## a) Title: Periodization. Is it really dead?

Subtitle: 1st Part: Review of the latest critics to the concept of Periodization. 2nd Part: The components of planning and programming of training theories and how they can be mixed to form a sport specific model.

1st part

The subject of planning training is probably, in relation to its importance, the most misunderstood topic among the professionals that gravitate to the world of sports training.

Lev Matveyev's book "*The problem of Periodization of Training Process",* published in 1964, was based on the analysis of the training diaries of the soviet athletes who took part to the 1952 Olympic Games. Not surprising then, that in the same period, Tudor Bompa, was already applying the periodization of training to his athletes, including Mihaela Penes (gold medal in the javelin throw at 1964 Tokyo Olympics), and particularly developing what would become his breakthrough concept of *Periodization of Strength*. But it's only in 1983 that Bompa's work and the concept of periodization became popular, especially in North America, thanks to the book "Periodization. Theory and Methodology of Training".

*The term Periodization refers to two important aspects: the Periodization of the Annual Plan which allows to divide and manage the training program and to obtain the best shape for the major competitions, and the Periodization of Biomotor Abilities which allows the athlete to develop the highest level of the biomotor abilities (strength, speed, endurance)* [1]

Typically we may observe critics of periodization confusing programming with planning. Thus, criticizing the latter broader concept on the basis of some evidence that one particular method works better than another. This should bring to mind the discussion of linear vs non-linear periodization, which is based on the misconception that periodization is "classically" linear. Such debate is actually just a discussion of the macrocycle load progression. This doesn't invalidate the concept of periodization itself. Again, many coaches confuse sequential with linear, when the latter applies to the load progression, and the former to either the integration or development of motor capacities. A similar situation has been sparked by the study by Mann et al. on *The Effects of Autoregulatory Progressive Resistance Exercise vs Linear Periodization on Strength Improvementsin College Athletes*. This study practically compares autoregulatory RM training with a pre-fixed percentage/load linear progression. De facto, such kind of autoregulation is not a novelty. It is, in fact, a common practice using RM training in hypertrophy macrocycles; and to a lesser extent, in maximum strength macrocycles, where more advanced coaches tend to favor sets of explosive concentrics not taken to failure. Thus, autoregulation may be utilized as a load regulating method within a periodized plan. The mechanistic rigidity often associated with the concept of periodization is probably based on the linear periodization of strength popularized in the US in the 80's, which required very long training periods during which time the body was supposed to go thru a "mathematical" progression. Such an approach has little to do with the more sophisticated, and educated,

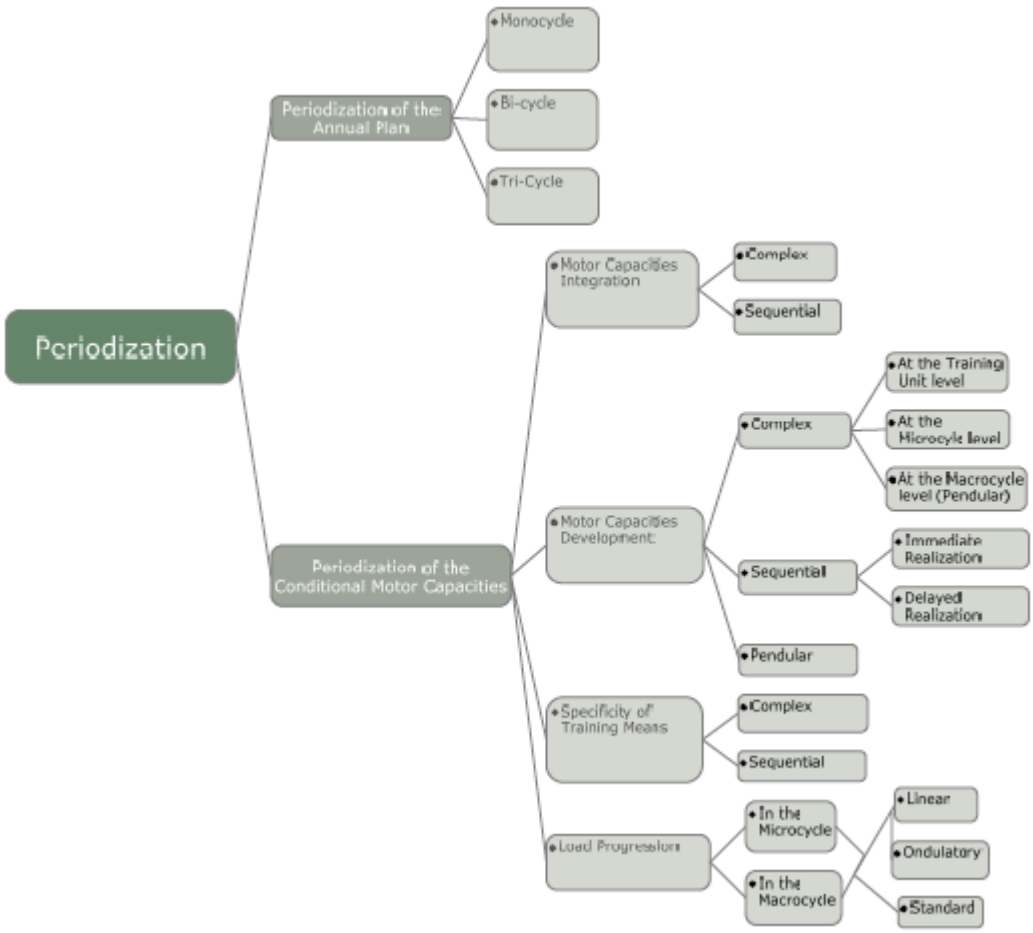
1 See. Tudor O. Bompa, 1999a.

periodized strategies of the best coaches who base the load determination on a continuous feed-forward/feedback/adjustment process, as it should be.

In recent years it has become a common thought among some strength and conditioning coaches in team sports that periodization is an impracticable way of planning and programming for team sports, and therefore not practiced. This is due to the fact that periodization, historically, was born as a methodological mean for individual sports, characterized by very few competitions and therefore by a very long preparatory period, with the goal of reaching peak performance in one or more well defined moment of the season. These features, long preparatory phase and short competition phase, are missing in some team sports, especially after the advent of professionalism and very long competitive phases. The above mentioned definition of periodization shows that any plan that divides the year into periods meets one of its two main characteristics. What would change in a sport with a long competitive phase with frequent competitions should be the periodization of biomotor abilities and the ratio between general and specific work.

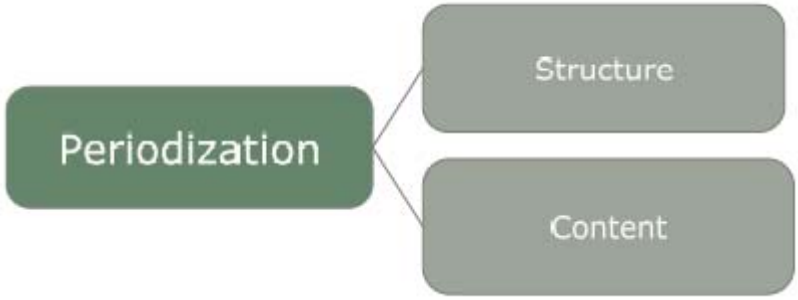
## 2nd Part

As we can see in the following image the concept of periodization is rather wide as it includes many theoretical and methodological concepts.

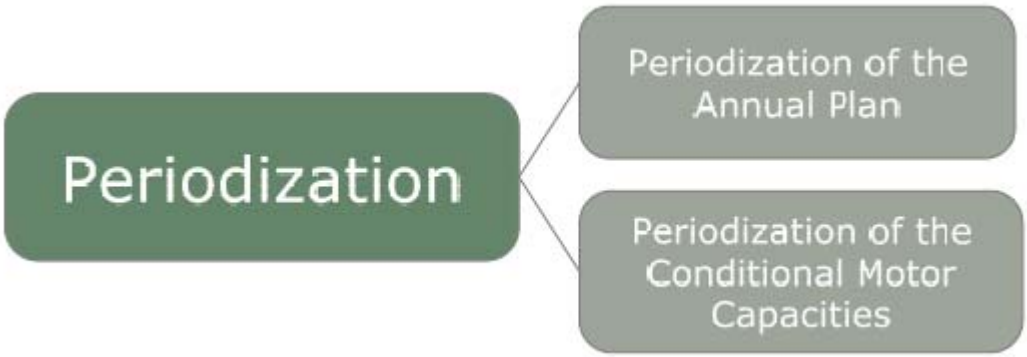


In this image we have listed the smallest components of every theory on planning the training process.
In fact, before we discuss which planning and programming method is better suited for a certain situation, we should agree on the terminology; and even more important, the very concepts that form the theory of planning and programming of training.

**Planning and Programming**
First, let's define planning and programming. Planning may be defined as the long and mid-term strategy that regulates the training process, i.e. the structure within which the training process will take place. Programming, on the other hand, is the act of filling said structure with actual content, i.e. the actual training modalities.




**Periodization of Training**
As Prof. Tudor Bompa writes, periodization refers to two important aspects of planning and
programming the training:
a) The Periodization of the Annual Plan which, by dividing the year into smaller training phases, makes it easier to manage the training and peaking processes.
b) The Periodization of the Conditional Motor Capacities (aka biomotor abilities), which
enables one to develop the motor capacities: strength, speed and endurance to an optimal
level for sport performance.




Given what has been just stated, each time we have a division of the year into smaller phases and a sequence of development for each conditional motor capacity, we have a periodized plan. Some critics of periodization state that it was born for individual sports that include a long preparation phase and a short competitive phase. Thus, it would not be applicable to modern team sports; which have a short preparation period and a very long competitive period. This would only be true if one combination of all the factors were possible. In reality, however, we may design as

many periodized plans as necessary; relative to the possible situations we may encounter in the sport training process.
Furthermore, if we were to analyze what these coaches actually do, their plans would still entail a division of the year into smaller periods and a periodization of conditional motor capacities; thereby, satisfying the requirements to define those schemes as "periodized plans".

**Periodization of the Annual Plan**

The annual plan periodization is based on fundamental concepts such as:

a) Sport performance improvement is based, especially for the high level athlete, on the increase of the athlete's motor potential.

b) Morpho-functional adaptations require some time, as well as an alternation of work and recovery, to manifest themselves.

c) The development of the conditional motor capacities and the improvement of the technical and tactical aspects require a progressive approach where training stimuli intensity is gradually increased, on the basis of previously induced morphological and\or functional adaptations.

d) The athlete cannot maintain peak performance for a prolonged or undefined time.[2]

Bompa's terminology differs from that of the Soviets, who speak of microcycle, mesocycle and macrocycle, the latter of various time length: six-months, annual, four years (Olympic cycle). Our concepts imply the following terminology:

**Annual Plan -** (annual macrocycle for the Soviets): Division of the year in phases, subphases, macrocylces and microcycles, to better manage the training process.

**Phases -** (macrocycles for the Soviets): Preparation, competition, transition.

**Subphases –** Further definition of the content of the phases, named as: General Preparation, Specific Preparation, Precompetitive Competitive and Transition. Groups of macrocylces with the same training direction, and whose length can vary from one week (a short transition phase) to twenty-four weeks (a long General Preparation Phase) .

**Macrocycle -** (mesocycle for the Soviets): Group of microcycles with the same training direction (according to the macrocycle and sub-phase), whose length can vary from two (a pre-competitive unload macrocycle, called *taper*) to six weeks (a long introductory macrocycle in General Preparation), generally three or four weeks long.

**Microcycle -** Cyclic sequence of training units that follow the macrocycle goals, whose length vary from five to fourteen days, usually a week.

---

[2] *See*. Yurij L.V. Verkhoshanskij, *2008*.

