

# Organization of the training process

by Yuri Verkhohansky

NSI © by IAAF

13:3; 21-31, 1998

“ This article continues the theme of the previous article, 'Main features of a modern scientific sports training theory', focusing on the principles which form the basis for the scientific organization of sports training: (1) The fundamental principle – methodological concepts must be in accordance with the course of the body's adaptation to an intense muscle activity. (2) Systematization of the training stimuli. The work load should be considered as a complete unit, in which great care has been taken over the chronological order of the training stimuli. This implies continuity, consistency and interdependence of the effects of the training stimuli on the athlete's organism. (3) Specific orientation of the whole system of training stimuli. (4) Superimposition of work loads having different priorities. This implies regulating work loads with different priorities according to the successive-contiguous method (as differing from the traditional complex-parallel method). (5) Absolute priority of the special physical preparation – improvement in skill depends on an increase of the motor potential. These principles are fully explained and elaborated, with practical suggestions of how to utilize them in establishing a training system.”

Professor Yuri V. Verkhoshansky PhD is the President of the International Association of the Theory and Methodology of Training in Elite Sports. At present he is working as an advisor for theory and methodology of training at the CONI Scuola dello Sport in Rome, Italy.

(Translated from the original Italian by Alessandra Lombardi. Figures by R. Corradini, SdS Coni.)

## 1 Introduction

In the article, 'Main features of a modern scientific sports training theory', it was suggested that a modern sports training system should be based on a thorough knowledge of the physiology of muscular activity, of functional biochemistry and of the mechanics of the body's adaptation to muscular work. Also, its organization must be centred on a specific aim and on the methodical monitoring of the organism's complex systems. Several modern principles and concepts, drawn from the rules governing the body's adaptation to intense muscular work and from those governing the acquisition of sports skills, provide a methodological basis for the organization of the training process (3, 4, 6, 16).

## 2 Principles for the organization of sports training

Structural principles, consistent with the more recent findings concerning the scientific basis of sports training, have not, as yet, been clearly established. However, it is already possible to support the accuracy of a number of principles for the organization of an annual training cycle, especially as regards high level athletes (5, 7, 9).

- ① Methodological concepts must be in accordance with the course of the body's adaptation to an intense muscle activity; this is the fundamental principle of modern sports training theory (STT) and aims at creating, during the training process, conditions necessary to:
  - stimulate the organism's adaptation to the work regimen, characteristic of a given motor activity;
  - fulfill the conditions necessary for the desired morphological and functional specialization;
  - improve the energy mechanisms and favour their rational exploitation;
  - induce an efficient regulation of the athlete's metabolism during intense muscular work.

These are the bases for the methodological concept of an efficient training system that will guarantee an athlete's adequate preparation.

② **Systematization of the training stimuli;** this is the essence of the STT's methodological concept. It indicates that the work load is to be considered not as a number of training means and methods, put together in order to solve a given problem, but as a monolithic unit, in which the training stimuli have been ordered chronologically with great care. The unity is given by the progression of the adaptive changes that occur in accordance with the trend of the organism's morphological and functional specialization in response to a given work regimen.

A systematic approach implies continuity, consistency and interdependence of the effects of the training stimuli on the athlete's organism.

**Continuity** means that work and rest periods should be adequately proportioned, so as to ensure the body's constant functional activity in the conditions determined by the training stimuli. The interval between one work unit and the following one is meant for rest and recuperation but, most of all, it is the lapse of time during which the biosynthesis processes induced by the muscular activity are developed. These processes determine the body's functional state; they are, therefore, the basis for the following work load and greatly influence its training effect.

**Consistency** of the training stimuli requires an accurate combination and distribution in time of the work loads, so as to ensure the desired effect.

**Interdependence** of the training effects implies that the combination and distribution of the work loads must be studied, so that the effect of one load will favour the realization of the following one. Also, each of the scheduled work loads determines the conditions that must be satisfied by the preceding loads.

A systematic use of training means must be based on the following concepts (5):

- the training effect of a given load decreases as the athlete's special preparation level increases, due to the effect of that load;
- the body's functional reaction to a given work load and, therefore, its training effect, is influenced by the outcome of the preceding load;
- the training effect of the selected work loads is determined, not so much by the sum of all their respective effects, as by the way in which they are combined, their succession and the lapse of time that separates one from the other;
- a variation in the chronological order of the work loads significantly influences their training effect.

A systematized application of training stimuli, therefore, implies:

- a careful choice of the combination of means having the required training potential, i.e. those that are likely to stimulate the desired adaptive reactions;
- an adequate organization of the interaction of training loads having different priorities;
- a gradual introduction of training means with higher potential, so as to maintain the development trend;
- a rational combination of means with a high training effect (intensive method) and means with an optimal effect (extensive method);
- an adequate duration of the selected means, sufficient to induce a stable adaptation.

③ **Specific orientation of the whole system of training stimuli.** This means that the work loads used must be specifically aimed at inducing a morphological and functional specialization of the athlete's organism, consistent with the work regimen characteristic of competition conditions. In the preparation of high level athletes, a high training potential of the work load is important but, even more important, is the quality of the training effect (i.e. the result of the training process) which must involve all the organism's physiological systems. The complex composition and the total volume of the work load, as expressed in L. Matveyev's "periodization" (MATVEYEV: *Osnovy sportivnoj trenirovki. Uchebnoe posobie dlja institutov fiskul'tury* - Fundamentals of Sports Training, Handbook for the Institutes of Physical Education, Moscow 1977), cannot satisfy this requirement, because they induce a generalized reaction, in which the quantitative aspects of loads having different priorities are not distinguishable. Also, a given work load may negatively influence the effect of another one. For this reason, it is essential that training means be carefully selected and organized, so as to ensure the realization of the desired specific effect, in line with the overall training strategy. Scientific studies confirm that, during each training phase, the loads used should all have the same priorities (for instance development of special strength, or movement velocity, or improvement of technical skills) and be aimed at the achievement of a stable effect.

