extraneous stressors to add extra fatigue to the system. This creates a very strong stimulus to adapt over a long period of time.

Bompa (1999) also concludes that the approach to periodisation should be in the context of the athletes' readiness for heavy schedule competition irrespective of whether the athlete is in a sport typified by multi-peaks. For novice athletes, he recommends a mono-cycle periodised plan, containing a long preparatory phase free from the stress of competition, allowing the coach to concentrate on developing skills and a strong foundation of physical training.

A bi-cycle is suggested for intermediate athletes who can qualify for national championships. Even in this case he suggests a preparatory phase for as long as possible. Finally for advanced, international class athletes a tri-cycle is advocated where it is presumed that they have a solid foundation.

Bompa does not specify loading objectives for the training of specific physical traits, but it still supports the assumption that novice athletes can obtain results from a simplistic approach to the planning of their training, such as the Linear model which is mono-cyclic, as it only has one peak and can accommodate a long preparatory phase. Bompa's view, although technically different from other experts, still supports the contention that the elite class athlete requires more time spent in training geared toward specific physical preparedness for sports, whereas the beginner and intermediate athletes' training must be rooted in longer phases of general preparation and skill acquisition.

It is apparent that many experts with differing views mostly still agree on the appropriateness of classifying athletes according to their level of proficiency before applying a periodised model for training

The information presented provides us with a choice of answers depending on the level of athlete we are training and the type of sport we are involved in.
The list of periodisation models outlined here is not exhaustive by any means, but it presents the theories and thoughts of some of the most influential and successful coaches and scientists involved in physical preparation for sport.

As strength and conditioning coaches it is our responsibility to adapt the findings of such experts to our coaching situation and environment. Many of us who may work part-time as coaches may not have the time or resources to prepare and apply such detailed models for our athletes. However, having an awareness of the principles that lie behind the utilisation of periodisation models should allow us to develop a more informed approach and obtain better results.

I have learnt that an over-reliance on anything often leads to closed-mindedness. The late Dr. Mel Siff states that the organization of training is as much art, trial-and-error and intuition as it is science, so that periodisation schemes should serve as approximate guidelines to be followed and modified by ongoing analysis of physiological and psychological markers of progress (Siff 2003).

Periodisation and the planning of training is an immense topic with many intricacies, the magnitude of which cannot be explored in this article. Unfortunately texts and papers on this topic are mostly either too simplified or grossly over-scientific, meaning that the practicing coach is unable to avail him/herself of understandable

knowledge to correctly apply the theories to their athletes. As a result many take the ad-hoc approach where guesswork replaces intuition.

It is a given that every strength coach should use periodisation to plan training, but now it should be a given that every coach understands the interaction between the principles of training, basic physiology, the synergistic and interference-causing relationship between training methods and means and the nature of the chosen sport in order to properly plan.

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Tables and Figures

Table 1 – A comparison of results of studies between periodised and non-periodised training programs (Fleck 1999)

Reference	Training Program Duration	Tests	Periodised Program Results (% increase)	Non-Periodised Program Results (Multi-set) (% increase)	Non-Periodised Program Results (Single- Set) (% increase)
Stowers et al. 1983	7 weeks	Bench Press	9%	9%	7%
		Squat	27%	20%	14%
		Vertical Jump	10%	1%	0
Willoughby 1992*	12 weeks	Bench Press	28%	17%	-
		Squat	48%	26%	-
Willoughby 1992*	16 weeks	Bench Press	23%	10%	-
		Squat	34%	22%	-
Baker et al. 1994*	12	Bench Press	16%	12%	-
		Squat	28%	26%	-
		Vertical Jump	10%	9%	-
Kraemer 1997	14	Bench Press	11%		3%
		Hang Clean	19%		4%
		Vertical Jump	17%		3%

* Indicates that two groups using multi-set, non-periodised programs were tested in the study, utilising different training variables. The test results for the multi-set, non-periodised programs presented in this table represent the tests that yielded the highest percentage increases of the two groups.

Table 2 – Early Specialisation vs. Multilateral Programming (Myslinski 2001)

EARLY SPECIALIZATION	MULTILATERAL PROGRAM
• Performance improvements were immediate • Best performances between 15-16 because of early adaptation • Performance inconsistencies within competitions • By 18, many athletes quit or "burnout" • Forced adaptation accounted for a high rate of injuries	• Performance improvements were continuous • Best performances over 18 due to physical and mental maturation • Performance consistencies within competitions • After 18, many athletes were starting to "come into their own" • Gradual adaptation accounted for a low rate of injuries

The following table demonstrates a modified program of traditional and undulated Periodisation strength programs, described by Poliquin (1988):

Table 3

Traditional Periodisation						
Weeks	1-4	5-8	9-12	13-16		
Reps	10	5	3	2		
Sets	5	3	3	3		
Undulating Periodisation						
Weeks	1-2	3-4	5-6	7-8	8-10	11-12
Reps	10-12	4-6	8-10	3-5	5-7	2-3
Sets	3	5	4	5	4	6

Table 3: Comparison of Traditional and Non-Traditional Undulated Periodised Strength Programs over 12 weeks.

Figure 1 – Linear periodisation model

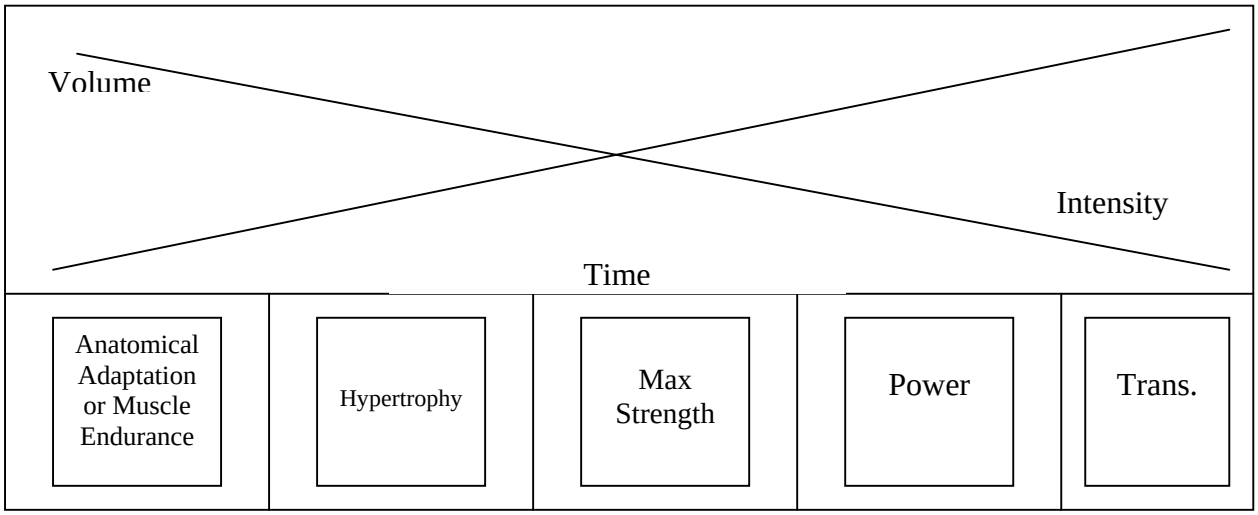

Figure 1. The Linear model depicts the relationship between volume and intensity and how it corresponds to the training of specific bio-motor abilities in each phase.

Figure 2 – Conjugate periodisation model