**Training Unit -** It is the single training session with intra-pauses shorter than 45 minutes.

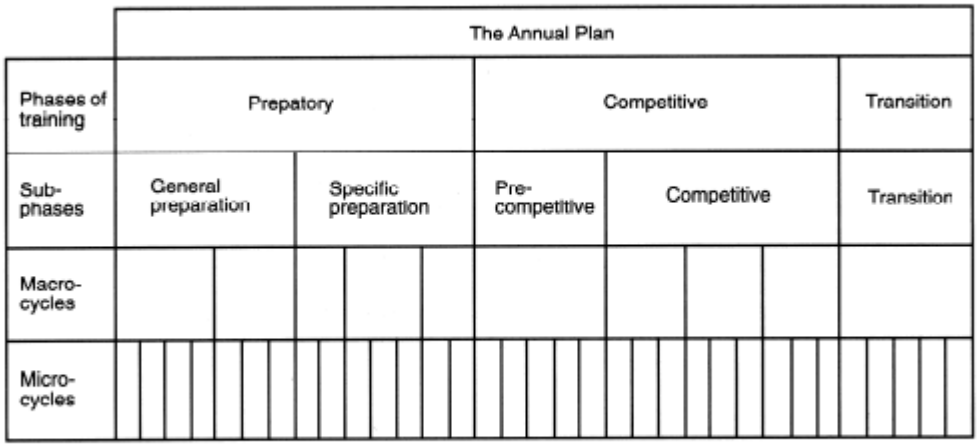


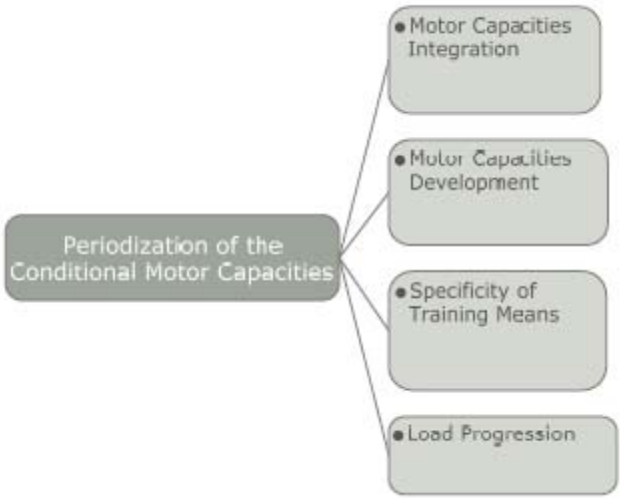

**Figure 8.1** Division of an annual plan into its phases and cycles of training

Annual plans are characterized by the number of competitive phases, and defined as monocyclical, bi-cyclical and tri-cyclal based on such characteristic.

**Periodization of the Conditional Motor Capacities**

Much more important is to describe the concepts related to the periodization of conditional motor
capacities. The four elements that differentiate each theory and methodology of planning and
programming of training, in reference to the periodization of strength, speed and endurance, are:

1) Integration of the conditional motor capacities
2) Development of each conditional motor capacity throughout the plan
3) Degree of specificity of the training means throughout the plan
4) Load progression




**Integration**

The integration of the conditional motor capacities refers to the way each motor capacity is trained
in the annual plan; in relation to the others. We can have two strategies:
a) **Complex**: strength, speed and endurance are all trained at the same time.
b) **Sequential**: strength, speed and endurance are emphasized at different times during the
annual plan (*concentrated loading*). In such kind of plans, usually it's strength that is separated from the development of speed (for example, Verkhoshansky's strength block).

**Development**

The concept of development of a conditional motor capacity refers to the way each conditional
motor capacity is trained during the annual plan. We can have three different approaches:
1) **Complex**, all the qualities of a conditional motor capacity are trained simultaneously (for
example maximum strength, speed strength and muscular endurance). This can happen at
different levels:
a) Training Unit; maximum strength, speed strength and muscular endurance are trained with
this sequence within the single training unit.
b) Microcycle; maximum strength, speed strength and muscular endurance are all trained in the
microcycle, in different training units.
c) Macrocycle; maximum strength, speed strength and muscular endurance are trained
throughout the macrocycle, during dedicated microcycles.
2) **Sequential**, the qualities of a conditional motor capacity are trained sequentially (for
example anatomical adaptation followed by maximum strength followed by power).
The loading parameters for the sequential approach can be manipulated in such a way to have
either:
a) An immediate realization; at the end of the macrocycle, the indexes of the trained conditional motor capacity quality are improved.
b) A delayed realization; at the end of the macrocycle, the indexes of the trained conditional
motor capacity quality are depressed but improve later on (aka *planned overreaching*).
3) **Pendular**, two qualities of a conditional motor capacity are trained in alternative fashion
(for example maximum strength followed by power followed by maximum strength followed by power).

## Specificity of the Training Means

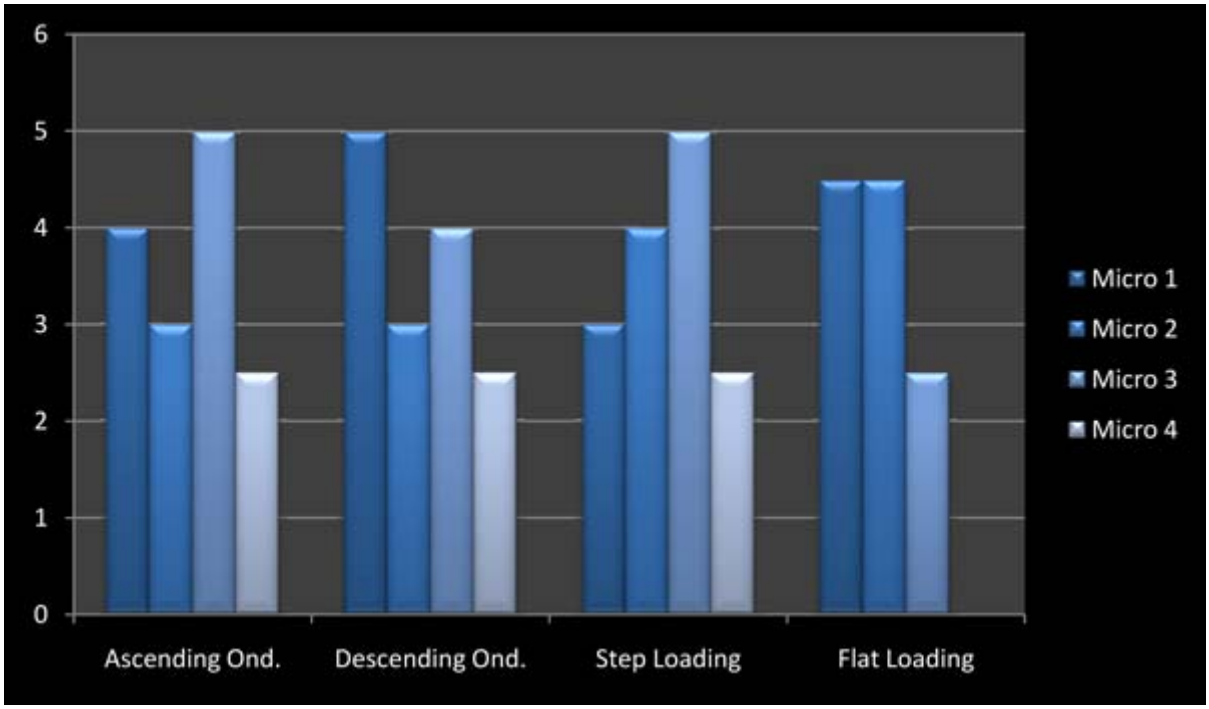
Again, we can have two different approaches for the use of specific training means. Allow me to provide you with an example of what happens in the world of

football (soccer) training. For instance, in some third world countries, the number of teams is small and the competitive season is short. Thus the preparation period is longer than what we have in Europe. During their general preparation, the training is much more concentrated on the improvement of the conditional motor capacities than on the use of specific means (the ball) and loading parameters. On the other hand, in Europe, players use the ball (specific training mean) from day one of the relatively short preparation period (in which the training of conditional motor capacities still dominates) and might play the first friendly game after only 5-7 days of preparation (specific loading parameter).

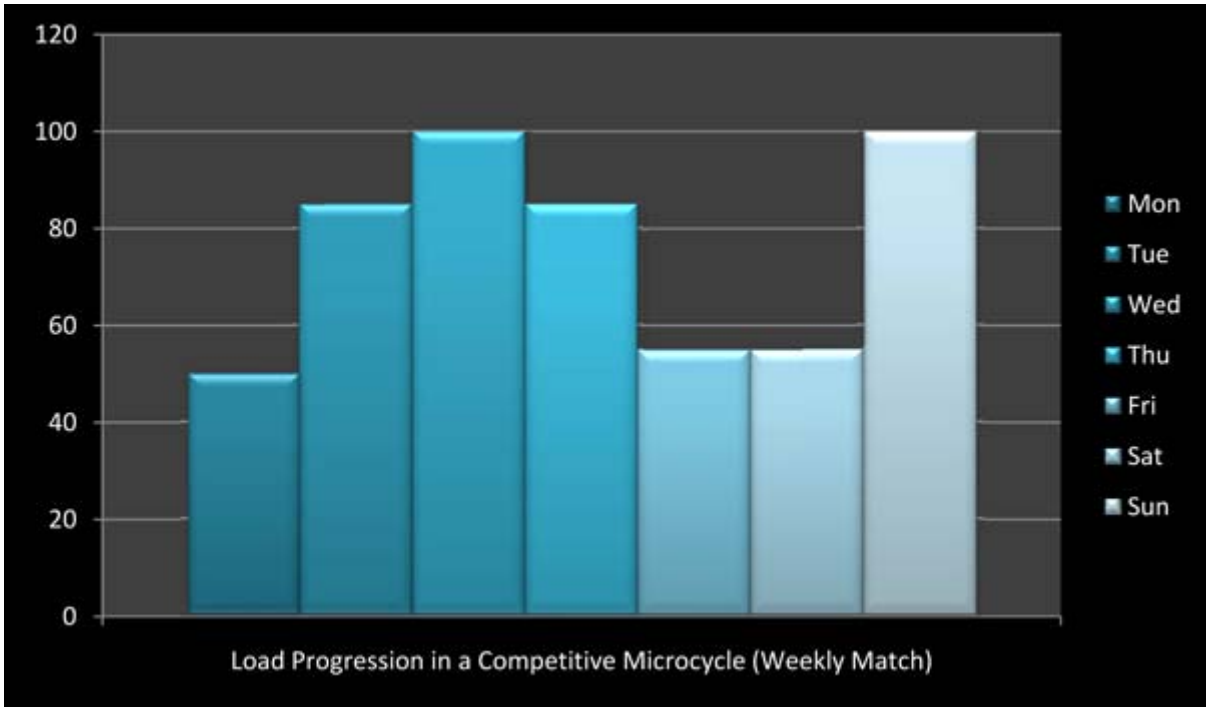
For the sake of terminology consistency, I have called such approaches sequential (when the use of general training means precede the use of specific training means) and complex (when general and specific training means are used simultaneously).

**Load Progression**

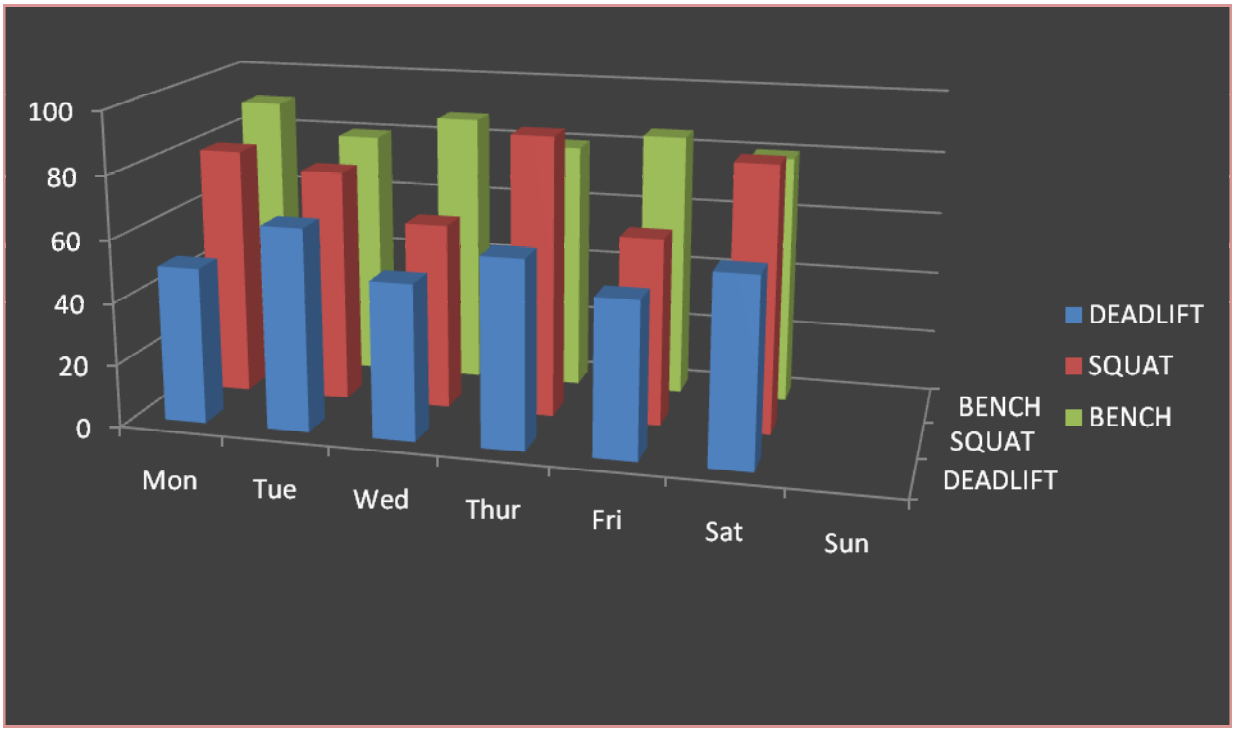
Linear loading has been proven, both scientifically and empirically, to be an inferior way of applying progressive overload. In fact, it's very unlikely that a biological system progresses in a mechanical/mathematical fashion over time. A cyclic, undulating and self-adjusting model is certainly more adequate to elicit continuous and positive morpho-functional adaptations. Such characteristics can, or better yet, should be taken into consideration when designing a periodized plan. The undulation can take place at the macrocycle and microcycle level. The macrocycle can be undulated by alternating microcycles of different load (Column 1, macrocycle sometime used by Cuban weightlifters, and 2) or by placing a deload microcycle at the end of it (Column 3, typical general preparation macrocycle set-up – Step loading / Column 4, typical specific preparation macrocycle set-up, Flat loading).



