Original Article

Applied periodization: a methodological approach

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ABSTRACT

Naclerio F, Moody J, Chapman M. Applied Periodization: A Methodological Approach. *J. Hum. Sport Exerc.* Vol. 8, No. 2, pp. 350-366, 2013. Periodization represents an optimal modality for organizing training programs in athletes, recreational and rehabilitative practitioners. The selected procedure, however, should be based on the athlete's age, level of performance, specific goals or competition characteristics. A common theme throughout all periodization paradigms is the requirement to manipulate the entire program variables (intensity, volume, frequency, recovery periods and exercise selection) in order to progress from general to a more sport-specific training, dissipate fatigue and reduce the risk of injury. Although further scientific evidences are required, the understanding of periodization methodology including the appropriate procedure for designing sessions, microcycles and mesocycles is of paramount importance. **Key words**: TRAINING PLAN, PROGRAM DESIGN, MACROCYCLE, MESOCYCLE, MICROCYCLE, SESSION.

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INTRODUCTION

The progression of increased knowledge within the sports sciences has resulted in different criteria for organizing training programs which is often dominated by the trend to design workouts based on the specific adaptation and outcomes achieved throughout the training process. Therefore athletes can pursue performance progressions with more complex or effective training modalities only once they have achieved progressive basic adaptations (Verkhoshansky, 1998).

The foundations of modern periodization were developed in the Soviet Union around the time of the Russian revolution, Kotov (1917) divided training into general, preparatory, and specific stages while Ozolin (1949) stressed the importance of considering the competitive calendar and climatic factors in periodization (Graham, 2002). Later, Matveyev summarized the modern concept of periodization dividing the training year into distinct phases, each with different characteristics and special application to train endurance or strength and power athletes (Siff, 2004). The fundamental concepts presented by Matveyev were applied to the preparation of many sports such as track and field, swimming, rowing, cycling, skiing, weightlifting or skating (Issurin, 2010; Siff, 2004). However, when the competitive practices were expanded, the increasing number of competitions together with the improvement in technology and facilities led to further variation of periodization structures with the introduction of double or triple peaked periodized cycles (Issurin, 2010).

From a team sports perspective, the implementation of longer competitive periods, with additional complications like mid-week fixtures illustrate that the generalized concept of achieving maximum peaking and tapering is not probable or indeed possible. This is one of the reasons by which many coaches within the team sport environment in an effort to adapt the basic concept of periodization with the specific sports calendar or current competition structure have created and proposed forms of training that in some cases violate many of the core concept associated with the construction of periodization training plans. The aim of this article is to review some of the basic and classic periodization concept and analyse how to integrate this theoretical paradigm with the requirement of modern athletes with specific emphasize on team sports. In addition basics orientation for organizing microcycles and mesocycles are provided.

DEFINING PERIODIZATION AND BASIC PROCEDURES

Periodization has been defined as the methodical planning and structuring of training process that involve a logical and systematic sequencing of multiple training variables (intensity, volume, frequency, recovery period and exercises) in an integrative fashion aimed to optimize specific performance outcomes at predetermined time points. Periodization should not only focus on performance but also on athlete’s development and injury prevention (Haff, 2013). Although, several periodization paradigms have been proposed across different sports and competitions structures (Baker, 1998; Gamble, 2006), athletes age or level of performance (Bondarchuk, 1988; Plisk & Stone, 2003; Tschiene, 2000; Verkhoshansky, 1998), the primary characteristics of such approaches are the systematic variations in training content and/or the intensity and volume of the workload throughout the overall program (Plisk & Stone, 2003; Wathen et al., 2008). However, periodization should not be considered a simply training variation strategy but an appropriate sequencing and integration of different training variables involving not only volume and intensity but also frequency, recovery periods or density and exercises selection. Thus the main objective of periodization will be to achieve the desired outcomes and training gains at the predetermined time point within the training process (Haff, 2013).

Appropriate manipulation of all training variables should be considered at all levels within the training process (workout, day by day, microcycle, mesocycle and macrocycle, year and multi-year training plan). Variation should never be excessive or randomly applied rather it has to be introduced considering the interrelation and sequencing of each training variable (Haff, 2013).

The periodization approach is based on breaking the training plan into specific interrelated periods of time which are structured to meet specific goals (Haff, 2013). This procedure provides the opportunity for a systematic, organized method to all training in terms of several basic structural units, namely the training sessions which are the fundamental unit, the microcycles, mesocycles and macrocycles (figure 1). In addition to this, there are more extended cycles such as Olympic or quadrennial cycles that consider long time preparation for athletes (Siff, 2004).