Figure 1 shows the specificity of training effects with different strength training work regimens (5 sessions a week for four weeks). After isometric training, the strength momentum of the tarsotibial joint increased, while the dynamic strength values (angular velocity from 40° to 160° per second) decreased. Low velocity isokinetic training (40° per second) improved both isometric strength and the dynamic strength using low velocity movements. Work at high

velocity (160° per second) improved the parameters of strength expressed at high velocity (120° and even more so 160°). Therefore, the most significant increase in strength momentum was observed for the type of work used during training. Furthermore, isometric training negatively influenced the control mechanisms of muscle contraction during dynamic work, while isokinetic training at high velocity did not significantly improve isometric strength.

④ **Superimposition of work loads having different priorities.** This principle allows full exploitation of the advantages of a systematized use of work loads. It implies that, during the training process, more intense and specific training loads will be gradually introduced on the tail of the adaptive changes produced by preceding loads. Also, work loads having a given priority are used prevalently during the training phase in which that particular aim is essential to the development of the training process. The succession, variation and duration of specific training stimuli are determined by the differences in the resistance to adaptation of the body's physiological systems, by the heterochromia of their morphological and functional specialization and by their subsequent improvement as a result of training.

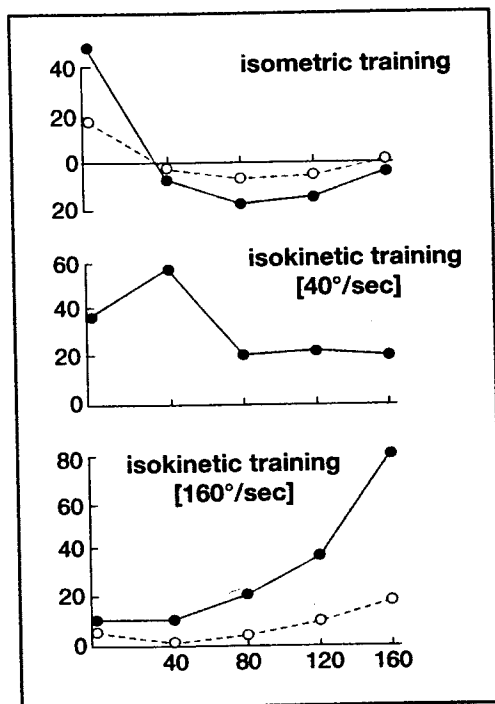


Figure 1: Adaptive changes in the tarsotibial joint induced by different types of strength training

On a practical level, superimposition is achieved by regulating work loads having different priorities according to the *successive-contiguous method* (Figure 2). This method is consistent with the well-known methodological rule – gradual increase of the intensity of training stimuli, which means that it is not advisable to apply high intensity training means at the beginning of the training process (C), when the organism is not physiologically ready for them. Such means would alter the natural course of the adaptive process and must, therefore, be introduced gradually.

One of the characteristic features of the successive-contiguous method is that, once the preceding loads, (for example load A in Figure 2), have produced the desired effect and are being substituted by loads with a higher training potential (load B in our example), they are not completely excluded from the training process, but become extensive training stimuli and induce the specific morphological changes whose onset they had originally caused. This also occurs with load B as load C is gradually introduced.

Figure 3 (next page) shows examples of the successive-contiguous method developed for use in the field (3, 4, 6, 16). It is immediately apparent that the method requires the systematization of the training means according to the intensity of their effect. They must also be ordered in groups of training means having different priorities, i.e. they must be classified according to the specificity of their effect. We must here underline that this is an extremely difficult problem but the person who can solve it will, indeed, become a great coach.

Figure 4 (next page) shows the main difference between the successive-contiguous method (I) and the traditional, complex-parallel method (II). With the latter, in a long training phase, work loads having different priorities (A, B and C in Figure 4), have a monotonous quantitative effect, despite the increase in volume and intensity. At

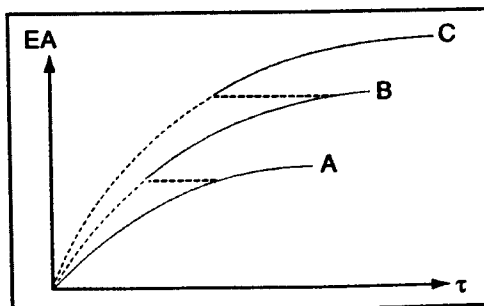


Figure 2: Organization of work loads having different priorities, according to the successive-contiguous method

the same time, the body's reactions to the specific components of the load are insignificant, because the adaptive changes are generalized. Consequently, the training effect (EA) of the work loads wears out very rapidly, the adaptation process slows down, and the athlete's special work capacity reaches a plateau, sometimes even decreases.

In the successive-contiguous method, the complex organization of the work loads (A, B and C), is the same over the long period. The organization is successive, in the sense that there is a very exact chronological order for the introduction of the work loads with a gradual increase of their intensity and of the specificity of their training effect. They are contiguous because their rational succession in time is organized so that load A induces morphological adaptations that will favour the achievement of the desired effect of loads B and C.