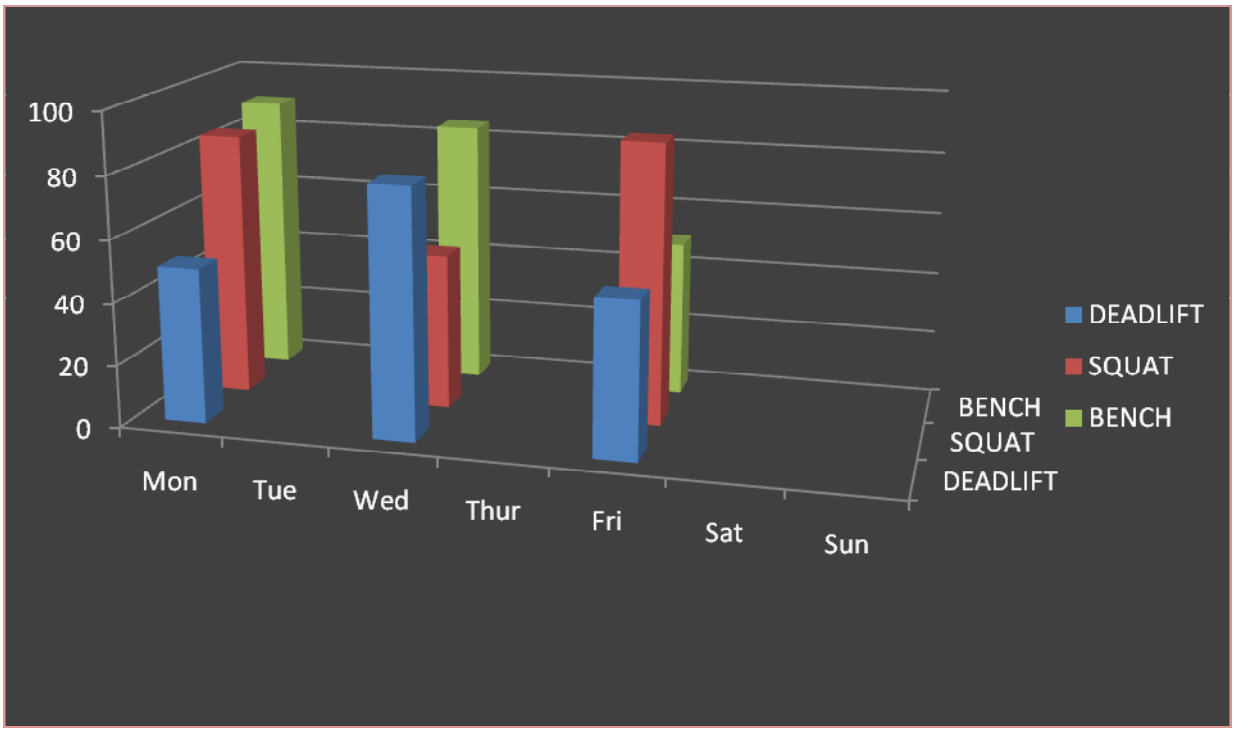
The undulation of the load within the microcycle follows the very important methodological concepts of energy systems and load alternation. In the case of competitive microcycles, the need for post-competition recovery and pre-competition deloading should also be taken into consideration.




The self-adjusting characteristic is obtained via the constant monitoring of the athletes, the readiness to change the daily program according to their feedback, the objective data collected during the training session, and by the placement of testing at the end of each macrocycle.




Load alternation within the microcycle, in a powerlifting specialized program




Load alternation within the microcycle, in a MxS program for an individual sport

## Conclusion

Periodization is not set in stone; rather it's a bundle of methodological concepts whose application we adapt to specific situations. For this reason, it can take

many different forms. Coaches should be aware of the existence of different planning models that are more indicated for certain sports and for certain athlete's developmental levels, On the "programming side", knowing the methodological concepts related to programming, along with basic exercise physiology knowledge, should enable the coaches to have informed intuitions on how the bodies of their athletes work and change upon the application of the training stimuli. Thus, permitting coaches to foresee the morpho-functional adaptations they seek. Nevertheless, the constant monitoring, assessment and adjustment of the program is paramount to achieve the maximum possible results.

We can summarize the benefits of training periodization with the following points:

- It helps coaches creating structured training systems.
- It makes the coaches aware of the need to alternate the training loads to get positive morpho-functional adaptations.
- It allows the management of fatigue and the exposure to a higher volume of qualitative training
- It avoids the accumulation of critical level of fatigue and overtraining
- It integrate at appropriate time the regeneration, nutrition and psychological techniques for peak performance

## b) Title: Periodization of Strength for Sports.

Subtitle: Nervous system adaptations and how they affect the planning and programming of strength training for a sport's specific needs.

Although each sport has a dominant conditional motor capacity, research suggests that conditional motor capacities influence each other. This is evident if we think of how muscle strength affects both speed and endurance. In fact, the literature shows us how the strength and power of the legs are significantly related to speed in sprinting, or how the strongest (relative to bodyweight) and most powerful athletes are able to run faster, and are usually more agile, too. Similarly, the literature shows us that the addition of strength training to the training regimen of endurance athletes, like runners, cyclists or skiers, results in significantly greater improvements in performance than using only the specific endurance training.

Periodization of Strength refers to how said biomotor ability is developed and integrated into an annual training plan. The term *integration* indicates the consideration, during the actual planning, of the dynamics according to which the training of each of the conditional motor capacity affects the training of the others; as well as the systemic organic and functional adaptations considered as the response to a summation of stimuli. In some sports, during the preparatory period, it has been traditionally pursued to develop multiple aspects of the physical preparation- such as aerobic capacity, maximum strength, strength endurance, acceleration, and specific endurance. Each of these biomotor qualities involve morpho-functional and psychological adaptations that can sometimes be in contrast with each other. For instance, the adaptations stimulated by training for maximum strength, both in the skeletal muscle structure and the nervous system, are limited by the metabolic and neural cost of endurance training. It is therefore indicated to determine the contribution of the two elements of the preparation of the athlete in relation to his event in order to prioritize the development of the two conditional motor capacities (i.e., simply stated, we cannot develop the endurance of a basketball player as we would for a 800m runner, that is, with the same means, methods, and load). Furthermore, the development of a single biomotor ability must take into account, in the case of a sequential approach, the most rational sequence of training means and methods, in relation to its qualities that we aim to develop (e.g. anatomical adaptation - > maximum strength -> power -> power-endurance).

The periodization of strength is, therefore, a fundamental concept of training methodology.

### Adaptations to Strength Training

Up until a few years ago, we believed that strength was determined mainly by the muscles' Cross Sectional Area (CSA); for this reason, weight training was being utilized to increase "the engine size" (muscular hypertrophy). Despite the fact that the CSA is the single best predicting factor of an individual's strength level, strength training research, already since the 80's, and authors such as Zatsiorsky and Bompa, have switched the

focus on the neural component of strength expression. In fact, such primary role of the nervous system in strength expression is well documented by a 2001 review[3].

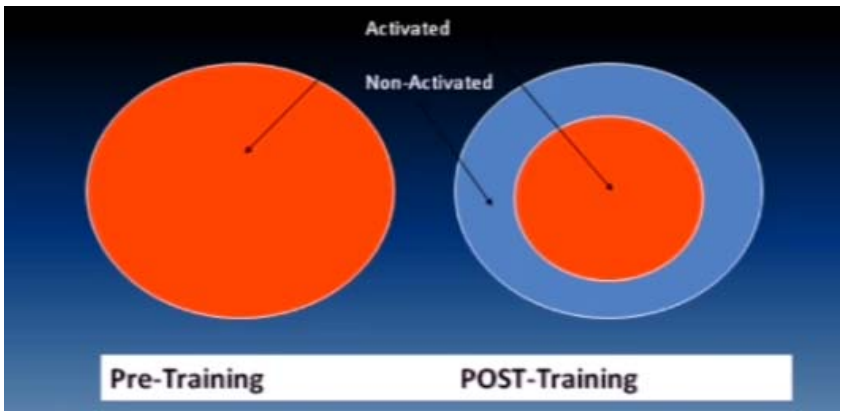
Neural adaptations to strength training involve inter and intra muscular coordination and the disinhibition of the inhibitory mechanisms (Golgi Tendon Organs, Renshaw cells, pre-synaptic inhibitory response, cutaneous receptors and sovraspinal inhibitory signals).

The components of intramuscular coordination are as follows:

- Sinchronyzation, the capacity to contract Motor Units simultaneously or with a minimum latency (<5ms)
- Recruitment, the capacity to recruit Motor Units simultaneously
- Rate Coding, the capacity to increase firing rate in order to express more strength

Intramuscular coordination adaptations have a high transfer from an exercise to another.

Intermuscular coordination represents the capacity of the nervous system to coordinate the "rings" of the kinetic chain, making the gesture more efficient. With time, as the nervous system "learns" the gesture, less motor units gets activated with the same weight, leaving more MU available for activation for higher loads. To increase the weight lifted in a exercise over the long term, intermuscular coordination training (technique) is the key. It is also very important that the concentric action be explosive, in order to activate the fast twitch muscle fibers, responsible for the highest and fastest force generation, as well as the highest hypertrophy. Nevertheless, intermuscular coordination is exercise specific, so its transfer to other exercises (including the sport specific ones) is very limited.




Despite the fact that the hypertrophic response to training is immediate[4], the accretion of muscular protein becomes evident after at least 6-8 weeks[5]. These proteins, that represent the specific adaptive response to the imposed training, stabilize the achieved neural adaptations. This is the way to read the famous study by Moritani T and deVries HA of 1979[6], because the neural adaptations, once they take place, are neither at their full

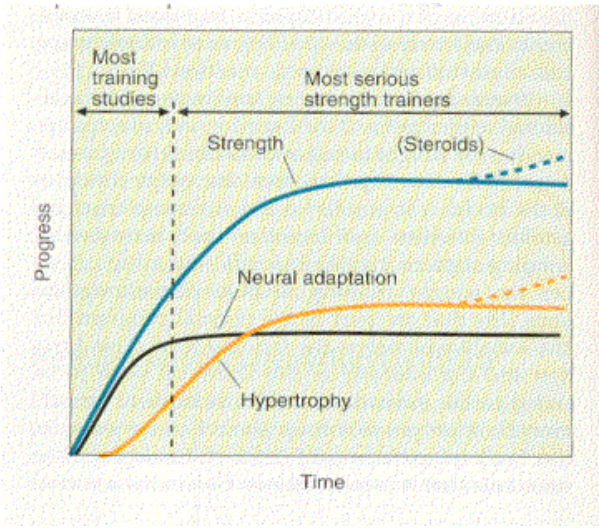
[3] Broughton Amanda, *Neural mechanism are the most important determinants of strength adaptations*, proposition for debate, School of Physiotherapy, Curtin University, http://physiotherapy.curtin.edu.au.