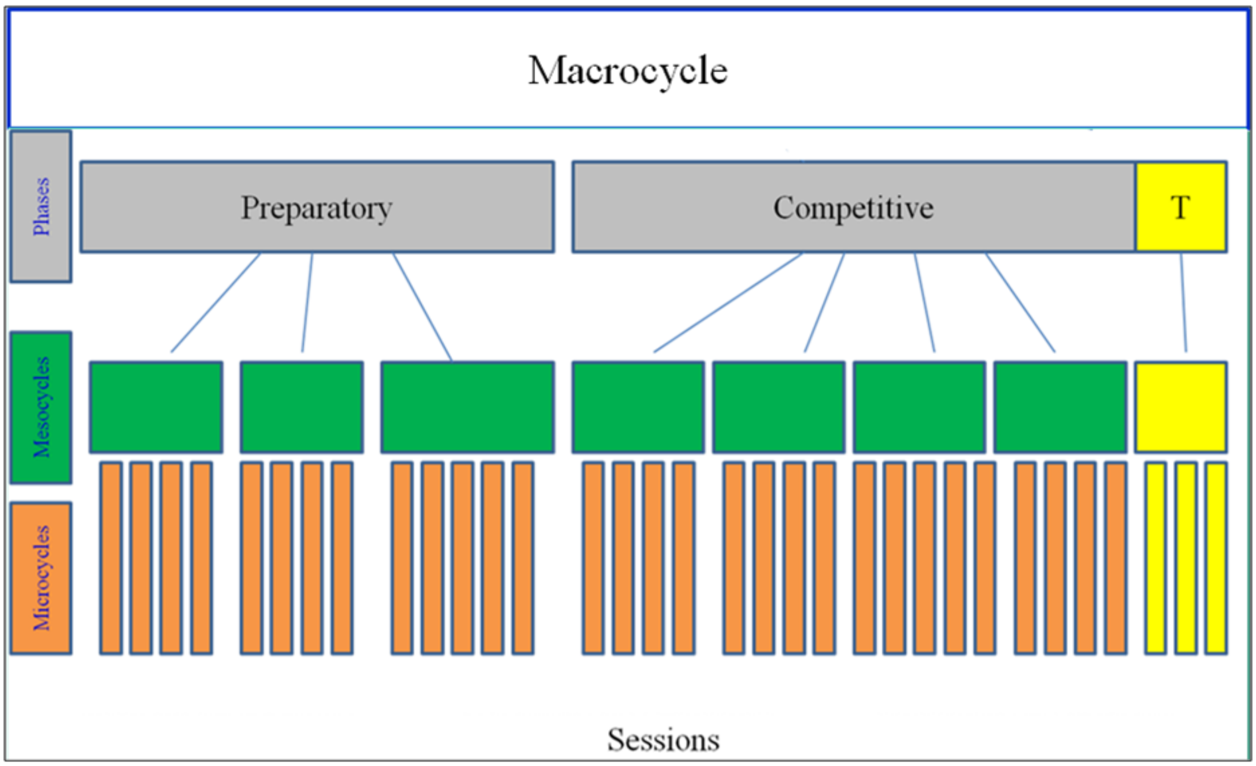

Figure 1. *Basic component of training plan. T: transition period.*

ANNUAL PLAN, MACROCYCLES, AND PHASES

Depending on the sports and athletes characteristics, there are several variants for developing annual training plans. In general, the number of competitive period serves as a foundation to determine the number of macrocycles within an annual training plan.

Macrocycles

The Macrocycle is generally referred to a single competitive season. One macrocycle involves a number of mesocycles that in addition can be assigned to specific period or phases: Preparatory (general and specific), competitive and transition (Bompa & Haff, 2009). In some cases as in the Olympic programs, macrocycles can run over a 4 years cycle (Turner, 2011). Macrocycles are structured to contain the entire season of training. Thus, is not an annual training plan, for example, some sports such as swimming or boxing can contain multiple seasons or macrocycles over the annual calendar (Haff, 2013).

Preparatory phase: Depending upon the length of the macrocycle, type of sport and athletes level of performance, this phase can last for more than 2 until 6 month. Even if this phase is usually broken down into a general and specific preparation, both general and specific sub phases should be always considered interconnected unit (Siff, 2004). The General preparatory phase is aimed to provide fundamentals physical and technical conditioning (basic strength, endurance, flexibility and basic motor skills) in order to support the further development of the specific capacities and motor sport skills (Siff, 2004; Verchoshansky, 1996). In general more advanced athletes will depend less on this phase compared to less prepared or novice athletes (Haff, 2013).

Conversely the specific preparatory phase is aimed to translate the previously established fitness gains into very specific performance characteristics. This subphase is focused to develop specific sports capacities while maintaining the general performance achieved during the previous general phase. Its length is longer in high performance athletes (Haff, 2013; Verchoshansky, 1996).

Competitive phase: Used to develop the specific competitive sport skills meanwhile maintaining the general physical performance achieved at the end of preparatory phase. During this phase athletes reduce the general conditioning preparation while emphasise more skill-based conditioning activities focused on technical or tactical preparedness for competition (Haff, 2013).

Transition Phase: Crucial linking structure used to bridge macrocycles or annual training plans in which athletes have the opportunity to recover from the previous training cycle (Haff, 2013). Athletes should not completely stop training but reduce load and minimize the emphasis on sports specific skills. In general this phase last for 2 to 4 weeks (Haff, 2013; Siff, 2004).

Mesocycles

Medium duration training cycles that typically contains more than two to six interrelated microcycles. These microcycles serve as a recurring unit over a period of several weeks along the mesocycle extension (Plisk & Stone, 2003; Turner, 2011). As the mesocycle configure the minimum required period of time needed to produce a measurable and relatively stable adaptation, this special period has been denominated “biocycle of adaptation” (Zatsiorsky & Kraemer, 2006). A biocycle configure the functional units of the season which usually involve between 4 and 6 weeks or microcycles (Turner, 2011). Every microcycle within each particular mesocycle should have its own specific objectives, which have to be consistently integrated with the general purpose of the entire mesocycle and phase. Therefore, the mesocycle involves a specific and fundamental period of time over which the training objectives should be subsequently established across the season (Verkhoshansky, 1998).

Microcycle

This structure targets very specific training objectives that serve as basic for achieving the goals set forth the mesocycle structure (Haff, 2013). A Microcycle involves a number of training sessions appropriately interrelated in order to reach one or more specific objectives. It is generally accepted that a microcycle can range from a few days to 14 days in length (McHugh & Tetro, 2003), with the most common length being 7 days (Turner, 2011). The microcycle duration will depend on its characteristic. For example, a restorative microcycle can last from a few to 7 or more days but shock or impact microcycles usually extend for more than 7 to 14 days (Siff, 2004).

Mesocycles as the basic structure of training process

Periodization should not be considered as a rigid concept and perhaps more as a framework within an interdisciplinary support team can be able to design a program for a specific performance or training goal. This model also lends itself to the establishment of training and performance objectives, emphasis of training and test standards for each determined period of training, thereby eliminating the random approach that may lead to excessive increases of training loads, and insufficient regeneration (Smith, 2003).