The distinctive feature of the successive-contiguous method is that work loads having the same priorities are concentrated within a limited period of time, so as to enhance their specialization effect, and those with different priorities are chronologically ordered and separated, so that each load may induce stable adaptive changes.

Furthermore, it is important to note that the separation of work loads with different priorities (A, B and C in Figure 4), is not clear-cut; one load is never completely abandoned before beginning

the following one. During the training process, one load, for instance load B, gradually substitutes the preceding one, for example load A. Also, all work loads (A and B) create the morphological and functional basis that will enhance the training effect of the following loads (C). These, in turn, will favour a further improvement of the adaptive changes induced by loads A and B at a higher level of intensity. This ensures a gradual intensity increase of the training effects (EA) on the athlete's organism.

⑤ **Absolute priority of the special physical preparation.** This principle is based on one of the more important rules concerning the improvement of sport skills, according to which the increase of the athlete's motor potential is the principal factor that determines the improvement of an athlete's sport skill during a multiannual training process. This means that one should begin planning this process by organizing the special physical preparation (SPP) in the annual cycle (objectives, content, volume and order of the work loads) and only then establish the order of importance of all the other objectives (technique, speed, preparation for competition). Such an approach does not underestimate the importance of these latter aspects; on the contrary, it is aimed at creating the most favourable conditions for their development.

#### 4 Principles for establishing a training system

The organization of a training plan should be based on the following methodological principles:

① The training plan should be organized, not around the microcycle (as in the "periodiza-

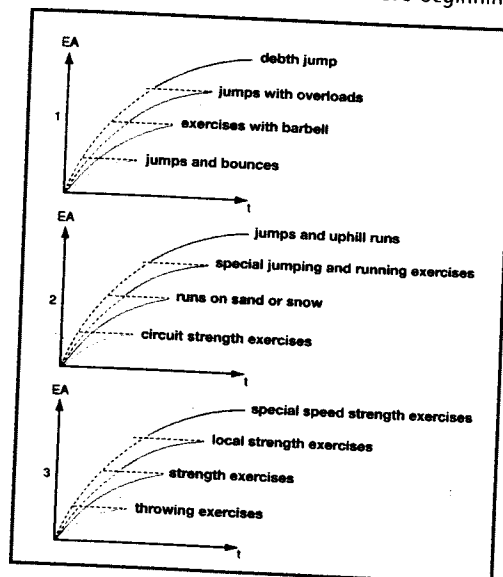


Figure 3: Examples of the organization of STT means according to the successive-contiguous method for: 1) jumpers (VERKHOSHANSKY 1970); 2) middle distance runners (NURMEKIVI 1974); 3) throwers (TSCHIENE 1978)

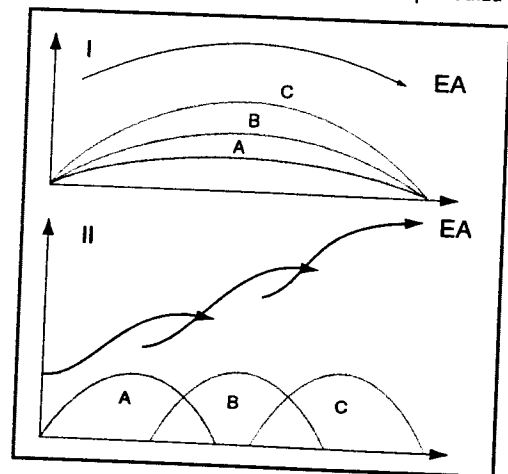


Figure 4: Comparison of the complex-parallel method (I) with the successive-contiguous method (II); EA - training effect

tion" proposed by MATVEYEV 1977), but around the main adaptation cycle (MAC) is aimed at increasing the athlete's skill by exploiting in full his actual adaptation potential (AAP).<sup>1</sup>

- ② The final result of the training process, which brings about an improvement of the athlete's skill and performance is determined by an increase of the organism's effective work power in a given work regimen.
- ③ The trend of the athlete's functional state provides a clear indication of the effectiveness of the training process. It can be evaluated by monitoring the functional parameters specific to the chosen sports discipline.
- ④ The methodological concept of the preparation follows a logical reasoning: if there is no improvement of the special physical preparation, then a significant development of the athlete's technical-tactical skill, of the organism's work potential and of the speed of execution of the competition specific exercise will probably not be achieved. If these aspects are not developed to the highest degree, by means of an adequate level of special physical preparation, it is unlikely that the scheduled improvement of performance will be attained.
- ⑤ The overall strategy of the training process requires that the three main aspects of training, each of which covers a number of intermediate or partial objectives, be consistent with the principal objective:
  - increase of the athlete's motor potential (special physical preparation);
  - improvement of the athlete's capacity to use effectively his motor potential in the competition specific exercise (technical-tactical preparation);
  - improvement of the athlete's skill level and of its stability (psychological and competition preparation);
- ⑥ The main methodological objective of the training process is an adequate ordering of the content, so that work aimed at developing the athlete's specific work power will not be obstructed by his functional capacities or

by his skill level, and, at the same time, does not interfere with the work aimed at improving technique and speed of execution of the competition specific exercise.

## 5 Main concepts for programming the training process

The main concepts are a category of the methodological principles that may be described as intermediate or partial, as against the fundamental principles of the training process. They are aimed at 1) adjusting the fundamental principles to the specific conditions of high level athletes, and 2) expressing practical rules for the organization of the training process (3-6, 16, 17).