[4]

[5] Moritani T and deVries HA, Neural factors versus hypertrophy in the time course of muscle strength gain. American Journal of Physical Medicine 58(3):115-130.

[6] *Idem*.

potential, nor absolutely stable, thus, to increase strength over time, it is necessary to keep training the above mentioned factors; particularly the intermuscular coordination allows an increase of the loads in the mid and long term on the basis of a ever increasing efficiency of the system as well as a specific hypertrophy.




The on the field experience of weightlifters (except the bulgarian and greek schools), as well as the russian and italian powerlifters, has helped to switch the focus from the Zone 5 loads (soviet intensity ladder; Zone 5= loads over 90%) to the Zone 3 (70-80%). That is, the analysis of the programs of the best weightlifters[7] and powerlifters have shown a concentration of the training loads in the Zone 3. To state that the Zone 3 is the most important zone for maximum strength development is an actual change of episteme, as almost the totality of the classic literature on strength training indicates that the training loads for maximum strength development are those from 85% of 1RM and up.

The field has shown us that:

a) the majority of the adaptations of the neuromuscular system in function of an increase of maximum strength happen with loads less than 90% of 1RM;

b) the time of exposure to loads of 90% and up, necessary in order to elicit the adaptations specific to that intensity range, is very short (a few weeks).

Following we have an explicatory table regarding the neuromuscular adaptations per intensity range:

| | **Intensity Zone** |
|---|---|

[7] Roman Suarez Ivan, Levantamiento de Pesas – Periodo Competitivo, Editorial Cientifico Tecnico, La Habana (Cuba), 1986.

| **Adaptations** | 50-70% | 70-80% | 80-85% | 85-90% | 90-100% |
|---|---|---|---|---|---|
| Intramuscular Coordination | | | | | |
| Sinchronization | **** | **** | **** | **** | **** |
| Recruitment | ** | *** | **** | **** | **** |
| Rate Coding | **** | *** | *** | *** | **** |
| | | | | | |
| Intermuscular Coordination | **** | **** | *** | ** | * |
| | | | | | |
| Disinhibition of Inhibitory Mechanisms | * | *** | *** | *** | **** |
| | | | | | |
| Specific Hypertrophy | ** | **** | **** | *** | ** |
| Note: All loads are supposed to be moved with the most explosive (and technical) concentric action that the loads allow. | | | | | |

What do we get from this table?

- That the majority of the intramuscular coordination gains happen with loads over 80%.
- That the majority of the intermuscular coordination gains happen with loads under 80%.
- That we need to use the full spectrum of intensities to maximize the neuromuscular adaptations, and consequently the maximum strength.

Methodologically speaking:

- In a preparation phase with limited time to dedicate to the development of maximum strength, the intensities utilized in the MxS macrocycles will be high (80% and up). This is usually what happens with team sports after a few weeks of Anatomical Adaptation training.
- In the preparation phase of an individual sport with a lot of time to dedicate to the development of maximum strength, and especially in a multi-year perspective that

foresee a continous progression in the mid and long term, most of the attention in the periodized plan will be placed on the intermuscular coordination factor.

- Nevertheless, for the development of maximum strength, in every periodized plan, we will start from lower intensities, higher times under tension per set (that favour the anatomical adaptations) and a focus on technique, to get to higher intensities in order to elicit a high muscular tension, later on.

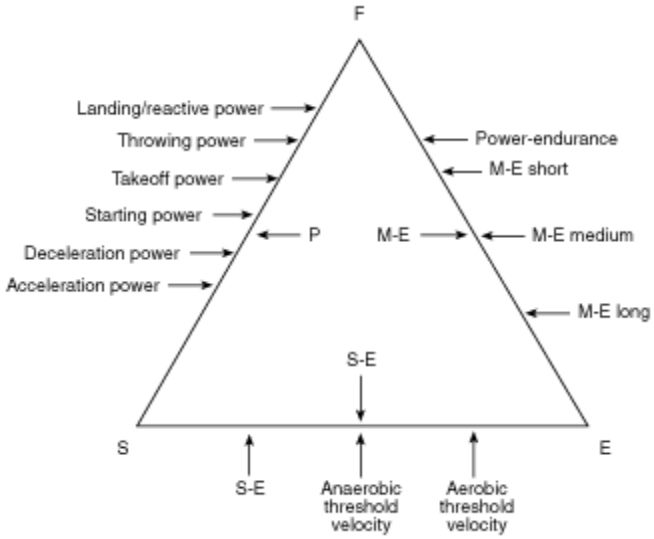
**PERDIODIZATION OF STRENGTH**

| PHASES | PREPARATION | | | | | | | | | | | | | | | | | | | | | | COMPETITION | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SUB-PHASES | GENERAL | | | | | | | | | | | | SPECIFIC | | | | | | | | | | PRE-COMP | | | | COMPETITIVE | | | | | | | |
| MACROCYCLES | 1 | | | | 2 | | | 3 | | | 4 | | 5 | | | 6 | | | | 7 | | | 8 | | | 9 | | | | 10 | | | | 11 | | 12 | |
| MICROCYCLES | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 32 | 33 | 34 |
| PERIODIZATION OF STRENGTH | ANATOMICAL ADAPTATION | | | | HYPERTROPHY | | | | | | MAXIMUM STRENGTH (MxS) | | | | | | | | | | CONVERSION TO SPECIFIC STRENGTH | | | MAINTENANCE | | | | | | | | | | |

In the periodization of strength, typically, the first macrocycle is dedicated to Anatomical Adaptation. During this period we have a progressive increase of loads that prepares the connective tissues (ligaments, tendons, muscles) to the following intensified work that occurs during the maximum strength macrocycles. In planning this next phase we must consider that "*what is intensification for a sport is accumulation for another. For example, when synchronized swimmers work in the range of 6-8RM, they are doing intensification; for weight lifters this range represents an accumulation*"[4]. The objective of this phase of maximum strength is not, therefore, the increase of maximum strength to the highest possible level, but rather the development of an optimal level of maximum strength specific to the sport and whose achievement process can efficiently be integrated within the global plan of training. For this same reason it makes little sense to do a period of development of maximum strength with low reps and intensities higher than 80% of 1 RM or insert multiple macrocycles dedicated to maximum strength for those athletes whose sports require muscular endurance of long duration.

The next phase is the so-called Conversion Phase. This is a fundamental phase of the periodization of strength, whose objective is the "conversion" of the maximum strength gains resulting from the earlier stage into a specific combination of qualities of strength, be it power, power endurance or muscular endurance (short, medium or long). For this reason the loading parameters used in the conversion stage should reflect the characteristics of the sport, particularly the relationship between strength and the dominant energy system. During the year, the goals of strength training, and their consistent methods, vary depending on the

characteristics of sport, the characteristics of the athlete and the competition calendar, yet the ultimate goal is the maximization of specific strength.




We can distinguish two main types of sports in relation to the final objective of the strength training periodization:

1) those sports that require the development of power (a synonym for speed-strength, or starting strength and explosive strength in the force-time curve[3]), i.e. the ability to apply force as quickly as possible, such as the jumps, throws and sprints in athletics, most team sports, and all those sports in which power has a strong influence on performance;

2) those that require the development of muscular endurance, the ability to apply less force but for a longer time, as in most of the events in swimming, rowing, kayaking, triathlon , cross-country skiing, middle and long distance running and so on.

What do we need to do, then, to determine the specific strength of a sport and plan the periodization of strength in the Annual Plan?

1. Determine, through the scientific literature, the contribution of each energy system to the event (at the exact same competitive level of the athlete or team you are going to do the planning for);
2. Derive the quality or qualities of strength that are specific to the event, among maximum strength, power, power endurance, muscle endurance short, medium or long. The entire periodization of strength will have the increase of this/these quality/qualities as the ultimate goal. Also, keep in mind that the morpho-functional adaptations to training of the endurance type of strengths, of a more metabolic nature, require a longer period of exposure to the stimuli compared to the neural adaptations, and this directly affects the length of the conversion phase, and the time remaining for the other phases, as the plan designing process works backwards from the end point.

3. Evaluate the appropriate duration for Anatomical Adaptation period in accordance with the characteristics of the athlete and the time available for such an introductory phase.
4. Assess whether or not to implement a period devoted to hypertrophy, in agreement with the characteristics of the athlete and the sporting event.
5. Analyze the sport movements in order to determine exercises and loading parameters:
    - Planes on which the movements take place (sagittal, frontal, transverse)
    - Force expressed at various joint angles within the sport specific range of motion (i.e. the zone that must be most affected by the development of the specific strength)
    - Muscle groups producing the movements (aka prime movers, that also must be most affected by the development of the specific strength)
    - Muscle actions (concentric, eccentric, isometric)
6. Choose the methods to be used in each macrocycle and the progression of training means.
7. Analyze the training tradition of the sport you are going to do the planning for. Over the years coaches have found solutions that combine merely practical troubleshooting with the ideas of scientific research. Equipped with the latest knowledge and your practical experience, you can find, using traditional training modalities, the ideal starting point to overcome such tradition.
8. Determine the actual degree of training of the athlete. For what concerns the testing of maximum strength, the 1RM test is advisable to be performed only by athletes with some strength training experience and only after macrocycles that implied some exposure to loads equal or greater than 80% of 1RM. This is especially true for beginners. Furthermore, you should also test the muscle strength balance around the joints that you consider most important for the sport with submaximal weights (3-8RM), as well as test for the sport specific strength at the beginning of the year, to monitor its progression and get information on the dynamics of adaptation to your training programs.

**Functional Training and Specificity**

It often happens that the concept of functional strength is confused with that of specific strength. The term "functional strength" is fairly recent. Can we think that the Olympics and World Championships have been won and world records set, without having worked on specific strength, or not having done so in an optimal manner, until the year 2000? In fact, specific strength and functional strength are not synonymous. Training the specific strength for a sport means to replicate the specific modality of force expression of the event, both neurally and metabolically, using exercises that mimic the action of the kinetic chains that take part to the specific motor skill (including specific ROM and force vector), with particular emphasis on the prime movers, without disturbing the motor patterns required for the sport's technique. The term functional strength, however, instead of referring to the physiological and biomechanical parameters of the specific event or motor skill, is more commonly considered as indicating the manner in which strength is trained in terms of training means; specifically, free weights or cables, unilateral, possibly standing and multiplanar (an exception to this definition is represented by propedeutic exercises and some core stability exercises). In other words, in order to talk about specific strength training, the biomechanical and, in particular, the physiological parameters of the event, are the essential starting point; while "functional training" is simply defined by the use of exercises with the above listed characteristics. To state that it is methodologically wrong is obvious, but it is also true that the best "functionalist" apply the concept of periodization of strength to their planning and they take into account not only the biomechanics in the selection of exercises, but also the physiology for the choice of the load parameters; despite preferring certain exercises and methods. At this point we should, however, ask ourselves to what extent certain functional training methodics are appropriate to reach the levels of maximum strength development needed in certain power sports.

---

[1] Tudor O. Bompa & Haff Gregory G., Periodization. Theory and Methodology of Training, 5th Edition, Human Kinetics, 2009, pg. 126.

2 "Exercises performed on various equipment such as balls, ABS pipes with foam and proprioceptive platforms, designed to create an environment more difficult to increase participation by small and deep stabilizing muscles, Charles Staley, Muscle Logic, cit. in Michael Boyle, Advances in Functional Training, OTP, Aptos, 2010, pg. 22.

[3] Yuri Verkhoshanskij, Fundamentals of Special Strength-Training in Sport, Sportivny Press, Livonia, 1986, pg. 61.

[4] Charles Poliquin, Theory 1 Manual, PPC, 2004, pg. I-10.

