Speed training for high level athletes

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The method to develop speed recommended by the author applies only to top level sprinters, who have undergone a thorough preparation and have acquired an efficient technique. In addition, they are to be used only in certain phases of the training cycle.

The system comprises two stages: 1) A gradual adaptation to an increase in speed of execution. 2) A phase in which the speed already attained is further enhanced by means of extra stimuli. To achieve the first goal, four methods of training are recommended.

The second aim is to be reached by means of four different, more advanced methods. All of these methods are described in detail, as well as 3 ways of intensifying the stimulus during the second phase.

1 Introduction

An effective way to adapt to an intensified work regimen is for the athlete to perform competition specific exercises at high velocity. This system can be used only:

a) with high level athletes;
b) in particular phases of the annual training cycle;
c) after an adequate preparation.

Two conditions are particularly important:

- the athlete must have already mastered the required technique
- he must have achieved the necessary degree of functional preparation for a high velocity work regimen.

The method may be divided into two stages (*Figure 1*). The first step aims principally at a progressive increase of the speed of execution of a competition specific exercise, so that the organism will gradually adapt to the high velocity work regimen. The second stage, when a certain velocity has been attained, aims to produce a further velocity increase by stimulating new adaptive changes, which correspond to the new work capacity level.

It is important to underline that in both cases the limiting factor, in terms of velocity increase, is technique, which must not be allowed to deteriorate. In other words, velocity should be high enough to stimulate adequate adaptive changes, but not so high as to produce a deterioration of technique.

Methods for a progressive velocity increase

1) Long accelerations.
2) Fartlek.
3) Competition specific exercises performed at increasingly higher speed.
4) Progressively longer distances performed at the aimed at speed.

1) Long accelerations are effective means of producing a programmed (gradual) adaptation to a high velocity work regimen. The aim is to progress gradually to maximum speed and then

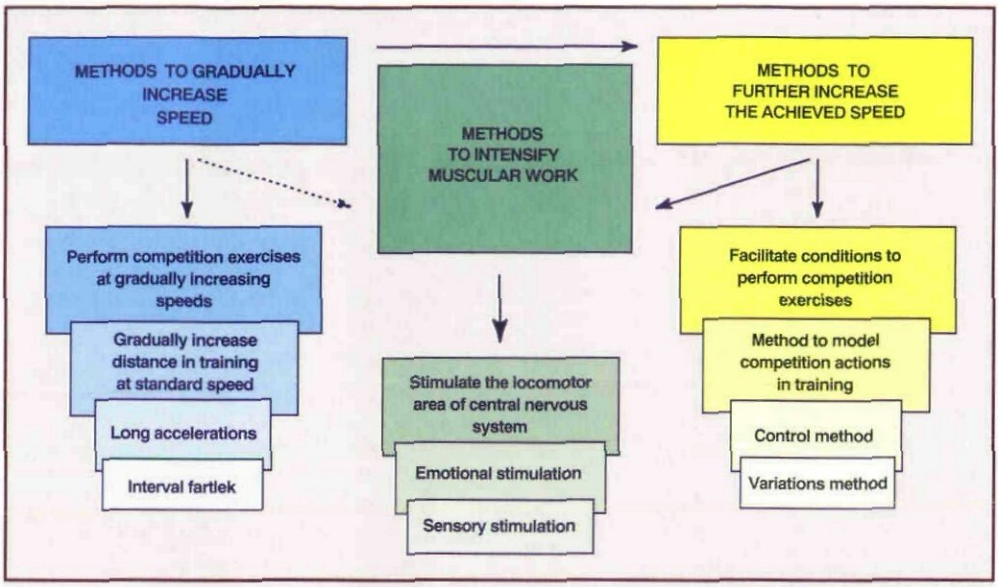


Figure 1: Methods of developing speed

maintain the level achieved. During accelerations the intensity of the muscle effort decreases gradually, but rhythm and movement technique must be maintained and controlled right up to the end. As the training session progresses, maximum speed increases and the distance that must be covered at maximum speed also increases. Rest intervals must be sufficient to ensure complete recovery.

2) **Fartlek** is used mainly with middle distance runners. Long accelerations (8-12 seconds) are interspersed during moderate intensity work not exceeding anaerobic threshold. The speed, distance and number of the accelerations are gradually increased, while the intervals between accelerations are maintained and their duration is dictated by the athlete's condition.

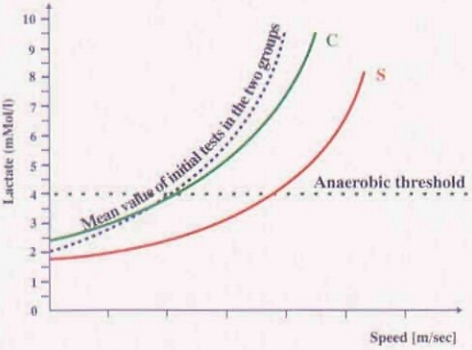
Experiments have proved the efficiency of short (up to 8 seconds) maximal accelerations performed during long distance swimming at anaerobic threshold level (*Figure 2*). The intervals between successive accelerations were such that lactate concentration was not allowed to exceed threshold level. This training method favours an intensification of phosphocreatine ATP resynthesis and, at the same time, stimulates oxidative phosphorylation. In a very short time it induces an increase in swimming speed at anaerobic threshold level, maximum swimming speed and speed endurance.