- ① **Realize the athlete's AAP;** this concept implies that the work load must follow the trend of the organism's adaptation to specialized muscular work. To this end, the annual training cycle includes specific phases of preparation (MAC), with well defined aims, content volume and organization of the work loads. These phases must be adjusted to fit present day requirements of high level athletes. Note that the annual cycle may include one, two or three MACs.
- ② **Use training means and methods systematically,** so as to ensure the necessary specificity of the effect of all the training loads.
- ③ **Maintain the training potential of the work loads** by a scheduled increase of the intensity and specificity of the load's training effect, so as to induce the development of the organism's work capacity. This can be obtained by organizing the work loads having different training intensity following the successive-contiguous method (*Figure 2 and 4 II*).
- ④ **Concentrate SPP means in phases of limited duration** so as to concentrate their effect. This method ensures a significant increase in the organism's work capacity and creates the functional bases for the subsequent loads, aimed at improving skill, work capacity within the specific work regimen and movement velocity.
- ⑤ **Give precedence to SPP;** this concept underlines that the SPP is essential to the achievement of scheduled results with high level athletes. Work on the SPP must be placed before work on technique or on speed of execution of the competition specific exercise, so as to create the conditions necessary to improve both technique and speed.
- ⑥ **Separate chronologically work loads having different priorities;** this allows the rational use of loads whose training effects are incompatible, as, for instance, loads aimed at

<sup>1</sup> The elaboration of the methodological principles and of the training system model discussed here was begun around 1960 when the author was working as a coach (2). It was later continued on the basis of scientific data obtained during research in laboratories and on the field, carried out with a large group of researchers and coaches (1, 3-5, 13, 14, 16, 17). The training models have been confirmed by work with high level athletes specializing in various track and field disciplines (5, 7-13).

developing SPP, or at improving technique, or speed of execution of the competition specific exercise. It is possible in this way to eliminate, or minimize, reciprocal negative influences and their distancing in time also allows an accumulation their respective training effects.

⑦ **Exploit the long term delayed effect (LTDE) of concentrated SPP loads**, so as to ensure conditions that favour technical preparation, speed development and competition preparation. Note that the LTDE has a particular relationship between the dynamics of the athlete's functional state and the work load established for long lasting training phases (3-6, 13, 15-17). It is characterized by a 10-12% decrease of the functional parameters during the concentrated SPP loads, which is followed by an "over-recuperation" that raises these parameters to about 20-30% more than their initial value (Figure 5). The physiology of the LTDE and its expression in various sports disciplines have been discussed in previous publications (13, 15); in the present instance we shall only outline briefly its main characteristics and the conditions that favour its expression. Figure 6 shows the LTDE's development trend.

- The development occurs in two phases; conditions favouring its production are first created ( $t_1$ ) and it is then expressed in the second phase ( $t_2$ ).

- The condition that mainly induces LTDE is a large volume (A) of SPP loads concentrated in a phase of limited duration ( $t_1$ ). This method

enhances the training effect by intensifying the organism's work regimen and so inducing the corresponding adaptive changes. This leads to a decrease of the athlete's functional capacities (f).

- The greater the decrease (within certain limits) of the functional parameters in this first phase, the greater their subsequent increase in the second phase (curves  $t_1$  and  $t_2$ ). When the concentration of SPP loads is too great, however, this will lead to an excessive decrease of the athlete's functional capacities, thus altering the adaptation trend (curve  $f_3$ ).

- During the phase of concentrated SPP loads aimed at producing LTDE, it is not advisable to use intensive means since the concentration is in itself sufficient to intensify the training effect.

- The expression of the LTDE is favoured by specific work at gradually increasing intensity (B). During this phase, the organism easily tolerates intensive loads but reacts negatively to high work volumes. This is indicated by a slackening of the over-recuperation, sometimes even a decrease of the functional parameters. The volume of the loads should, therefore, not be increased during the expression of the LTDE:

- The duration of the LTDE (phase  $t_2$ ) is determined by the volume and the duration of the concentrated SPP loads. As a rule, the duration of the LTDE ( $t_2$ ) is equal to the duration of concentrated work ( $t_1$ ). This tendency was observed in high level athletes who were