**Anatomical Adaptation (AA): Target Last Set (TLS) method**

| | |
|---|---|
| **Duration (weeks)** | 2-6 |
| **% 1 RM** | 60-75 |
| **Number of Exercices** | 3/6 Fundamental + 4/6 Complementary<br>per training unit |
| **Number of Repetitions** | From 10 to 6 for the Fundamentals; from 12 to 8-10 for the Complementary |
| **Numero delle Serie** | 2/3 per exercise |
| **R.I.** | 30-45" |
| **Frequency** | 2-3 x per microcycle |

**Hypertrophy method for sport (HYP)**

| | |
|---|---|
| **Duration (weeks)** | 6-8 |
| **% 1 RM** | 70-80 |
| **Number of Exercices** | 3/6 Fundamental + 2/3 Complementary<br>per training unit |
| **Number of Repetitions** | Da 12 a 6 for the Fundamentals; da 10 a 8 for the Complementary<br>6 weeks example: 2x12-3x10-1x8/2x8-3x6-T<br>8 weeks example: 2x12-3x10-3x8-1x8/2x10-3x8-3x6-T |
| **Number of Sets** | 2/3 per exercise |
| **R.I.** | 1-2' in jump set; 2-4' straight sets<br>(shorter rest intervals at the beginning of the macrocycle) |
| **Tempo** | Concentric: Medium/Fast |

| | |
|---|---|
| | Eccentric: Slow |
| **Frequency** | 2-3 (Full-Body)<br><br>3-4 (Split) |

**Modified Maximum Load Method (MxS)**

| | |
|---|---|
| **Duration (weeks)** | 4-12 |
| **% 1 RM** | 80-90 (100 for testing) |
| **Number of Exercices** | 3/6 Fundamental + 2/3 Complementary<br>per training unit |
| **Number of Repetitions** | 1-5 for the Fundamentals; from 8 to 5 for the Complementary |
| **Buffer*** | From 0 (absolute strength) to 10% (speed-strength), depending on the case |
| **Number of Sets** | 2-3 per exercise |
| **R.I.** | 90"-3' in jump set; 2' in circuit; 2-6' straight sets |
| **Tempo** | Concentric: Fast<br>Eccentric: Slow |
| **Frequency** | 2-3 |

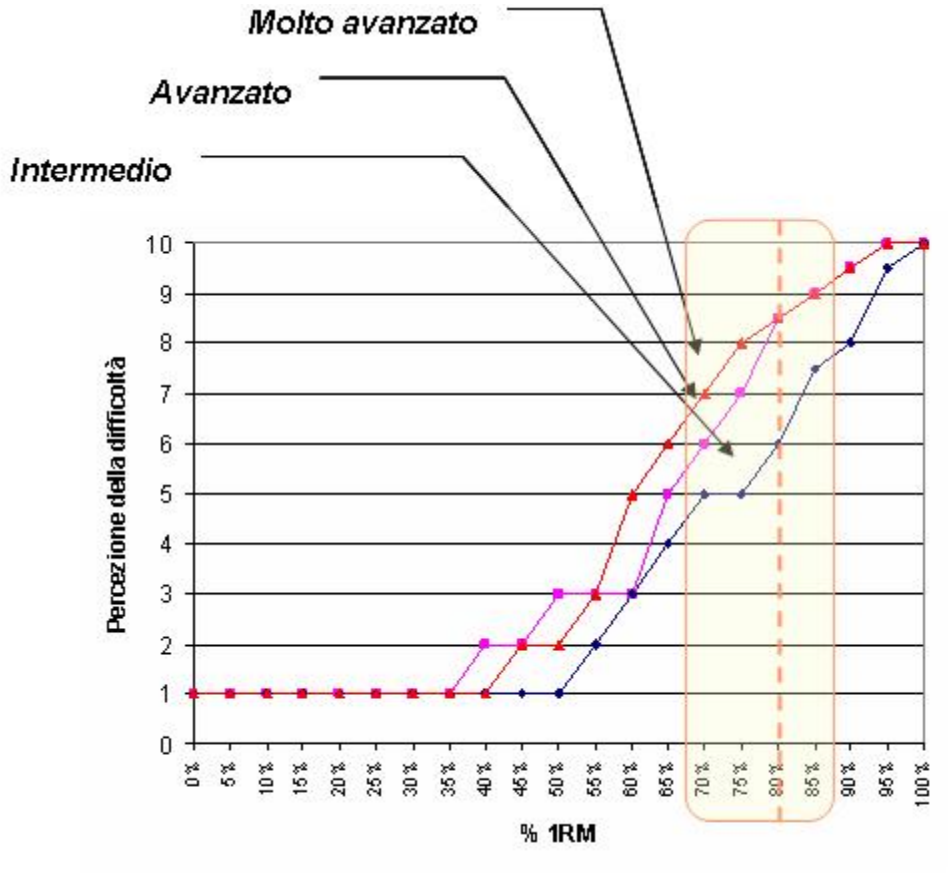
***** The difference between the repetitions that is possible to perform with a certain load and the actual repetitions performed in a set. The higher the buffer, the faster the bar will move concentrically during the whole set.

| | **BUFFER** | | |
|---|---|---|---|
| **% 1RM** | **0%** | **2,5%** | **5%** |
| **100%** | 1 repetition | 1 with 97,5% of the1RM | 1 with 95% of the 1RM |
| **95%** | 2 repetitions | 1 repetition or 2 with 92,5% | 2 with 90% |
| **90%** | 3 repetitions | 2 repetitions or 3 with l'87,5% | 3 with 85% |
| **85%** | 5 repetitions | 4 repetitions or 5 with l'82,5% | 5 with 80% |
| **80%** | 6 repetitions | 5 repetitions or 6 with 77,5% | 6 with 75% |
| **75%** | 8 repetitions | 7 repetitions or 8 with 72,5% | 8 with 70% |

## Modelli di Progressione della Forza

| | | | Macrociclo | Microciclo | Esempi | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Step Volume | Volume | Crescente | Ondulatorio | | | | | | | 4x3@80% | 4x5@50% | 4x1@85% | | | |
| | | Intensità | Standard | Ondulatorio | | | | 3x3@80% | 3x5@50% | 3x1@85% | | | | | | |
| | | | | | 3x3@80% | 3x5@50% | 3x1@85% | | | | | | | 2x3@70% | 2x5@50% | Tes |
| | | | Macrociclo | Microciclo | | | | | | | | | | | | |
| 2 | Step Volume e Intensità | Volume | Crescente | Ondulatorio | | | | | | | 3x3@85% | 4x5@55% | 3x1@90% | | | |
| | | Intensità | Crescente | Ondulatorio | | | | 3x3@82,5% | 3x5@52,5% | 3x1@87,5% | | | | | | |
| | | | | | 2x3@80% | 2x5@50% | 2x1@85% | | | | | | | 2x3@70% | 2x5@50% | Tes |
| | | | Macrociclo | Microciclo | | | | | | | | | | | | |
| 3 | Step Intensità (coordinazione intermuscolare) | Volume | Standard | Ondulatorio | | | | | | | 3x5@75% | 6x1@85% | 5x3@80% | | | |
| | | Intensità | Crescente | Ondulatorio | | | | 3x5@72,5% | 6x1@82,5% | 5x3@77,5% | | | | | | |
| | | | | | 3x5@70% | 6x1@80% | 5x3@75% | | | | | | | 2x3@70% | 2x5@50% | Tes |
| | | | Macrociclo | Microciclo | | | | | | | | | | | | |
| 4 | Step Intensità (Wave) | Volume | Standard | Standard | | | | | | | 2x5@80% | | | | | |
| | | Intensità | Crescente | Standard | | | | 2x5@77,5% | | | 2x3@85% | | | | | |
| | | | | | 2x5@75% | | | 2x3@82,5% | | | 2x1@90% | | | 2x3@70% | 2x5@50% | Tes |
| | | | | | 2x3@80% | | | 2x1@87,5% | | | | | | | | |
| | | | | | 2x1@85% | | | | | | | | | | | |

**Possible ways of load progressions in MxS macrocycles**




**Perception of effort in relation to the level of the athlete, given the same 1RM percentage**

| Event Duration and Strength Conversion (Specific Strength) | | | |
|---|---|---|---|
| **Event Duration** | **Event Intensity** | **Main Energy Systems** | **Specific Strength** |
| Less than 10" | Maximum | ATP-PC | Power |
| Up to 30" | From Maximum to High | Anaerobic Glycolysis | Power Endurance |
| From 30" to 2' | Moderately High | Anaerobic / Aerobic Glycolysis | Muscle Endurance – Short |
| From 2' to 10' | From Moderately High to Low | Aerobic Glycolysis | Muscle Endurance – Medium |
| More than 10' | From Moderately High to Low | Aerobic Glycolysis/Fat Oxidation | Muscle Endurance – Long |

**Power (P)**

**Indicated for: Alactic sports, team sports with low lactate production (e.g. soccer) and the first part of a Power Endurance macrocycle.**

| | |
|---|---|
| **Duration (weeks)** | 4-6 |
| **% 1 RM** | Ciclic: 30-50<br>Aciclic: 50-80 |
| **Number of Exercices** | 3-6 |
| **Number of Repetitions** | See following table. |
| **Number of Sets** | 2-3 per exercise |
| **R.I.** | 1-5' |
| **Tempo** | Explosive |
| **Frequency** | 2-3 |

| | |
|---|---|
| | |

| Volume and Intensities for intermuscular coordination and speed-strength/strength-speed training (Prilepin) | | |
|---|---|---|
| **IntensitY % 1RM** | **Reps Range per Set** | **Total Repetitions per Exercise** |
| 30-50% | 6-10 | 18-20 |
| 50-80% | 3-6 | 12-18 |
| 80-85% | 1-3 | 6-12 |
| 85-95% | 1-2 | 4-6 |

## Plyometrics Progression

1° phase "concentric" or "reduced eccentric"-> Rope, medicine ball, skip, low hurdles, jumps up.

2° phase concentric-eccentric-concentric -> Jumps over hurdles, bounds.

3° phase eccentric-concentric -> Depth jumps and landings.

| Intensity | Classification | Exercise Type | Number of RepetitionsxSet | Number of Repetitions per Session | Rest Interval |
|---|---|---|---|---|---|
| 1 | High Impact | Depth landings (80-110cm) | 1-5x3-6 | 3-20 | 5'-8' |
| | | Depth Jumps (>70cm) | 1-10x2-6 | 3-40 | 4'-8' |
| | | Bounds on one or two legs | 40-100m x 2-4 | 30-150 | 3'-5' |

| | | | | | |
|---|---|---|---|---|---|
| 2 | | Jumps over hurdles (>60cm) | 3-12x2-6 | 6-72 | 3'-5' |
| | | Bounds on one or two legs | 6-30m x 2-6 | 20-60 | 3'-5' |
| | | Speed Squat (acc. ecc.)– Jump Squat – American Swing | 3-6x2-6 | 12-24 | 2'-4' |
| 3 | | Jumps over hurdles (30-60cm) | 6-20x2-6 | 18-80 | 3'-5' |
| 4 | Low Impact | Jump Ups (60-110cm) | 3-15x2-6 | 12-60 | 3'-5' |
| | | Swing | 10-30x2-6 | 30-180 | 1'-2' |
| 5 | | Low Hurdles (<30cm) | 6-20x3-6 | 18-80 | 2'-3' |
| | | Skip | 10-30m x7-15 | 70-250 | 0-2' |
| | | Medicine Ball | 5-12x4-6 | 20-72 | 1'-3' |
| | | Rope | 15-50x2-6 | 30-300 | 1'-3' |

The five levels of intensity for the plyometric exercise[8].

[8] Adapted by Carlo Buzzichelli, from Bompa Tudor O., *Power Training for Sport*, 2nd edition, Mosaic Press/Coaching Association of Canada, Oakville, 1996.