The modern scientific foundation of sports sciences support the criteria by which the organization of the entire training process should be designed on the basis of specific aims athletes are required to achieve throughout the training process (Verkhoshansky, 1998). Therefore, the guidelines for driving the training process should be based on the summation of positive accumulated after-effects thorough the different mesocycles and phases. For example, the development of explosive strength should be based on the maximal strength performances achieved from previous phases. Thus the positive outcomes of preceding training periods will result in more unidirectional elevation of performance to a higher and more stable work capacity (Siff, 2004). Strength and power together with endurance are important in terms of basic physiological capacities in many athletes (Siff, 2004). In soccer and others team sports, a minimum level of maximal strength is usually connected with an improvement of power, sprint and specific skills performance (Hoff, 2006) in addition to a less injury rates (Reilly et al., 2008). This required level of maximal strength has been associated with a performance close to 2 kg per kg of body mass in parallel squat (Hoff, 2006). Thus, by increasing the available force at the end of preparatory period, team athletes would be better prepared for supporting specific performance enhancement and reduce injury rate during competition.

Mesocycles organization

There are three fundamental unit of training that need to be distinguished: Macrocycle, mesocycles, and the microcycles. As stated above, the preparatory period usually involves two phases (general and specific) each of one can involve between one or two mesocycles assigned to reach different conditioning or technical outcomes (Siff, 2004).

Mesocycles usually are composed of three to five microcycles where the final one serves as a recovery and restoration stage (Plisk & Stone, 2003; Siff, 2004; Stone et al., 2007). There are several forms of microcycle combinations or loading paradigms available, however these can be developed over time based on the coach/athlete relationship and understanding of adaptation to training stress (figure 2).

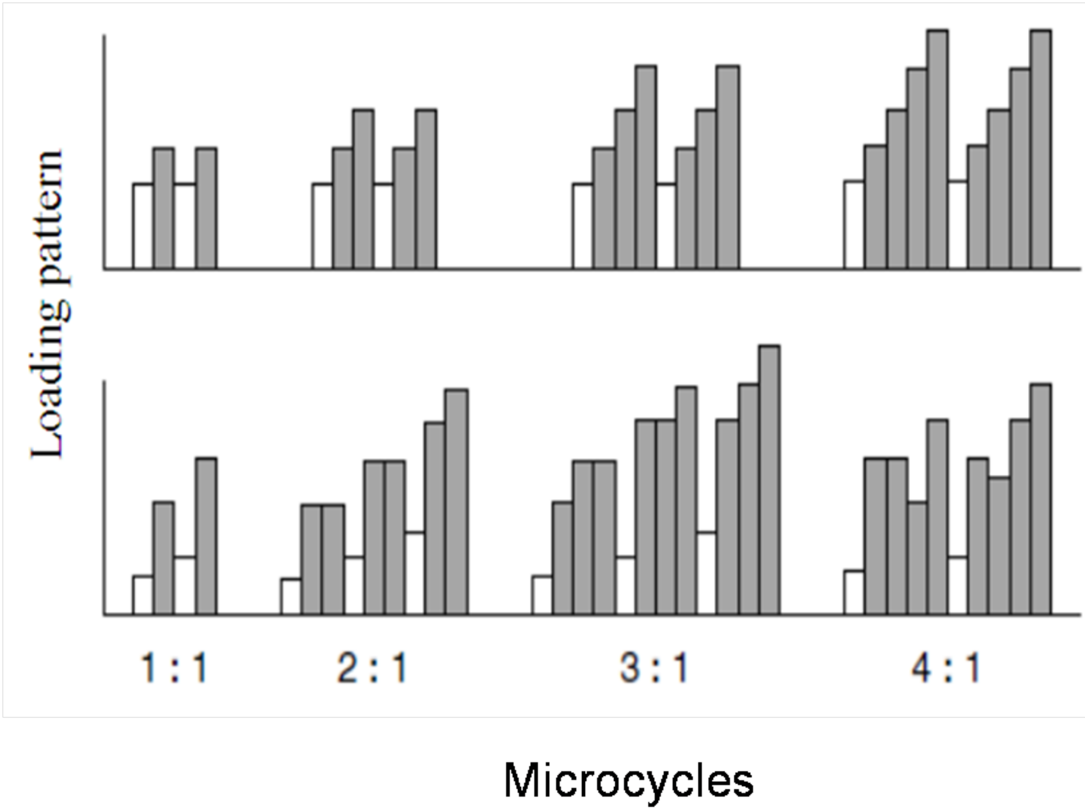

***Figure 2**. Example of different microcycles pattern paradigms.*

In a ‘2 x 1’ model, progressive loading increase for two microcycles followed by one with progressive decrease or lighter loading is the normal procedure. A ‘3 x 1’ model shows a progressive increase for the first three microcycles followed by a forth with a significant reduced load. This model is the most popular loading paradigm (Turner, 2011). The load progressively increase through the first three microcycles and decreases during the fourth one with the aim of restoration. The recovery microcycle reduces fatigue and thus allows adaptations to occur across the overall mesocycle (Stone et al., 2007). This structure would favour a super-compensation expression during the subsequent fifth microcycle.

Depending of the amount of fatigue accumulated during the first three microcycles, the fourth or restorative can be shorted to 3 or 4 days (Stone et al., 2007). In this case it is possible to include a fifth microcycle involving two to three days for assessing the athletes’ performance (figure 3). The results obtained from the fifth microcycle would be used to establish and design the objectives and training programs for the subsequent mesocycles or phases. This methodical monitoring will objectively indicates the development of the training process, allowing coaches to quantify its efficiency and supporting an athlete motivation (Verchoshanski, 1999).