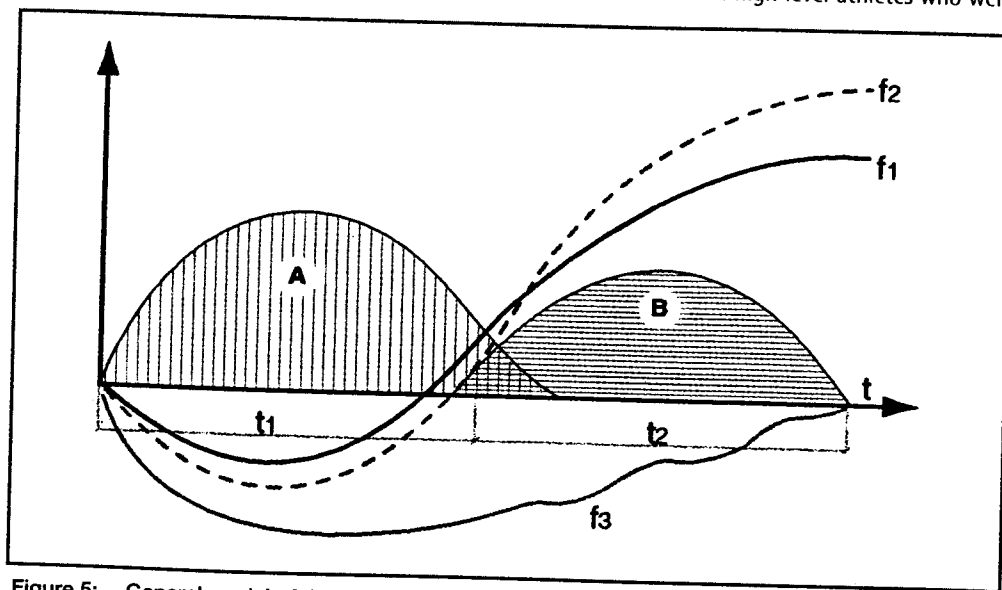


Figure 5: General model of the LTDE of concentrated strength loads; see text

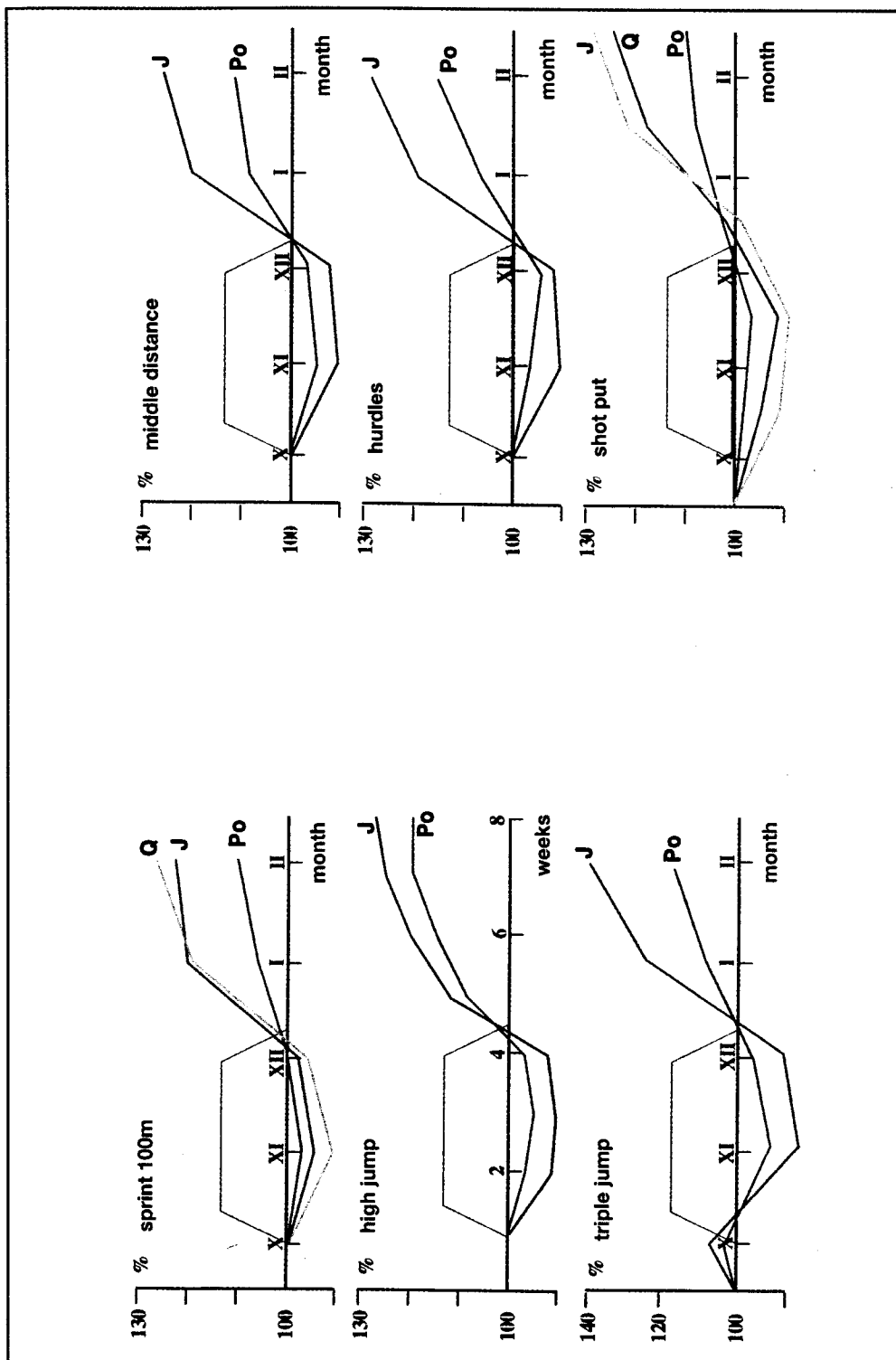


Figure 6: Trend of the parameters of maximum strength (Po), explosive strength (J) and initial strength (Q), induced by concentrated special strength loads in various track & field disciplines

submitted to phases of concentrated work ( $t_1$ ) lasting between 4 and 12 weeks;

- the expression of the LTDE is closely connected to the athlete's individual characteristics, in particular the degree of tolerance to high work volumes and the organism's capacity to recover despite frequent training units and high work volumes.

- ⑧ **Reproduce the competition specific exercise during training**, so that the organism is submitted to a similar work regimen and similar conditions, with a gradual increase (depending on the training phase) of the strength effort. This method facilitates an efficient physical, psychological, technical and tactical preparation of the athlete.