**POWER ENDURANCE (P-E)**

**Indicated for: Lactic sports lasting up to 30" and lactic team sports (e.g. hockey).**

| | |
|---|---|
| **Duration (weeks)** | 4-6 |
| **% 1 RM** | 50-70% |
| **Number of Exercices** | 2-6 |
| **Number of Repetitions** | 15-30<br>(stop when the concentric phase slows down) |
| **Number of Sets** | 2-3 per exercise |
| **R.I.** | 3-7' |
| **Tempo** | Explosive |
| **Frequency** | 2 (3 max.) |

**MUSCLE ENDURANCE – SHORT (M-ES)**

**Indicated for: Lactic sports lasting from 30" to 2'.**

| | |
|---|---|
| **Duration (weeks)** | 4-6 |
| **% 1 RM** | 40-60 |
| **Number of Exercices** | 2-6 |
| **Durata delle Serie** | 30"-60" |
| **Number of Sets** | 2-6 per exercise |
| **R.I.** | 30"-60" (lactic acid tolerance extensive or split intensive followed by longer R.I.)<br>3'-5' (lactic acid tolerance intensive – bigger role of the NS) |
| **Tempo** | Explosive |
| **Frequency** | 2-3 |

**MUSCLE ENDURANCE - MEDIUM (M-EM)**

**Indicated for: Mixed ergogenesis sports or aerobic sports, lasting from 2' to 10'.**

| | |
|---|---|
| **Duration (weeks)** | 8-10 |
| **% 1 RM** | 40-50 |
| **Number of Exercices** | 4-8 |
| **Durata delle Serie** | 1'-4' |
| **Number of Sets** | 1-2 per exercise |
| **R.I.** | 1'-2' between sets – 5' between circuits |
| **Tempo** | Fast |
| **Frequency** | 2-3 |

**MUSCLE ENDURANCE – LONG (ME-L)**

**Indicated for: Aerobic sports lasting more than 10'.**

| | |
|---|---|
| **Duration (weeks)** | 8-10 |
| **% 1 RM** | 30-40% |
| **Number of Exercices** | 4-6 |
| **Durata delle Serie** | 4'-10' |
| **Number of Sets** | 1-2 per exercise |
| **R.I.** | From 5' to 1' between circuits - from 2' to 1' between sets |
| **Tempo** | Medium |
| **Frequency** | 2-3 |

**Note: Contrary to what is usually suggested in the literature, in training the ME-L, the progression goes from circuits to sets in order to further increase the local muscle endurance, as the circuit training has a higher "central" impact, on the cardiovascular system which is already well trained by the high volume of specialized work, typical of the endurance sports.**

## C) Title:"Microcycle organization strategies for strength, power and endurance development".

Subtitle:Designing non linear Periodization workouts for the development of Strength and Power and Endurance.

As we have covered the organization of the microcycle in a ondulatory fashion in the previous chapters, we will cover the general guidelines for the microcycle organization.

The microcycle must be organized with an alternation of loads (volume+intensity) and energy systems, taking into consideration both the need for conditional motor capacities optimal development and the need for technical-tactical learning and/or improvement. The coach has to consider the close relationship between work and the subsequent recovery, i.e. between the training stimulus and the adaptations occurring during the recovery time after it, as well as the changes in the functional status of the athlete induced by each workout.

Microcycle planning is thus characterized by the following methodological concepts:

- Load alternation
- Energy systems alternation

**Load alternation**

It is paramount to alternate the load of the training units within the microcycle, considering the fatigue accumulation due to the load summation (internal load), and the recovery time necessary before training again the same energy system or proposing another high load training session. Said restoration and supercompensation period is influenced by the residual fatigue generated by previous workouts, by the following low and medium load workouts and by the regeneration techniques utilized. A high internal load can reduce work tolerance; such high internal load can be due to an high load workout performed the previous day (acute) or due to the load utilized during several microcycles (chronic). The very same workout can induce: a) a higher fatigue if it is allocated in a moment where the general training load is high; b) a lower fatigue if the general load is reduced.

Consequently, it is useful to identify from 3 to 5 training load levels according to the physiological demands of the specific sport, and to alternate them in a cyclic way during the microcycle itself. Usually the microcycle should begin with a low-medium load session and then the intensity should increase. If a single high load session is planned, it should be placed in one of the three intermediate days of the week; in case the high load days planned are two, they should be placed at the extremes of the week, unless a "modeling"

plan is used (mimicking a competitions held during a whole week-end). In power and speed sports, the microcycle can begin with a high intensity session, to take advantage of the recovery during the last day of the previous week.

The high load sessions should be one, two or at most three each microcycle, and should usually be done in an almost complete recovered status and followed by low load sessions. During the preparatory phase it can be necessary to repeat the training sessions with similar goals twice or three times a week in order to allow the athlete to get the technical elements and to stimulate properly the conditional motor capacities development. It is not advisable to introduce new elements or training means never used before, in a high intensity session in order not to deprive the athlete of the energy and concentration necessary to make a quality workout.

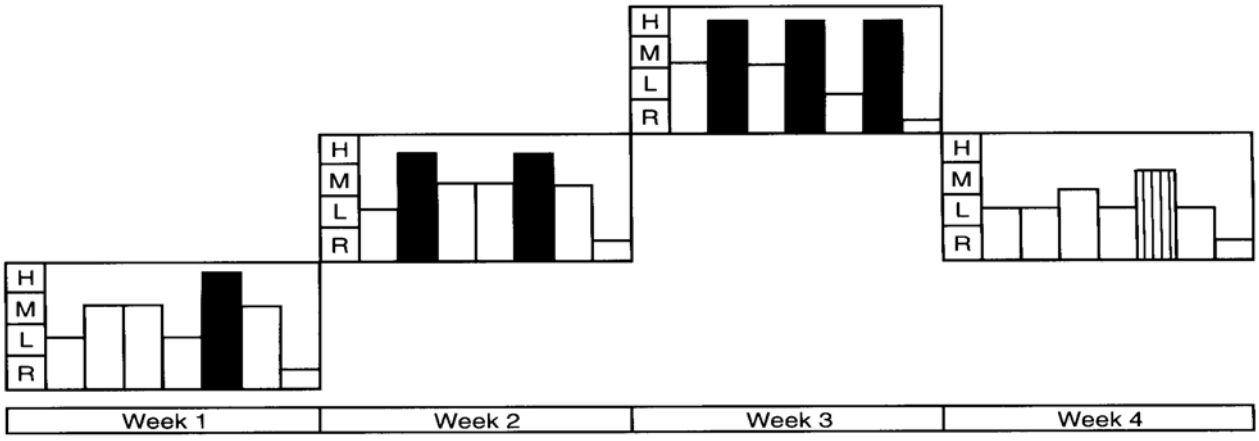
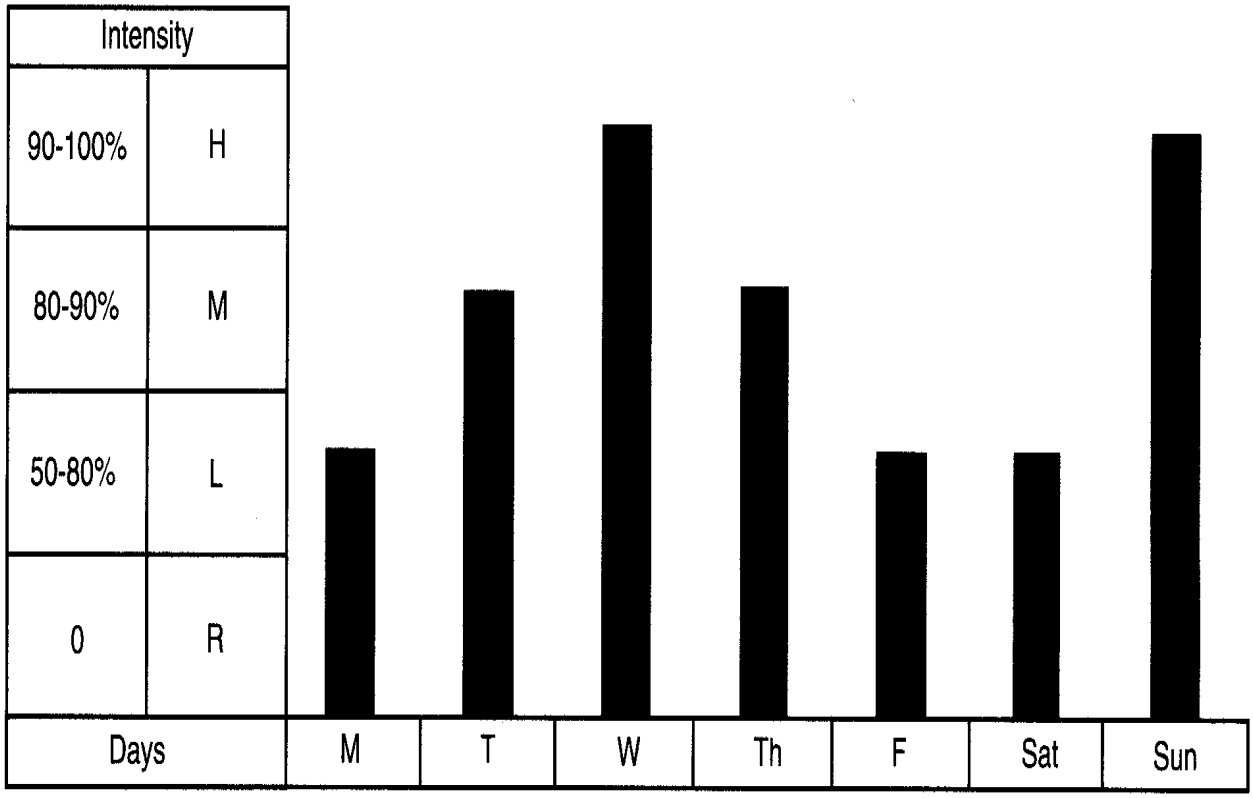



**Figure 2.8** How to increase the training load (i.e., number of high-intensity training sessions per microcycle)




A greater fatigue following a training session may be due to the following factors:

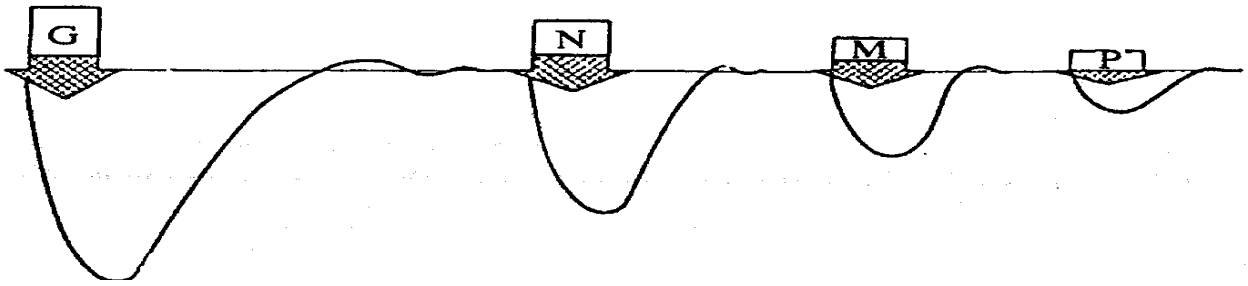
⇒ Unusual high intensity

⇒ High intensity lasting more than usual

⇒ New exercises or exercises more complex than usual

⇒ High density of high intensity exercises (too short rest intervals)

Remember that the rate of recovery is directly proportional to the load (volume + intensity) of the training session.

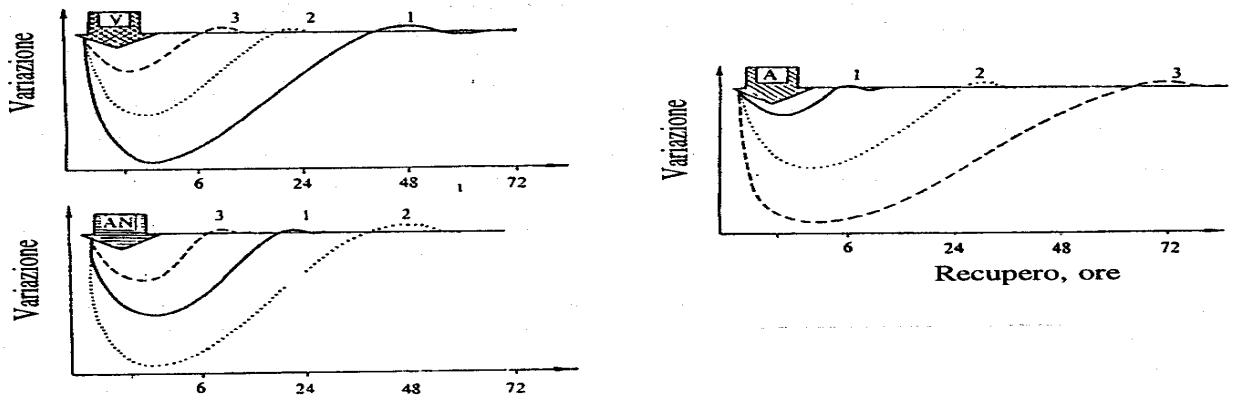



9

[9] V. Platonov, *Ibidem*.

**Energy Systems Alternation**

Because each energy system has its own rate of recovery after being emploied in training or competition, we suggest (especially for individual sports) to alternate them within the microcycle.