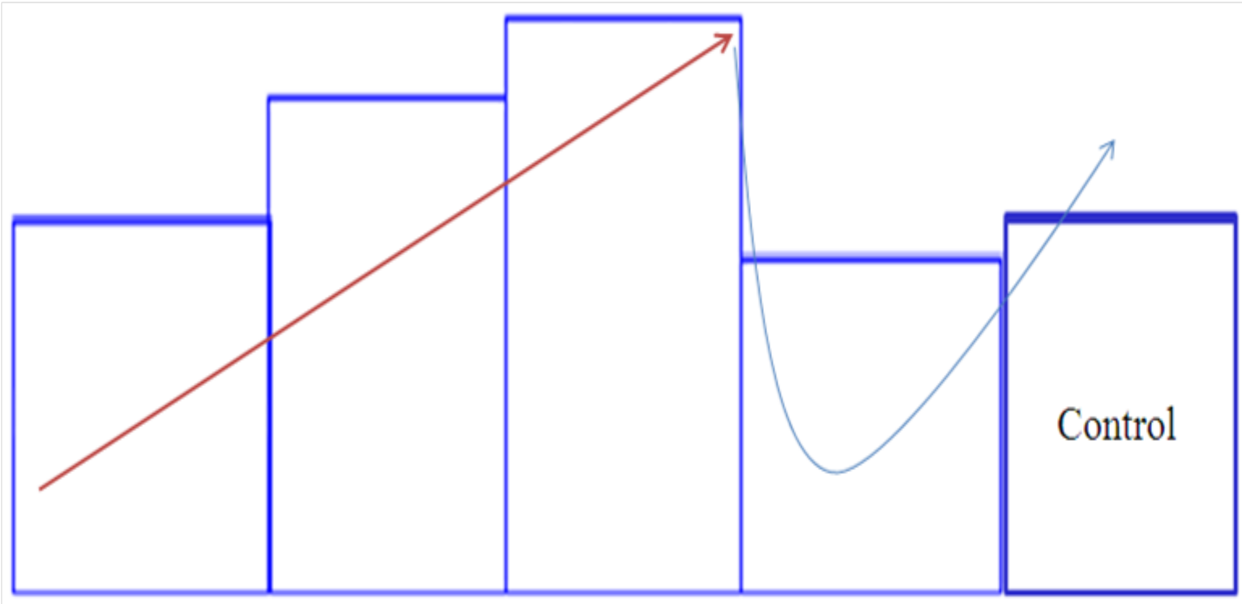

Figure 3. *Theoretical representation of 3 x 1 plus a control mesocycle paradigm.*

Considering mesocycles as a key period where measurable effects can be assessed, only after gaining a greater understanding of how an individual athlete adapts and responds to the applied training stimulus (load/volume/intensity/frequency/duration) a coach will be in a position to establish a realistic objective for the next phase and design the most appropriate training method for the following mesocycles or phases (Verkhoshansky, 1998). This procedure would allow a coherent mesocycle connection where the outcomes achieved at the end of each biocycle provide the framework and support for further increase in the athletes' performance (Viru, 1995; Zatsiorsky et al., 2006). Therefore, the success of training process as a whole will depend on a full understanding of the objectives and the most appropriate individualized training methodology to get the proposed results for each specific phase.

Microcycles characteristics configure and determine mesocycles goals

Microcycle constitute the basic unit of mesocycles providing their characteristics. Microcycles are essential tools that permit an adequate control of training variable (volume, intensity, recovery periods, frequency and exercise selection) in order to establish priorities at any stage of the training process (Platonov, 2001). Throughout the annual plan, the nature and dynamic of microcycles will change according to the phase of training, objectives, physiological and psychological demands of the different sporting activities (Bompa & Haff, 2009).

Each microcycle involves specific numbers of sessions that have to be coherently organised and effectively sequenced. The organisation of the loading, and associated characteristics of every session within the microcycle should be established in accordance with the specific objectives of each microcycle and the general goals of the entire mesocycle. Therefore, the selected training activities have to allow athletes to train at the required level of performance for achieving the expected training outcomes (Smith, 2003).

Session as a basic unit of microcycles

A session is the key element for organising the daily programs (Bompa & Haff, 2009). Although sessions tend to be the smallest components within a periodized plan, in more complex and advanced programs design a session can include several small numbers of training units (Platonov, 2001). Training sessions and their composition are the primary requirement for the configuration of microcycles, providing them with their final appearance and detailed characteristics (Siff, 2004). However, it is important to highlight that the definitive design of both sessions and microcycle have to be based on the mesocycle main objectives.

Depending on the dominant factor and the dynamic correspondence, each session can be allocated into the following three main groups:

- Physical conditioning: These sessions are specifically oriented to develop physical capacities such as strength, explosiveness, speed, flexibility, and aerobic or anaerobic endurance. In addition these can be aimed to assess or control the athletes' level of performance.
- Technical: These sessions are focused on learning and technique and therefore should not be performed in fatigue state. Fatigue not only has the potential to hinder the learning process but can also induce negative outcomes related to the assimilation of incorrect motor patterns (Bompa & Haff, 2009).
- Tactical: Involves specific sports actions with correct technique, motor control and knowledge of the dynamic roles and basic structure of the sports. These sessions are often emphasised in high performance athletes as opposed to novice athletes who would usually focus on the progression of physical conditioning and the development of technical proficiency.

It is important to highlight that both technical and tactical sessions will contribute to the imposed physiological and mechanical demand on the athletes' body depending on the sport specific requirements and the intensity of the assigned training task.

The effect of any training session is determined by the orientation of training load (Oca & Navarro, 2011). Load orientation will depend on two main factors:

- Qualitative, refers to the predominant physical capacity to be trained. From a physiological point of view this variable is identified by the intensity of exercise (Smith, 2003).
- Quantitative, refers to the amount of work performed and is related to the volume. The amount of volume athletes can perform within a given intensity is highly related with the athlete's level of performance (Kuznetsov, 1989).

To obtain the desired adaptation at the end of each mesocycle or phase, several sessions with similar qualitative orientation although often, with a different volume, must be repeated several times (Bompa & Haff, 2009). Regardless of the quality, each training session can be classified according the assigned volume as low, moderate, high and maximal (Platonov, 2001). For this classification the individual maximum tolerated volume for a given intensity is considered the 100%. Thereby the amount of work allocated for low (~30%), moderate (>30% to 60) and high (>60% to 80) will be determined in accordance with the corresponding maximum (Kuznetsov, 1989). These volumes are also connected with the main athletic preparation objectives: maintenance, activation, regain and increase performance. Table 1, depicts the principal characteristics of low, moderate, high or maximal volume sessions, their most common allocation within the microcycle and supposed effects on performance (Kuznetsov, 1989; Platonov, 2001).