## 6 Standard model for the main adaptation cycle

It has already been underlined that the training process should be organized around the main adaptation cycle (MAC - re. 'Main features of a modern scientific sports training theory'). Figure 7 illustrates the standard model of the MAC. This model is intended as a possible alternative for the organization of the training process; it is not in opposition to other conceptions and is not considered as the definitive solution.

- 1) The main components are (Figure 7):

- a model of the dynamics of the body's effective work power in the specific conditions of a given work regimen ( $W$ );
- a model of the dynamics of the athlete's functional state, as expressed by the main functional parameters ( $f$ );
- a model of the work load system (blocks A, B and C).

- 2) The parameters are:

$W_1$  - maximum level of the organism's work power achieved in the preceding phase of the training process;

$W_2$  - maximum level of the organism's work power aimed at;

$f_1$  - maximum level of the main functional parameters achieved in the preceding phase of the training process;

$f_2$  - maximum level of the main functional parameters aimed at;

$\Delta W$  and  $\Delta f$  - scheduled improvement of the work power and of the functional parameters;

A - concentrated SPP loads;

B - speed training and technique training;

C - competition preparation loads;

P - total volume of the work loads;

$\tau$  - duration of the MAC

- 3) The MAC is divided into three blocks whose succession is meticulously ordered:

**Block A** (basic phase) is dedicated to the activation of the adaptive process which is oriented towards the morphological and functional specialization required for the specific work regimen. The main objective of this block is to improve the athlete's motor potential, taking into account the particularities of the competition specific exercise.

**Block B** (special phase) is dedicated to the development of the organism's work power in a specific work regimen and in conditions consistent with those found in competition. The main objective of this block is to accustom the athlete to make full use of his increasing motor potential and to execute the competition exercise with progressively greater intensity. A number of competitions will be scheduled during this phase.

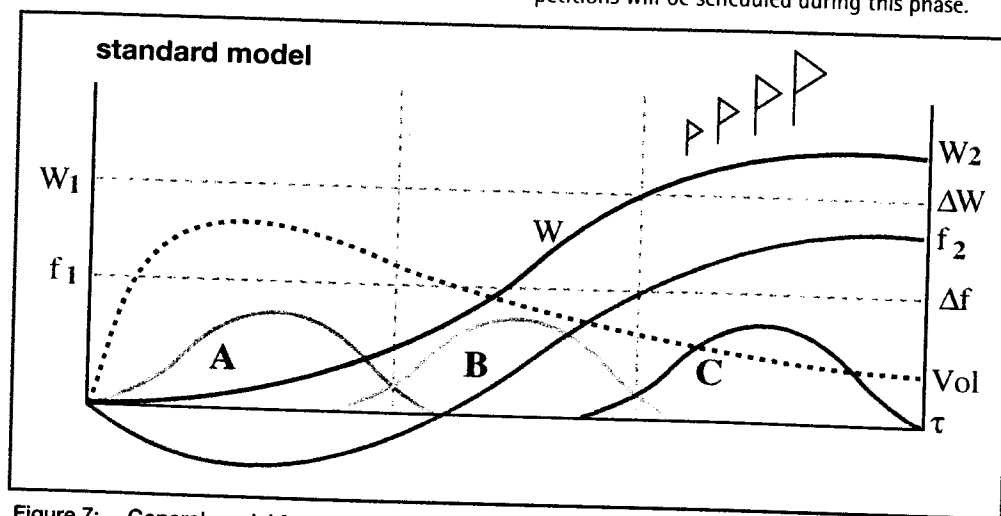


Figure 7: General model for the organization of the main adaptation cycle (MAC)



*Block C* (phase covering the more important competitions) is the conclusion of the adaptation cycle; during this phase the athlete will achieve the maximum level of work power in the competition specific regimen. The main objective of this block is to obtain maximum efficiency by exploiting in full the motor potential during competition.

Curves A, B and C in the MAC model indicate the different priorities of the training effect of the respective loads in each phase, not their volume.

4) The organization of the MAC reflects the concept of a gradual intensification of the organism's work regimen. It begins with SPP loads (block A), goes on to technique and speed work (block B), and finally to competition preparation (block C). As the competition specific exercise gradually substitutes SPP means, it becomes the intensification factor, while SPP means are meant to maintain the conditions achieved. Note that block B is aimed at improving the speed of execution of the competition exercise but also, and more importantly, at improving the athlete's capacity to express power at that specific work regimen. This concludes the preparation of the energy requirements for work at maximum intensity in the competition phase.

The development of the organism's work power must be carefully graded, so as to avoid over-training. To this end, it is advisable to distinguish three levels of work power or intensity:

- optimal intensity for the main load volume in the basic phase;
- maximum intensity that the athlete can achieve during the special phase through the specific preparation, without incurring fatigue or impairing the movement structure;
- utmost intensity – this is the ultimate objective of the training process and should be achieved in time for the more important competitions.

5) It is important to underline that the MAC does not include a preparation phase and a competition phase in the traditional interpretation of these terms. In that instance, the training process was divided into two phases that had only a very slight connection. The conception may be briefly outlined as follows: during the preparation phase the athlete "accumulates" the potential which will then be expressed during the competition phase. This implies that the athlete maintains and recovers the potential after a competition, but does nothing to develop it further. So, the work load in the preparation phase must be quite relevant because the "supply" must be sufficient to cover the entire competition phase.

This outdated conception, based on MATVEYEV's "periodization", overlooks the possibility of putting to use the athlete's actual adaptation potential, and it involves the athlete in a very significant, and pointless, expenditure of energy. This explains the tendency to associate any improvement to an increase of the work volume during training (7, 9).