To do this, the training means with the same ergogenesis are grouped in the same training unit.

| Anaerobic Alactic | Anaerobic Lactic | Aerobic |
|---|---|---|
| Technical Abilities 1-10" | Technical Abilities 10-60" | Technical Abilities of long duration (>60") |
| Tactical Abilities 5-10" | Tactical Abilities 10-60" | Tactical Abilities of medium and long duration (>60") |
| Acceleration and Max Speed | Speed Endurance and Special Endurance 10-60" | Aerobic Endurance |
| Power and Maximum Strength | Power Endurance and Muscular Endurance-Short | Muscular Endurance-Medium and Long |

Ideal Sequences:

1) AL-O2-LA-O2-AL-O2

2) AL-O2-LA-O2-AL-LA

3) AL-LA-O2-AL-LA-O2

By alternating loads and energy systems within the microcycle we have a undulatory progression, which allows lower levels of fatigue and more positive morpho-functional adaptations to the training stimuli.

## D) Title:Tapering and Peaking

Sub Title:Tapering and Peaking for a major tournament in individual and team sport.

**THE PEAK OF ATHLETIC SHAPE**

We may define the **Peak status** as a temporary athletic shape status (maintainable for two or three weeks at most), where the psychological and the physiological efficiency are maximal and the level of technical and tactical preparedness is optimal.

This superior biological status is characterized by perfect health and an optimal physiological status, expressed by a very fast adaptation to training stimuli and by a quick recovery after training sessions and competitions. From a psychological point of view, the peak is a characterized by the readiness for action with an intense emotional a*rousal.* The objective aspect of peaking from a psychological point of view, is a quicker and more efficient adaptation capacity to the stress of competition. Subjectively the athlete experiences a greater self-confidence, great motivation, and he has the perception of a high motor and biological synergy. The capacity of the athlete to withstand the frustrations before, during and after competition is greater during the peak. By using model planning and the preparatory competitions since the pre-competitive phase, the coach facilitates such preparedness.

The biological characteristics of the peak status vary according to the specific characteristic of the sports:

- for anaerobic dominance sports, it is **the capacity of maximal activation in a short time with fast recovery;**
- for aerobic dominance sports, it is **an high working capacity based on an high physiological efficiency;**
- for "mixed" sports, like team sports, it is **the capacity to repeat high intensity efforts on the basis of an high physiological efficiency.**

The **Training Level** represents the basis over which one can build the various levels of the **Athletic Shape** and it includes a general and a specific component. Since the **Peak of Athetic Shape** is the result of a progress through other levels of athletic shape, an optimal athletic shape status is the basis for peaking.

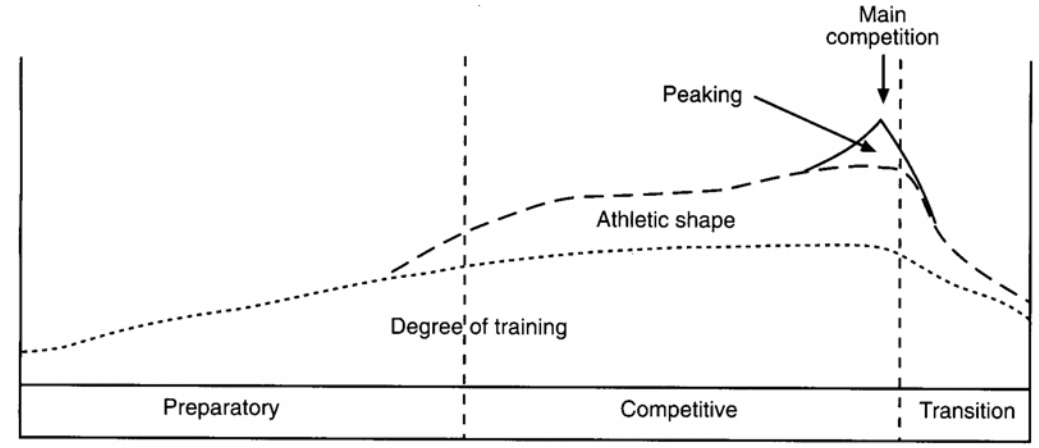



**Figure 10.1** Accumulation and elevation of training states throughout training phases in a monocycle

**Taper and Scientific Literature**

The dynamics of the peaking microcycles allow to face the most important competition of the year at the top of psycho-physical energy. These microcycles, where the training load is gradually reduced in order to eliminate the fatigue induced by training and simultaneously maintain or enhance the positive adaptations elicited by it, represent an unload macrocycle called *taper macrocycle* and are used for most sports, and in particular in individual sports, no matter what is the annual plan structure (mono, bi or tri-cycle).

Most of scientific literature that we have on the taper regards individual sports, as it is shown in a recent review by Pyne and colleagues[10]. According to Mujika, this is due mostly to two elements:

a) the closer correlation among the shape level, the training input (modification of volume, intensity and frequency parameters) and the performance output;

[10] Pyne et al, *Peaking for optimal performance: research limitations and future directions*, Australian Institute of Sport, J Sports Sci. 2009.

b) the greater ease with which it is possible to quantify and isolate the training load factors and the performance components in individual sports compared to team sports, as a consequence of the multifactorial nature (different types of activities, variable environmental conditions, interindividual variability of response and adaptation to training) of the latter[11].

In the scientific literature there are at least 35 studies on the positive effects of taper on sport performance. A study, done three weeks before the Sidney 2000 Olympics on 99 swimmers, shows that performance improved for 91 out 99 athletes[12], with an average of 2,18% +/- 1,5%. These improvements could seem insignificant at first sight, but we must consider that the same study shows that the difference between a gold medal and the fourth place, as well as the difference between the bronze medal and the last position in the final, was lower than the performance improvement induced by the Taper (1,6%). This means that *the taper* may have a decisive influence on the final result of the participation to the most important event of the year.

In various studies, it has been observed an improvement of the ratio between endogen testosterone and cortisol during the *taper*[13][14], suggesting a better recovery, the elimination of the previous fatigue and a greater readiness of the system to face the competition demands, especially the neural ones. The improvements found during the taper are not limited to the hormonal profile, (increase of testosterone, increase of IGF-1, decrease of cortisol), but also include the hematological ones (increase of the cells volume, increase of the hematocrit, increase of hemoglobin, increase of haptoglobin, increase of reticulocytes), biochemical (decrease of CPK, increase of muscle glycogen) and psychological (reduced effort perception, less mood swings, lower fatigue perception, greater vigor, better sleep quality) [15].

Usually, the taper lasts two weeks and entails a planned, progressive training load reduction as well as a reduction of all types of stress inducing factors, especially on the psychological sphere. It is a key factor in the success of the training program and of the whole season, exactly because of its proximity to the most important competition.

During the *tapering,* we have the elimination of fatigue, the restoration of working capacity reduced by the previous training volume, the occurrence of adaptations induced by it, plus those ones induced by the training done during the taper itself, and the supercompensation of all the physiological systems, including the CNS, which elicit a positive psychological state over the competition.

According to Krestovnikov (1938), the nervous cell recovers 7 times more slowly than the muscle-skeletal cells. This suggests the importance of the CNS recovery before, during and after the competition (Bompa, 1969).

---

[11] Mujika, 2007 cit in Mujika, 2009.
[12] Mujika et al, 2002b.
[13] Adlercreutz et al, *Effect of Training on Plasma Anabolic and Catabolic Steroid Hormones and their Response During Physical Exercise,* International Journal of Sports Medicine, 1986.
[14] Kuoppasalmi e Adlercreutz, *Interaction Between Anabolic and Catabolic Steroid Hormones in Muscular Exercise*, Exercise Endocrinology, 1985, cit. in Mujika, 2009.
[15] Mujika, *Ibidem*, 2009.

**Tapering Methodology**

The tapering macrocycle *has a maximum duration of three weeks* in order to avoid detraining of some physiological systems functional to performance, and unlike the tradition in some sports such as swimming, where a 5-6 weeks taper is used, with a reduction of the training volume and its simultaneous intensification.

During the taper, new methods or exercises should never be introduced. in fact, during the competitive season you have to create a pre-competition routine to be followed for the most important race of the year.

To plan the tapering macrocycle, the coach can manipulate the following parameters:

a) The modality of load reduction;

b) The taper duration;

c) The entity of the load reduction in its components "volume, intensity, frequency".

**Types of Load Reduction**

In the literature four types of tapering are recognized, according to the modality the training load decreases in the pre-competition weeks:

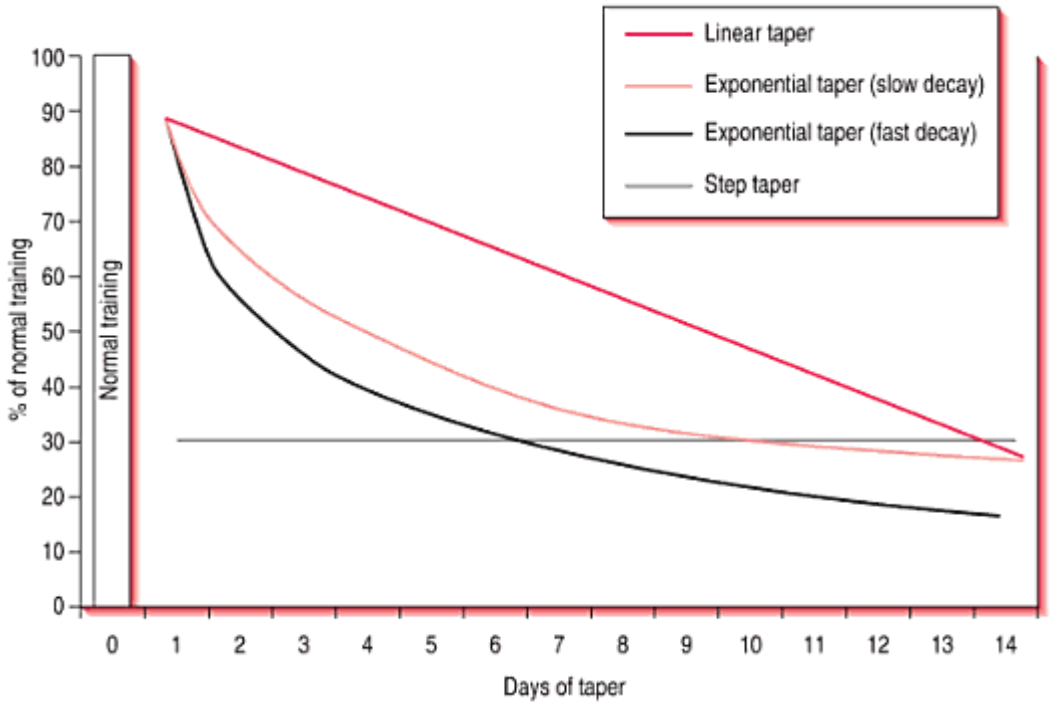
1) Linear

2) Exponential (slow decay)

3) Exponential (fast decay)

4) Step taper

The percentage variation of the training load during the taper, is represented graphically this way:




(Mujika & Padilla, *Scientific bases for pre-competition tapering strategies*, in Whyte, 2006)

As we can see, in the case of a linear taper the average and total training load in the period is higher; the final training load is lower with the exponential (fast decay) taper, and the lowest average load is used in the step taper. Two studies have found that the exponential-fast decay taper usually gives better results than both the step taper and the exponential-slow decay taper[16][17]; probably because the first one leads to no more than a maintenance, if not to a decrease of the positive adaptations, while the second one, as it would be for the linear type, has a too high average load in the first week of the macrocycle, not maximizing the elimination of the fatigue.

**Taper Duration**

Despite what is written above, it has been proven several times, both in practice and in studies, that not all the athletes have the same response to the same type of tapering and

[16] Banister et al, *Training Theory and Taper, Validation in Triathlon Athletes*, European Journal of Applied Physiology, 1999.

[17] Zarkadas et al, *Modelling the Effect of Taper on Performance, Maximal Oxygen Uptake, and the Anaerobic Treshold in Endurance Triathletes*, cit. in Mujika, 2009.

this indicates the necessity to individualize the type of unload according to the adaptive profile of each athlete[18]. Even the timing of response to taper is individual, so we can distinguish three types of athletes:

a) slow response

b) fast response

c) biphasic response

Given the same internal load, the first ones need three unloading weeks to maximize the performance improvements, which is realized almost completely during the third and last unloading week. The second ones need two weeks and the third one have the improvement distributed in such a way over the three weeks: 50%-5%-45%[19].

Most athletes who are not in an overreaching status, have a quick response to the unload period and begin to detrain during the third week.

We can therefore claim that the internal load status of an athlete three weeks before the most important competition of the year is the fundamental factor to determine the length of the taper.