Table 1. *Training session characteristics Insert Table 1 near here.*

Volume	Amount of the work (%) respect to the maximum tolerated load	Principal objectives	Reccomended allocation within the microcycle
Low	10% 15 to 30%	Activate or potentiate Maintain performance	After hard trainng session (first session after shock microcycle), or the end of standard micocycle
Moderate	40-60%	Regain or slow performance improvement	More frequent in introductory microcycles or in the middle of competitive microcycle
High	>60 to 70% >70 to 80%	Moderate performance increase (non effective in elite athletes) Higher increase of performance (applied for most important capacities) specially effective in elite athletes	Usually applied at the start and the middle of standard and shock microcycles
Maximal	>80 to 100%	Maximum stimulation for expecting the higher degree of improvement	Only one for standard microcycles and until two or three for shock microcycles

Time of recovery between sessions

To some extent, the majority of sports require training of several motor abilities involving different degrees of speed, strength, and endurance. Performed abilities will demand a particular pattern of energy system contribution as well as different levels of neural and mechanical stress. This is because the rate of recovery will be different depending not only on the training workout characteristics (Bompa & Haff, 2009) but also upon the allocation of any particular session inside the microcycle. Such factors will significantly influence the recovery process of individual athletes (Platonov, 2001). The effect of a maximum volume session is substantially different from that determined by high, moderate or low volume (figure 4). After a low volume session the recovery process could take anything from a few minutes to a few hours, for a moderate volume session between 12 hours and one or even two days depending on the session quality (performed capacity), for example: high intensity with great metabolic demand such as anaerobic endurance could require up to two days of recovery, explosive strength with light load would need a minimum of one day, meanwhile in the case of light intensity endurance, 12 or 18 hours could be sufficient (Platonov, 2001). High volume training load requires a longer recovery period than moderate and low but significantly less when compared with a maximum volume session or competition where up to four days have been shown to be necessary for a complete recovery in team sports athletes (McLean et al., 2010). In elite athletes, high volume load could not produce benefits to increase performance and it would be necessary for several high or maximum volume sessions to occur in order to induce small benefits (Platonov, 2001). As a general orientation, after a high volume session, depending on both, the predominant energetic pathway and the physical stimulated capacity (strength, speed or endurance), one, two or three days would be required for recovery. For example, one day could be enough after a flexibility or a light intensity endurance workout; two days seems to be adequate for an explosive strength or moderate intensity aerobic endurance workout, meanwhile more than two days would be necessary for speed, maximal strength, hypertrophy, high intensity endurance (near maximal aerobic speed) or anaerobic-glycolytic endurance (Platonov, 2001). In addition, the success of a periodized plan is based on an optimal sequence of maximal; high; moderate and low volume sessions with different orientation throughout the microcycles. The appropriate organization of session will facilitate recovery and the expected positive adaptation to different training loads (Graham, 2002).

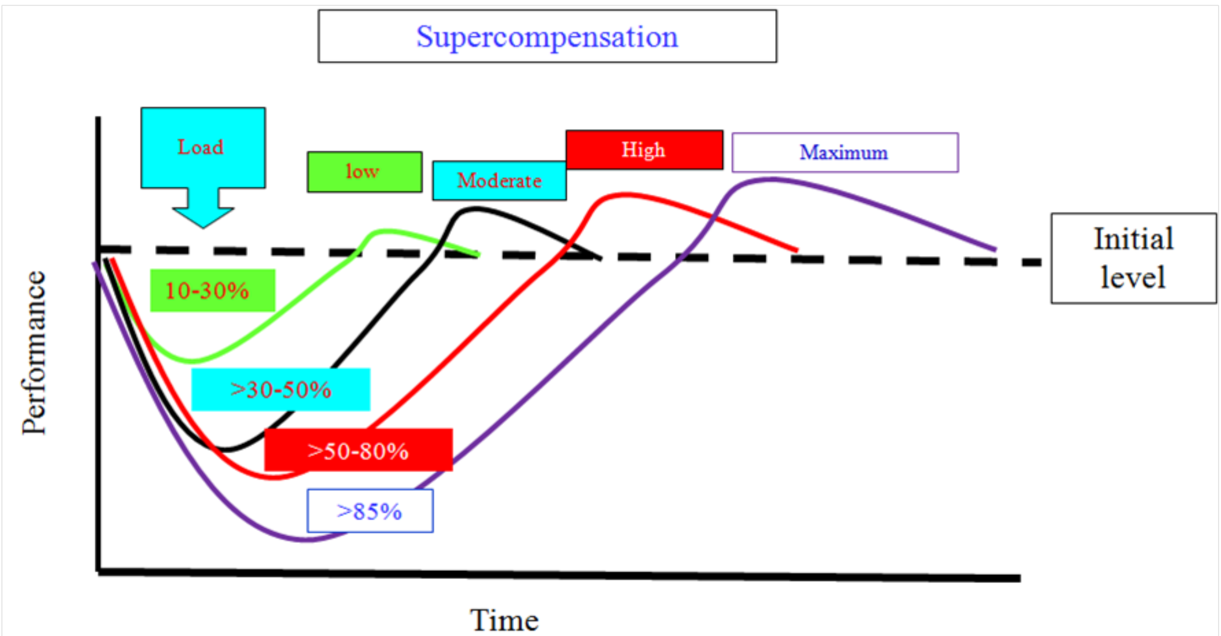

Figure 4. *Theoretical effect of low, moderate, high and maximum volume session on performance.*

Session orientation

When designing a single training session, maximal intensity and maximal strength training should always precede endurance (Chiu & Bernes, 2003). The onset of fatigue with more endurance oriented exercises is nearly immediate, as opposed to maximal intensity and strength, where the potentiation after-effect can offset the effect of fatigue especially if low volume is performed (Chiu & Bernes, 2003; Tillin & Bishop, 2009). Authors have speculated that this is because explosive, speed and more technical or tactical related activities should be performed first, leaving the more endurance related exercise for the end part of the workout (Chiu & Bernes, 2003; Verchoshansky, 1996).