6) The MAC is a completely new way of organizing the training process, based on the interdependence between competition activity and the continuous development of the athlete's adaptation. In other words, competition activity and the preparation that immediately precedes competition are incorporated into the process leading to the organism's morphological and functional specialization, and act as a powerful adaptation stimulus. The aim is to bring the organism's work regimen to maximum intensity during the last phase of the MAC, thus achieving the principal objective of the training process.

7) The outstanding feature of the MAC is that it includes a new phase (block B) whose role is extremely important: the very specialized work loads are a gradual progression from SPP to competition preparation<sup>2</sup>. In *Figure 7* block B corresponds to the point in which the intensity curve (W) changes direction, i.e. when the intensity is raised so that it will gradually reach the competition specific work regimen.

It is important to underline that block B gives great flexibility to the MAC, so that this type of training process may be adjusted to fit the requirements of different competition calendars, both for high level sports and recreational sports. For instance, when there is a very long competition season (there would be only one adaptation cycle), competitions may take place during the first half of block B. If there are two competition seasons in one year, there will be two adaptation cycles; in the first one the duration of block A may be increased by reducing block B and C, while in the second one, block A will be reduced (the intensity of the loads will be increased) and, depending on the specific aims, the duration of block B or of block C will be increased. In any case, the general structure of the MAC will remain unchanged.

8) The MAC is organized so that the SPP loads are concentrated in block A. This method will lead to a decrease of the athlete's functional parameters and of his specific work capacity (f). During this phase, therefore, it will be impossible to improve technique and/or speed of execution of the competition specific exercise. But this

<sup>2</sup> Block B is totally different from the traditional pre-competition phase.

decrease is only temporary (13, 15). After these concentrated loads the onset of their long term delayed effect (LTDE) can be clearly observed and it induces a remarkable, and stable, increase of the functional parameters to levels that are much higher than their initial values. Therefore, concentrated SPP loads and loads aimed at improving technique or speed of execution of the competition exercise, should be separated in time.

In other words, SPP loads must come before any specific work on these two aspects. In this case the SPP loads prepare the organism for high intensity work, so that technique and speed of execution work will be carried out during the LTDE, i.e. in extremely favourable conditions.

Therefore, during the organization of the training plan, the coach should look at the result, not in absolute terms, but in terms of improvement, as this is the ultimate objective of the training process. Also, in order to achieve this objective, the coach should aim at an improvement of the organism's work power (W) and of the functional parameters (f), but he should also establish the exact values of this improvement ( $\Delta W$  and  $\Delta f$ ), since these are the criteria for the selection of content and organization of the work loads. This

type of approach allows the coach to define clearly the requisites of the training means that will ensure the desired improvements and, therefore, increases the efficiency of the training process. (3, 4, 10)

As was mentioned in the first article, 'Main features of a modern scientific sports training theory', the organization of the MAC must satisfy two fundamental conditions: *the training loads must be specifically aimed*, i.e. their training effect must be directed towards specific physiological or energy systems, or specific functional capacities, and *the objective must be clearly established*. Therefore, the choice and organization of the work loads must take into account the functional capacities, the physiological and energy systems that determine athletes' specific work capacity, their respective resistance to adaptation, and the heterochronia of the adaptive reactions of the organism's physiological systems during the training process. Figure 8 outlines the structure and the order of the training effects affecting the functional parameters of the cardio-vascular system (CVS) and of the neuro-muscular apparatus (NMA), when the training strategy is directed towards an increase of running speed (V). The idea behind this structure is the following:

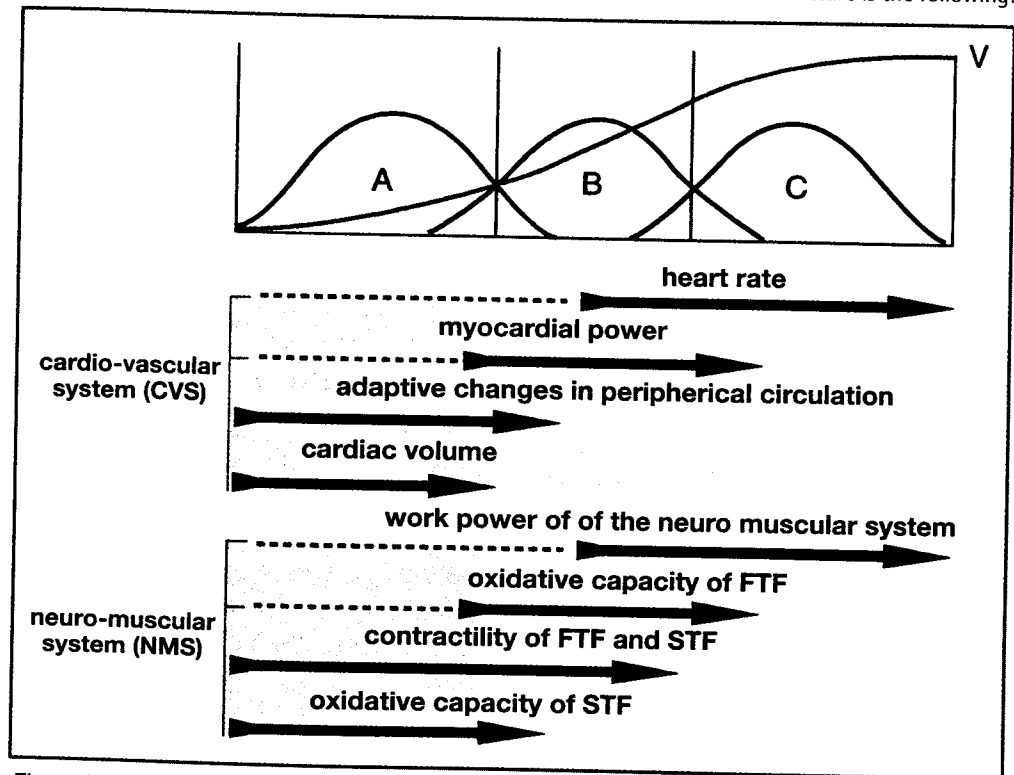


Figure 8: General model for the organization of the main adaptation cycle (MAC) for track and field disciplines requiring endurance