Results obtained in a series of studies showed that this method was more efficient than the one used with a control group, which also exercised at anaerobic threshold level but did not perform the short accelerations. According to data in the scientific literature (MADER/REISS 1977), the improved efficiency during exercise at anaerobic threshold level may be achieved after 4-5 weeks. In our research (VERKHOSHANSKY/CIERNIYAEVA 1984) this effect could already be observed on the 14th day and was maintained for the following two weeks.

3) **Competition specific exercises, performed at increasingly higher speeds**, are mainly used for cyclic disciplines requiring speed-strength. In speed-endurance events and in middle distance events, this method aims at lowering an athlete's time over the competition distance, according to the graph shown earlier. One of two variants may be used, both aimed mainly at progressively increasing average speed.

In the first variant the athlete must run the whole distance using a steady pace. It is important in this case to monitor technique and movement rhythm, especially in the end section, where there should be no increase in the rate of movement or intensity of effort.

In the second variant, the athlete may use any pace as long as he achieves the programmed result. A graph is used in both variants to monitor the pace over the whole distance but, in the second case, an effort is also made to identify individual optimum conditions. The first variant helps to perfect rhythm, find ideal stride length and maintain speed in the last section. With the second variant, the athlete works on perfecting an efficient technique and effort distribution, practising tactical changes and improving the recovery rate after accelerations. It is advisable to use a combination of both variants.



Curves of mean lactate accumulation in a test at increasing workloads, in swimmers subdivided into two groups, an experimental one (S) and a control (C). For two weeks, the control group swam at the individual level of the anaerobic threshold, whereas the experimental group performed fartlek (continuous swimming with short accelerations).

During prolonged swimming (10 to 15 minutes), at the anaerobic threshold level, short maximum accelerations are performed (8") . The interval among accelerations is selected to prevent lactate concentrations from exceeding individual anaerobic threshold levels. This method favours the intensification of ATP resynthesis phosphocreatinine mechanism, increases the amount of phosphocreatinine in energy transport and favours oxidative phosphorilation activation. In the short run (two weeks), this in turn favours the increase of swimming speed at the anaerobic threshold level, of absolute speed and resistance to speed.

Figure 2: "Fartlek" to develop speed endurace in swimming

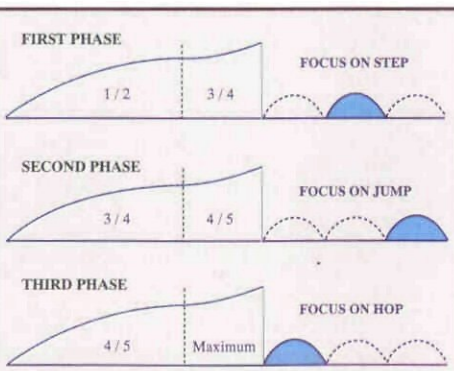
In acyclic events requiring speed/strength, the method used to develop increased speed is determined by the motor structure of the discipline itself. For example, in discus throwing, optimal speed is always used for the beginning of the rotation and then, during the subsequent phases up to the release, it is progressively increased up to its maximum possible value. The rhythmic structure of the whole movement and the final force applied to the implement is controlled.

Rotation velocity must be increased from one training unit to the next, as well as the explosive force applied in the final phase. Technique and the distance of each throw must be carefully monitored.

A variation of this is for the athlete to begin with a number of throws performed at less than maximum effort and then to continue with throws of progressively increased speed of rotation up to maximum level. The distance of the throws gradually increases but a decrease in the velocity of rotation occurs as soon as technique is disturbed. The training session should comprise a number of series of 6-8 throws each. The thrower should try to increase rotation velocity (including release velocity) from one training unit to the next and try also to achieve an increasingly higher number of technically valid throws.

In the case of triple jumpers, the following method is used (*Figure 3*): as speed gradually increases (during the acceleration phase) the accent is first placed on the step, then on the jump and lastly on the hop. With high jumpers, the crossbar is progressively raised as high as possible. The exercise can be repeated 2-3 times in the course of one training session.

4) **Progressively longer distances performed at the aimed at racing speed.** This method consists in first attempting to perform the competition specific distance at a speed that will produce the programmed result. The exercise distance is that attained up to the point at which speed decreases and the aim of the exercise is gradually to increase this distance. For instance, during the



During gradual speed increasing (in the acceleration phase), focus is first on step, then on jump and lastly on hop.