In team sport, complex sessions involving several physical, technical or tactical tasks are a common practice (Bompa & Haff, 2009; Platonov, 2001). In such cases it is advisable to apply low volume load for each of the combined capacities. Moderate load can be an alternative when coaches wish to focus in one special preparation over another, (perhaps technical or tactical in the last few days before a competition) (Platonov, 2001). When using complex sessions, coaches must be aware that the summation of three or four different activities can easily determine high or maximum volume of training, which may, as a result, require longer recovery periods. Such an example can occur in team sports with one or two competition per week. Complex sessions involving more than three or four capacities should be trained toward the middle of microcycle when there is enough time for appropriate recovery before the match.

Types of Microcycles
As the specific microcycle design will determine their global effects and outcomes achieved at the end of the planned mesocycles, their structure should be considered in the context of mesocycles and based on the sports demand and individual athletes' requirements (Platonov, 2001).

In general it is possible to distinguish between five types of microcycles: 1) introductory or applied; 2) standard or ordinary; 3) shock; 4) restorative and 5) competitive or activation (which include the session allocated before competition or test) (Siff, 2004). In order to facilitate the achievement of some specific goals (learning technique, maintenance or increases in performance) these microcycles should be appropriately integrated within the mesocycles.

Introductory or applied:
These microcycles do not include maximum volume session and are not recommended to involve high volume ones. Introductory microcycles could be applied to teach new technical skills, correct mistakes or adjust training loads. In addition they are used as a form of 'training barometer' of the programmed training tasks in order to assess if the prescribed training activities are appropriate for the athlete's age or biological maturation as well as the level of performance (Smith, 2003). In some sports, appropriately scheduled and structured low to moderate volume sessions could be more appropriate to minimise the potential of excessive fatigue which can impair the ability to learn, understand new motor skills, or ascertain the viability of new training methods and loads. Introductory or applied microcycles are usually included at the start of mesocycles lasting between 5 to 7 days (Viru, 1995).

Standard or ordinary:
These microcycles are the most frequently used throughout the annual plan, representing around 50% or more of the total microcycles of the structured macrocycle (Navarro, 1999). Standard macrocycles are classically defined as low or high. The rational for such classifications is the number of included high or maximum load volume sessions (Platonov, 2001). The simplest model would be as follows:

1. Low standard microcycles usually do not include maximum volume sessions. These microcycles include one high volume session and are more similar to introductory microcycles.
2. High standard microcycles are most common and include one maximum and one or two high volume session, being close to shock microcycles.

Standard microcycles are usually included at the beginning or after the introductory microcycles. The extension should vary between 5 to 7 or 8 days (Platonov, 2001).

Shock:
These microcycles are usually included during preseason when there is a need to stimulate profound adaptation in specific phases of the training cycle (Verchoshansky, 1996). Shock microcycles include more than one maximum (two to three) load volume sessions. However, when more than one session a day is programmed, four maximum load sessions can be included. Usually these types of microcycles involves between 7 (Platonov, 2001) to 10 days (Siff, 2004).

As general rule shock microcycles should be followed by regenerative microcycles. It is not recommended to assign shock microcycles during a period with frequent competitions, which is the case of many team sports that have at least one competition per week. The high level of fatigue determined by such a hard microcycle, in addition to impaired performance can contribute to an increased risk of injury or unplanned overreaching. Technical and strength and conditioning coaches must work closely together to carefully control and monitor athletes' performances during these extremely challenging microcycles (Smith, 2003). As a final recommendation, due its high levels of physical demand it is recommended not to use shock microcycles when training biologically young athletes (Martin et al., 2001).

Regenerative or restorative:
These microcycles are aimed to assist the body in recovery from a previous period of programmed shock training or several standard microcycles. The principal goal of these microcycles is to lead athletes to the level of performance required to continue with the next training phase. Restorative microcycles will always start with a regenerative session (low volume and low intensity exercises such as light aerobic swimming or light dynamic flexibility exercises). The end session of these microcycles usually involve some short high intensity exercise (explosive or speed) aimed to monitor the recovery process. Neuromuscular explosive capacities take more time to be completely restored (Siff, 2004) and thereby control the athletes capacity for performing explosive or high speed actions is a practical and effective method to assess the recovery state (Sanchez-Medina & Gonzalez-Badillo, 2011). Regenerative microcycles usually last between 3 to 5 days. Tapering strategies include regenerative sessions followed by a longer period with high intensity low volume activation session (this type of strategy can last between 8 to 14 days) (Bosquet et al., 2007).

Competitive or activation:
These microcycles are aimed to prepare athletes for competition and therefore include the competition as well (Siff, 2004). However, for the aim of this article we will consider only the few sessions situated immediately before the competition or any other special activity for which athletes must be able to express their maximal level of performance. Although the volume of activation microcycles can be as low as for the restorative, their purposes are different. Activation is aimed to potentiate athlete's performance for subsequent workouts, competition or test. Prior to begin an activation microcycle athletes should be appropriately recovered and be able to perform high intensity exercises. The activation microcycle should stimulate recovery processes ending with a short duration and low intensity exercises such as light flexibility or low intensity aerobic activity.

How to design microcycles with different characteristics
As previously stated, a training session is the functional unit that should determine the orientation and characteristics of each particular microcycle. Therefore, in order to achieve the desired outcomes each session should be appropriately integrated within the entire microcycle. Table 2; shows a practical orientation for designing different types of microcycles considering both 1 and 2 workouts per day.

***Table 2**. Guidelines for microcycles design. (Adapted from Platonov, 2001 p 435).*

Type of Microcycle	1 session per day workout programme design	2 or 3 session per day workout programme design
Restorative	Involve several low volume sessions, being possible to include 1 moderate at the end.	Involve several low volume sessions, being possible to include 2 moderate at the end.
Activation	Involve very low volume sessions (10% of maximum volume) with high intensity activities.	Involve very low volume sessions (10% of maximum volume) with high intensity activities.
Introductory	No maximum volume session; 1 high; 2 to 3 moderate and 1 or 2 low, where one should be a regenerative session.	No maximum volume session, 2 high 3 moderate and 2 or 3 lo, where at least one should be regenerative.
Standard	1 maximum volume sessions; 1 or 2 high; 2 moderate and 2 low, where one should be a regenerative session.	1 or 2 maximum volume sessions, 2 or 3 high 2 or 3 moderate and 2 or 3 low where at least one should be regenerative.
Shock (usually more than 7 days)	1 a 2 maximum volume sessions, 2 to 3 high; 2 moderate and 2 to 3 low where one should be a regenerative session.	3 to 4 maximum volume sessions, 3 to 4 high, 2 to 3 moderate and 3 to 4 low, where tow should be regenerative session.