a) as regards the CVS, at first (block A), the training effects are aimed at an increase of cardiac chamber volume and at the re-distribution of blood flow; subsequently at an increase in cardiac output, through the development of myocardial power (block B) and of heart rate (block C);

b) as regards the NMA, the training effects are initially aimed at improving simultaneously muscle contractility and the oxidative capacity of slow twitch muscle fibres (block A), then of fast twitch muscle fibres (block B); block C leads to an improvement of work power of the NMA in the specific cyclic regimen;

c) the abscissa clearly shows the contiguity of the training effects on the CVS (specific loads) and on the NMA (SPP loads). Note that SPP means include specific strength exercises, in particular exercises with overloads, aimed at developing strength, but also local muscular endurance (LME), of the muscle groups mainly involved in the competition specific exercise.

This type of structure of the training loads ensures an harmonious development of the organism's muscular, vegetative and energy systems, consistent with the work regimen specific to distance running. Results obtained with this type of structure applied to cyclic sports (5, 7-9, 14) show that it favours a more efficient use of the athlete's energy, as against the more traditional and empirical training systems (8, 14). In particular, high level middle distance runners achieved excellent results, despite a very significant decrease (2-2.4 times less) of the distance covered; the distance was reduced from 5000-6000km to 2000km a year (5, 8).

Note that we have here illustrated only a model MAC for high level athletes, without taking into account the competition calendar and the athlete's actual condition. It should, therefore, be adjusted to fit specific requirements, such as the movement structure of the competition event, competition calendar, rules of the event. An annual training cycle may include one or two MACs; in this second case, the more important competitions must occur during the second MAC and this determines objectives and content of both cycles.

A third and last article will deal with practical aspects of the programming of sports training.

## REFERENCES

(1) STIFF, M.; VERKHOSHANSKY, Y.:

Supertraining. A Textbook on the Biomechanics and Physiology of Strength Conditioning for all Sports. Johannesburg, South Africa: School of Mechanical Engineering, University of the Witwatersrand, 1993

(2) VERKHOSHANSKY, Y.:

Trojnij prygiok. In: Fizkul'tura i Sport, Moscow (1961)

(3) VERKHOSHANSKY, Y.:

La programmazione e l'organizzazione del processo di allenamento. In: Società Stampa Sportiva, Rome (1987)

(4) VERKHOSHANSKY, Y.:

Programming and Organization of Training. Sportivny Press, Livonia, Michigan, USA, 1988

(5) VERKHOSHANSKY, Y.:

Osnovy special'noj fiziceskoj podgotovki sportsmenov. In: Fizkul'tura i sport, Moscow (1988)

(6) VERJOSHANSKI, Y.:

Entrenamiento deportivo. Planificación y Programación. Deportes Tecnicas. Barcelona, 1990

(7) VERKHOSHANSKY, Y.:

Prinzipy organizatsii trenirovki sportsmenov vysokogo klassa v godichnom zikle. In: Teorija i praktika fiziceskoj kul'tury (1991)

(8) VERKHOSHANSKY, Y.:

Ein neues Trainingssystem für zyklische Sportarten. Münster: Philippka, 1992

(9) VERKHOSHANSKY, Y.:

Aktual'nye problemy sovremennoj teorii i metodiki sportivnyh trenirovki. In: Teorija i praktika fiziceskoj kul'tury, 1993

(10) VERKHOSHANSKY, Y.:

Ein neues Trainingssystem für azyklische Sportarten. Münster: Philippka, 1995

(11) VERKHOSHANSKY, Y.:

Preparacao de Forca Especial Modalidade Desportivas Ciclicas, Grupo Palestra Sport, Rio de Janeiro, 1995

(12) VERKHOSHANSKY, Y.:

Mezzi e metodi per l'allenamento della forza esplosiva. Tutto sul metodo d'urto. In: Società Stampa Sportiva, Rome (1997)

(13) VERKHOSHANSKY, Y. ET AL.:

Un modello per la direzione dell'allenamento. In: SdS - Rivista di Cultura Sportiva (1983), 2

(14) VERKHOSHANSKY, Y.; CIARYEVA, A.:

Problemy rasvitiya vynoslivosti. In: Naucno-sportivnyi vestnik (1984), 3

(15) WERCHOSHANSKI, J.:

Der langfristig verzögerte Trainingseffekt durch konzentriertes Krafttraining. In: Leistungssport 14 (1984), 3, pp. 41-42

(16) VERCHOSANSKI, J.V.:

Effektiv trainieren. Neue Wege zur Planung und Organisation des Trainingsprozesses. Berlin: Sportverlag, 1988

(17) VERKHOSHANSKY, Y.:

L'entraînement efficace. Pour une programmation efficace de l'entraînement. Presse Universitaires de France, 1992