Some general rules about the taper can be summarized in the following tables:

| Characteristics | | Effect on the Taper Duration |
|---|---|---|
| Body weight | High | More lasting |
| | Low | Less Lasting |
| | | |
| Gender | Male | More lasting with less time dedicated to strength |
| | Female | Less lasting with strength maintenance |
| | | |
| Load of the Pre-Taper Macrocycle | High | More lasting |
| | Low | Less lasting |
| | | |
| Load reduction during the Taper | Linear | More lasting |
| | Step | Less lasting |

[18] *Cfr*. Mujika, *Ibidem*, 2009.

[19] Trinity et al, *Maximal Mechanical Power During Taper in Elite Swimmer*, Medicine & Science in Sports & Exercise, 2006 cit. in Mujika, 2009.

| | | |
|---|---|---|

The shortest taper we can hypothesize is the one of a female athletes in an alactic discipline (e.g. 60m indoor in track and field) that trained at high intensity and low volume and who has a very low internal load; for her the taper can last just 5 days.

| Weekly training hours | Days of Taper |
|---|---|
| 6-10 | 7 |
| 11-15 | 14 |
| >15 | 21 |

E. McNeely and D. Sandler, Tapering for Endurance Athletes, Strength & Conditioning Journal 29(5):21, 2007.

Obviously even the type of load reduction during the taper is related to the load of the pre-taper macrocycle (and the internal load). A high load pre-taper macrocycle that determines an overreaching status needs a quicker load reduction, requiring the use of the exponential-fast decay taper in case of a three weeks duration or the use of step taper in case of a two weeks duration; on the contrary, a pre-taper macrocycle of a lower average load may require a slower reduction of the load itself (exponential-slow decay or linear taper) or a reduction of the taper length to 7-10 days in stead of 14. It will be the coach, with his experience and the informations given in this chapter, to optimally choose between a longer or a shorter unload period and between a more gradual or a quicker load reduction.

We can say that, as a general guideline to establish the ideal taper for each athlete, we suggest an exponential-fast decay taper of two weeks with a reduction of 60% of volume, preceded by a 3 weeks macrocycle of high intensity training.

**Intensity Manipulation**

It has been demonstrated in several studies that the intensity during the taper is of fundamental importance for the maintenance of the adaptations induced by the previous training as well as to stimulate further ones[20][21][22][23][24][25]. For this reason the intensity is reduced on average only by 5-10% for power sports and by 10-30% for endurance sports, reaching the highest reduction percentage only in the last days of the taper.

Recent computer simulations, however, suggest that the most important load reduction should be reached 4 days before the event, while during the last three days intensity should be increased again to stimulate further adaptations without impacting fatigue removal[26].

Remember that the days dedicated to the taper should not be used to do performance tests, particularly of the sport specific type.

---

[20] Hickson, R, et al. (1985). *Reduced training intensities and loss of aerobic power, endurance, and cardiac growth*. *J Appl Physiol*. 58:492-499.

[21] Shepley, B, MacDougall, J.D, Cipriano, N, Sutton, J.R, Tarnopolsky, M.A, and Coates, G. (1992*). Physiological effects of tapering in highly trained athletes*. J. Appl. Physiol. 72: 706-711.

[22] Convertino VA, Keil LC, Bernauer EM, Greenleaf JE. *Plasma volume, osmolality, vasopressin, and renin activity during graded exercise in man.* J Appl Physiol. 1981 Jan;50(1):123-8.

[23] Mujika, I. (1998). *The influence of training characteristics and tapering on the adaptation in highly trained individuals: A review*. Int. J. Sports Med. 19: 439-446.

[24] Bosquet L, Montpetit J, Arvisais D, Mujika I. *Effects of tapering on performance: a meta-analysis*. Med Sci Sports Exerc. 2007 Aug;39(8):1358-65.

[25] McNeely, Ed; Sandler, David. *Tapering for Endurance Athletes*. Strength & Conditioning Journal. 29(5):18-24, October 2007.

[26] Thomas et al, 2009, in stampa, cit. in Mujika, *Ibidem*.

**Volume manipulation**

A study has shown how the training adaptations obtained in 10 weeks of training could be maintained for an additional 15 weeks with just a reduction of volume from 30 to 60%. Several studies on elite athletes have reported the positive effects on performance with a range of reduction of the maximum volume during the taper from 40 to 85%, with the most consistent improvements in the range from 40 to 60% of reduction[27][28][29][30][31][32][33].

| Characteristics | | Effects over the Taper Volume |
|---|---|---|
| | | |
| Load of the Pre-Taper Macrocycle | High | Greater reduction |
| | Low | Smaller reduction |
| | | |
| Taper Duration | Short | Greater reduction |
| | Long | Smaller reduction |
| | | |

[27] Hickson et al. 1982, Houmard, J.A, Kirwan, J.P, Flynn, M.G, and Mitchell, J.B. (1989). *Effects of reduced training on submaximal and maximal running responses*. Int. J. Sports Med. 10: 30-33.
[28] McConell, G.K, Costill, D.L, Widrick, J.J, Hickey, M.S, Tanaka, H, and Gastin, P.B. (1993). *Reduced training volume and intensity maintain capacity but not performance in distance runners*. Int. J. Sports Med. 14: 33-37.
[29] Martin, D.T, Scifres, J.C, Zimmerman, S.D, and Wilkinson, J.G. (1994). *Effects of interval training and a taper on cycling performance and isokinetic leg strength*. Int. J. Sports Med. 15: 485-491.
[30] Rietjens GJ, Keizer HA, Kuipers H, Saris WH. *A reduction in training volume and intensity for 21 days does not impair performance in cyclists.* Br J Sports Med. 2001 Dec;35(6):431-4.
[31] Mujika I, Chatard JC, Busso T, Geyssant A, Barale F, Lacoste L. *Effects of training on performance in competitive swimming.* Can J Appl Physiol. 1995 Dec;20(4):395-406, 2000.
[32] Shepley et al. 1992.
[33] Bosquet et al. 2007.

| | | |
|---|---|---|
| Types of load reduction | Linear | Higher average volume |
| | Step | Lower average volume |
| | | |
| Types of load reduction | Linear | Lower final volume |
| | Step | Higher final volume |

**Frequency manipulation**

Part of the reduction of the volume necessary to reach peak shape, could be obtained through the reduction of training sessions per microcycle.

Instead of reducing the number of training units, it is suggested to reduce their volume, especially for those sports with an elevated technical component (swimming, rowing, cross skiing, kayak, gymnastic) and for high level athletes in general.

It is common practice in high level team sports to have two-three days off during the first week of the taper or between the first and the second week of the taper; this is due to the fact that team sport athletes usually get to the taper in an overreaching status because of the long competitive season.

**Adverse factors to peaking**

A coach has to know that there are situations that may negatively affect the achievement of the peak of shape. Among them we have:

- Unexpected variations of any kind, from the weather during the competition to the change of location or time, to transport or accommodation problems the day of the competition. It is a coach's duty to deal with all the logistics, as well as to simulate during training various possible situations so that their actual occurrence would not affect adversely the attainment of peak performance.

- Inadequate lifestyle of the athlete, like insufficient sleeping, use of alcohol, smoke, uncontrolled diet, all factors that affect the recovery and the athlete's readiness to perform.

- Negative attitude of the athlete as a consequence of social dissatisfaction, or problems with the coach, family, peers, at school or at work.

- Inadequate or too intense programming, with abrupt changes of load, with too many competitions or without regeneration periods. In particular, the lack of unload periods not only reduces the chances to reach the peak of athletic shape,

but it increases the probabilities of injury and, ultimately, the probability of overtraining.

**Conclusions**

Many coaches and athletes consider reaching the peak of shape in a competition, a favor dropped from heaven.

The ability of reaching peak shape, however, it is nothing but a strategy that you plan, manipulating the variables of the load to get a complete supercompensation before an important competition.

The performance unconsistencies we are witnesses of depend on the training the athlete does during the preparatory period, on the ratio between volume, intensity and recovery during it and/or on the number of competitions he takes part to.

---

# *Bibliografy*


A.A.V.V., *Sports Conditioning – The Complete Guide*, 2nd Edition, International Sport Science Association, 1994.

Beradi John, PhD, & Andrews Ryan, MS/MA, RD, *Nutrition: The Complete Guide*, International Sport Science Association, 2009.

*Bompa Tudor O., Power Training for Sport, 2nd Edition, Coaching Association of Canada, 1996.*

*Bompa Tudor O., Periodization Training for Sports, Human Kinetics, 1999.*

*Bompa Tudor O., Periodizing Training for Peak Performance, in Bill Foran (editor), High Performance Sport Conditioning, Human Kinetics, 2001.*

Bompa Tudor O., *Periodizzazione dell'Allenamento Sportivo*, Calzetti Mariucci Editori, 2002.

*Bompa Tudor O., Total Training for Coaching Team Sports, Sport Books Publisher, 2006.*

*Bompa Tudor O. & Claro Frederick, Periodization in Rugby, Meyer & Meyer Sport, 2009.*

*Bompa Tudor O. & Haff Gregory G., Periodization. Theory and Methodology of Training, 5th Edition, Human Kinetics, 2009.*

Buzzichelli Carlo, *Periodizzazione. Metodologia della Pianificazione e Programmazione dell'Allenamento*, Tudor Bompa Institute-Italia, 2010.

Contreras Bret, *A Simple Plan for Rotary Stability*, www.T-Nation.com, 2011.

*Freeman William H., Peak When It Counts, Tafnews Press, 2001.*

*Harre Dietrich, Teoria dell'Allenamento,* Società Stampa Sportiva, 2005.

*Issurin Vladimir, Block Periodization, Ultimate Athlete Concept, 2008.*

*Ivy John, PhD, & Portman Robert, PhD, Nutrient Timing, Basic Health Publications, 2004.*

Knopf Karl G., EdD, *Exercise Therapy*, 3rd Edition, International Sport Science Association, 2010.

*Matveijev Lev, Fundamentals of Sport Training, Progress Publishers, 1981.*

*McArdle William D., Katch Frank I., Katch Victor L., Essentials of Exercise Physiology, 3rd Edition, Lippincott Williams & Wilkins, 2005.*

*Mujika Iñigo, Tapering and Peaking for Optimal Performance, Human Kinetics, 2009.*

*Platonov Vladimir, Allenamento Sportivo: Teoria e Metodologia, Calzetti-Mariucci, 1996.*

*Platonov Vladimir, Fondamenti dell'Allenamento e dell'Attività di Gara, Calzetti-Mariucci, 2004.*

*Poliquin Charles, Current Trends in Strength Training, Dayton Publications, 1997.*

*Poliquin Charles, Strength Coaching Theory, Dayton Publications, 2000.*

*Poliquin Charles, Theory 1 Manual, www.CharlesPoliquin.net, 2006.*

Poliquin, Charles and McDermott Art, *Applied Strongman Training for Sport*, www.charlespoliquin.net, 2010.

*Rippetoe Mark & Kilgore Lon, Practical Programming for Strength Training, Aasgaard Company, 2006.*

Roman Suarez Ivan, Levantamiento de Pesas – Periodo Competitivo, Editorial Cientifico Tecnico, 1986.

*Siff Mel C. (and Yurij L. V. Verkhoshanskij), Supertraining, 6th Edition, Supertraining Institute, 2003.*

Verkhoshanskij Natalia, *Programming vs Periodization*, Supertraining Yahoo Group, 2010.

Verkhoshanskij Yurij L.V., *La Programmazione e l'Organizzazione del Processo di Allenamento*, Società Stampa Sportiva, 1987.

Verkhoshanskij Yurij L.V., *Tutto sul Metodo d'Urto*, Società Stampa Sportiva, 1997.

Verkhoshanskij Yurij L.V., *La Preparazione Fisica Speciale*, Società Stampa Sportiva, 2001a.

Verkhoshanskij Yurij L.V., *La Moderna Programmazione dell'Allenamento Sportivo*, Società Stampa Sportiva, 2001b.

Verkhoshanskij Yurij L.V., *Special Strength Training – A Practical Manual for Coaches*, *Ultimate Athlete Concept,* 2006.

Verkhoshanskij Yurij L.V., *Special Strength Training – A Practical Manual for Coaches*, 2nd Edition, copia *in revision pre-stampa, 2008*.

Verkhoshanskij Yurij L.V., *The Block Training System in Endurance Running*, *Verkhoshansky.com,* 2007.