Designing a microcycle

According to the fitness fatigue paradigm, athlete preparedness may be determined based on the principle after effects of training: fitness and fatigue (Chiu & Bernes, 2003). This concept differentiates the predominant type of stress determined after workout, such as neuromuscular, and metabolic stress (Chiu & Bernes, 2003). Therefore, if the athlete is too fatigued to repeat the same exercise with the required level of performance, he/she may still be able to perform another type of training. This, for example, provides the criteria for combining workouts with different orientation such as the concurrent training involving both aerobic and power exercise as usually designed in team or fighting sports (Platonov, 2001).

It is not advisable to introduce two high or maximum volume sessions with the same neural or physiological orientation (explosive strength, speed or maximal strength) in two consecutive session (Platonov, 2001). One possible exception to this rule is when training with light or moderate aerobic endurance loads using different type of motor patter such as in the case of triathletes for example who perform running, cycling or swimming in consecutive days or even in the same day (Bompa & Haff, 2009).

When concurrently training different qualities, early in the microcycle the emphasis should be on maximal intensity training (explosive strength or speed). As the fatigue after-effect is shortest for this type of activities rather than for predominantly metabolic ones (Chiu & Bernes, 2003), this arrangement will produce the smallest negative effect on subsequent days of training. However, depending on the sporting activity, performing neuromuscular high intensity sessions in the first day may positively influence subsequent training days. A day emphasizing maximal strength or endurance may be beneficial after explosive or speed training, so it does not negatively affect the previous explosive-speed training sessions. On the other hand, in well resistance trained athletes a previous low volume maximal strength session has only been shown not to hinder subsequent high intensity performance but also acts with a potentiating effects on the following speed or explosive activities (Dochety et al., 2004; Saez et al., 2007).

Depending on which paradigm is being implemented, endurance oriented sessions should occur toward the end of the week, closer to days of rest, which will allow fatigue to recover (Chiu & Bernes, 2003). When the coach has to include two sessions with high or maximum load in a row, they have to assign them with different orientation. For example, if the first session involves tactical activities that require high level of explosive strength, the second can be oriented to train anaerobic-glycolytic endurance (Verkhoshansky, 1998). It would not be advisable to perform power-oriented tasks that potentially will produce large neurological stress after a high volume endurance training session (some exception could be in endurance athletes such as triathletes). A fatigued body is not able to perform high quality and powerful muscle contractions. That is the reason by which explosive, power or maximal strength training that require a high recruitment of fast twitch fibres should be performed before endurance exercises (Bompa & Haff, 2009; Siff, 2004). High to maximum anaerobic-glycolytic volume session should be toward second part of the microcycle. This type of training has been shown to require longer recovery periods (Hellsten-Westing et al., 1993). Thereby when introduced at the beginning of the microcycle, before other high intensity training such as explosive or speed, performance of this activities can be seriously compromised (Hellsten-Westing et al., 1993).

Regardless of sports or special training goals it is not advisable to include two consecutive high or maximum volume session with a high amount of cognitive, coordinative or tactical task (Platonov, 2001). Due to accumulated fatigue the learning process and ability to concentrate in the subsequent highly cognitive demanding task would be seriously impaired (Bompa & Haff, 2009). Thus, it is advisable to alternate low or moderate sessions with different orientation (aimed to maintain the level of performance in the specific capacity) with maximum or high volume session. This approach can enhance recovery process and stimulate positive adaptations created by the main training capacity (Turner, 2011). The previous rationale legitimates the following two main considerations for an appropriate microcycle session's allocation:

1. The previous session have to support and not impair athletes performance during the subsequent session (this is the key principle that should not be violated).
2. Highly cognitive (tactical and technical), explosive or speed focused workouts should be introduced into the first part leaving more endurance oriented session for the middle or end part of the microcycle.

In order to check the accomplishment of the above principles, identify possible mistakes and determine the microcycle objectives, coaches should consider the following recommendations:

- The connection between all microcycles in the mesocycles should permit the compliance of the first principle.
- Confirm if the objectives and orientation assigned to the microcycles are coherent with the quality and volume of the assigned session. For standard and shock microcycles, the maximum and high volume sessions should be in-line with the above principal objective. Meanwhile the task included in moderate and low volume session should consider the secondary and other less demanding objectives (Platonov, 2001). For example, if one of the objectives is to maintain a given level of performance, to obtain this particular outcome, the inclusion of only low volume sessions would be appropriate (Gamble, 2006).

CONCLUSIONS

Periodization organizes the training process into phases and cycles to promote peak condition for the most important competitions. The macrocycle is divided into phases (preparatory, competitive and transition) each of which is allocated with a determined number of mesocycles that are designed to achieve specific physiological and performance goals. In all cases the specific nature of the sporting season and athlete's individualities dictates the length and number of mesocycles and phases during the macrocycle.

A comprehensive monitoring of athletes is necessary along the entire training process. This approach will allow a coach to make informed decisions regarding the effects and consequent planning of subsequent training programs. The principle of individualisation suggests that athletes will react and adapt differently over individual times frames even when presented with identical training regimes. The attainment of consistent high performance requires effective training that is carefully designed and monitored and is accompanied by planned recovery. Consider the possibilities in skill instruction, acquisition and the proposed goals throughout the phases as principal drivers of the training process will permit an optimal and flexible determination of the most appropriate training methods and further objectives for each particular athlete.

More researches are needed in the areas of multi-mode training, programs design for athletes of different level of performance, sports specialities and short- and long-term program design. Without this information, coaches have to continue to periodize based on the results coming from physiological and biomechanical researches as well as their experience and particular opinion.

REFERENCES

1. BAKER D. Applying in-Season Periodization of Strength and power Training to football. *Strength Cond. J.* 1998; 20(2):18-27.
2. BOMPA TO, HAFF GG. Periodization, Theory and Methodoly of Training: Human Kinetics. 2009.
3. BONDARCHUK AP. Constructing a training system. Track Tech. 1988; 102:3254-3269.
4. BOSQUET L, MONTPETIT J, ARVISAIS D, MUJIKA I. Effects of Tapering on Performance: A Meta-Analysis. *Med Sci Sport Exerc*. 2007; 39(8):1358-1365.
5. CHIU LZF, BERNES JL. The Fitness-Fatigue Model Revisited: Implication for Planning Short and Long term Training. *Strength Cond. J.* 2003; 25(6):42-51.
6. DOCHETY D, ROBBINS D, HODGSON M. Complex training revised: A review of its current status as viable training approach. *J. Strength Cond. Res*. 2004; 26(6):52-57.
7. GAMBLE P. Periodization of Training for Team Sports Athletes. *Strength Cond. J.* 2006; 28(5):56-66.
8. GRAHAM J. Periodizatión Research and Example Application. *Strength Cond. J.* 2002; 24(6):52-70.
9. HAFF G. Periodization of Training Chapter 14: 326-345 In T. J. B. Chandler, L.E (Ed.), *Conditioning for Strength and Human Performance: Lippincott Williams & Wilkins*. 2013.
10. HELLSTEN-WESTING Y, NORMAN B, BALSOM PD, SJODIN B. Decreased resting levels of adenine nucleotides in human skeletal muscle after high-intensity training. *J Appl Physiol.* 1993; 74(5):2523-2528.
11. HOFF J. Training and testing physical capacities for elite soccer placer. *J. Sports Sci.* 2006; 6:573-582.

12. ISSURIN VB. New horizons for the methodology and physiology of training periodization. *Sports Med*. 2010; 40(3):189-206.
13. KUZNETSOV VV. Metodología del entrenamiento de fuerza para deportistas de alto nivel (P. s. v. r. Traducción del titulo original: Silovaja, (1970) Mosca., Trans.). Buenos Aires: Stadium. 1989.
14. MARTIN D, CARL K, LEHNERTZ K. Manual de Metodología del Entrenamiento Deportivo. Barcelona: Paidotribo. 2001.
15. MCHUGH MP, TETRO DT. Changes in the relationship between joint angle and torque production associated with the repeated bout effect. *J Sports Sci*. 2003; 21(11):927-932.
16. MCLEAN BD, COUTTS AJ, KELLY V, MCGUIGAN MR, CORMACK SJ. Neuromuscular, endocrine, and perceptual fatigue responses during different length between-match microcycles in professional rugby league players. *Int J Sports Physiol Perform*. 2010; 5(3):367-383.
17. NAVARRO F. La estructura convencional de la planificación del entrenamiento versus la estructura contemporanea. *Revista de Entrenamiento Deportivo (RED)*. 1999; XIII:5-13.
18. OCA A, NAVARRO F. Principios básicos sobre programación y prescripción del entrenamiento deportivo, chapter 23. In F. Nacleiro (Ed.), *Entrenamiento deportivo, fundamentos y aplicaciones en diferentes deportes (1st ed.)*: Medica Panamericana. 2011.
19. PLATONOV VN. Teoría General del Entrenamiento Deportivo Olímpico: Paidotribo. 2001.
20. PLISK SS, STONE MH. Periodization strategies. *Strength Cond. J.* 2003; 25(6):19-37.
21. REILLY T, DRUST B, CLARKE N. Muscle Fatigue during Football Match-Play. *Sports Med*. 2008; 38(5):357-367.
22. SAEZ E, GONZÁLEZ-BADILLO JJ, IZQUIERDO M. Optimal warm-up stimuli of muscle activation to enhance short and long-term acute jumping performance. *Eur J Appl Physiol*. 2007; 100(4):393-401.
23. SANCHEZ-MEDINA L, GONZALEZ-BADILLO JJ. Velocity loss as an indicator of neuromuscular fatigue during resistance training. *Med Sci Sports Exerc*. 2011; 43(9):1725-1734.
24. SIFF MC. Supertraining (5º ed.). Denver USA: *Supertraining institute*. 2004.
25. SMITH DJ. A Framework for Understanding the Training Process Leading to Elite Performance. *Sports Med.* 2003; 33(15):1103-1126.
26. STONE MH, STONE M, SANDS WA. Principles and practice of resistance training. *Chapter 13 The concept of periodización: Human Kinetics*. 2007.
27. TILLIN NA, BISHOP D. Factors Modulating Post-Activation Potentiation and its Effect on Performance of Subsequent Explosive Activities. *Sport Med.* 2009; 39(2):147-166.
28. TSCHIENE P. Il nuovo orientamento delle structure dell'allenamento. *Scuola dello Sport*. 2000; XIX(47-48):13-21.
29. TURNER A. The Science and Practice of Periodization: A Brief Review Strength Cond. J. 2011; 33(1):34-46.
30. VERCHOSHANSKI J. The skills of programming the training process. New. Studies in Athletics. 1999; 14(4):45-54.
31. VERCHOSHANSKY Y. Sei principi della preparazione fisica speciale. *Rivista de Cultura Sportiva (SDS)*. 1996; (35):27-33.
32. VERKHOSHANSKY Y. Main features of modern scientific sports training theory. *New Studies in Athletics*. 1998a; 13(3):9-20.
33. VERKHOSHANSKY Y. Organization of the training process. *New Studies in Athletics*. 1998b; 13(3):21-31.
34. VIRU A. Adaptation in sport training. Boca Raton (FL): *CRC Press LLC*. 1995.

35. WATHEN D, BAECHLE TR, EARLE RW. (2008). Periodization, Chapter 19. In R. Earle, W. & T. R. Baechle (Eds.), *Essential of Strength Training and Conditioning (NSCA*). 2008:509-522. Champaing IL: Human Kinetics.
36. ZATSIORSKY VM, KRAEMER JW. Sciences and practice of strength training (2º ed.): *Human Kinetics*. 2006.