RUN - UP		JUMP		
14 - 16 running steps	6 running steps	Hop	Step	Jump
Level of commitment		Localize focus		
During acceleration	Before touch-down			

Figure 3: Scheme of speed perfecting process in triple jump with complete run-up

above mentioned research, carried out with the assistance of a luminous indicator, the swimmers began by swimming 50m intervals at the aimed at speed and then the distance was gradually increased to 200m for breaststroke and 400m for crawl. The swimmers were already attempting the full competition distance by the 15-16th training session. Between the 50th and the 55th session they managed to cover the distance at the speed shown on the luminous indicator.

In cycling (50km time trial), the competition distance was divided into 10x5km intervals. On the basis of the final aim, a performance time was set for each interval. The distance covered was gradually increased so as to achieve the programmed result. If the athlete is able to achieve the desired result over a significant portion of the distance (*Figure 4*), only the remaining distance need be divided into intervals. This method favours an increase in the level of functional and psychological preparation and is used with high level athletes at the end of the preparatory phase and during the competition period.

Interval sprinting may be used as a variation of the above method. It is performed using submaximal speed over fractions of the competition specific distance, with an adequate rest pause between each fraction. The distance of the first fraction is gradually increased up to total competition distance, while the duration of the rest pause is decreased. For example, a 200 metres sprinter will begin with 5x50m fractions; the duration of the rest pause is voluntary at first and is then reduced to 2 minutes. The distance of the first fraction is then increased as follows: 100m + (3x50m) and 150m + (2x50m). As the length of the first fraction increases, speed becomes slightly lower, closer to the aimed at competition speed. At first the length of the rest pause is dictated by the athlete's condition and it is subsequently reduced. For middle distance runners (800 metres) the combinations used are the following: 5x200m; 400m + (3x200m), 600m + (2x200m).

2 Methods for a further increase of the achieved speed

The methods used to intensify the organism's work regimen by means of a competition specific exercise performed at submaximal speed are the following:

1) Performing the competition specific exercise under facilitated conditions.
2) Exercise variation.
3) Modelling competition specific conditions during training.
4) Control method.

1) **Performing the competition specific exercise in facilitated conditions** signifies the artificial elimination of a percentage of the external resistance to the movement. Thus conditions will be created which will produce an intense impulse current from the motor cortex of the brain to the peripheral motor apparatus, so as to increase movement velocity and rate. This method favours the adaptive changes of the central and peripheral regulators of movement velocity, activates the potential of the other physiological systems and induces the development of a new functional structure, allowing a higher

NUMBER OF SEGMENTS	LENGTH OF SEGMENTS	RESULTS
1	5 km	7'12"
2	10 km	14'24"
3	15 km	21'36"
4	20 km	28'48"
5	25 km	36'00"
6	30 km	43'12"
7	35 km	50'24"
8	40 km	57'36"
9	45 km	1h 04'48"
10	50 km	1h 12'00"

The competition distance has been subdivided into 10 segments of 5km each. The time needed to cover each segment has been derived from the planned result. The aim of training is to increase the distance covered at the prescribed speed. The length of the distance is determined by the point at which speed decreases.

Figure 4: Training programme for road cyclists (Individual contest over 50km)

velocity work regimen. Furthermore, this method allows the athlete to feel the sensations of moving at greater speed and so acquire the corresponding sensory-motor image.

It should be noted, however, that this method may produce a reduction of stride length, which must be avoided. Therefore it should be used in combination with the competition specific exercises performed in normal, or more difficult, conditions.

In practice, the facilitation of performance conditions may be obtained either by using simple, natural methods or by means of a specific apparatus. Among the simple methods, we can mention downhill running, throwing a lighter implement, long jumps from an inclined board, using a lower gear in downhill cycling, wrestling matches with partners who belong to a lower weight category or are less skilled, using smaller-surfaced paddles in canoeing. In the latter, for example, it has been established that with the use of smaller-surfaced paddles (reduction of 25, 50 and 75%) the strength index decreases but so does the time index of the work phase of each movement cycle and so the rhythm improves and the movement rate increases. When compared to the movement with a normal paddle, blood flow to the upper limbs increases and that to the lower limbs decreases. This points to a greater work load on the shoulder girdle and to the possibility of inducing an adaptive reaction of the cardiovascular system in response to a higher work rate.

2) **Exercise variation** aims at creating contrasting muscular sensations, produced by performing competition specific exercise under different conditions (easier, normal, more difficult). This diminishes the sensory system's level of adaptation to the stimuli that would otherwise follow one another monotonously. The result is an intensification of the impulse current from the motor cortex of the brain to the muscle motor neurons and this, in turn, favours an increase of the functional velocity of the muscles. Furthermore, the athlete may acquire the sensory-motor image corresponding to this ease of performance. He will later try to reproduce similar sensations in normal conditions, thus increasing control capacities.

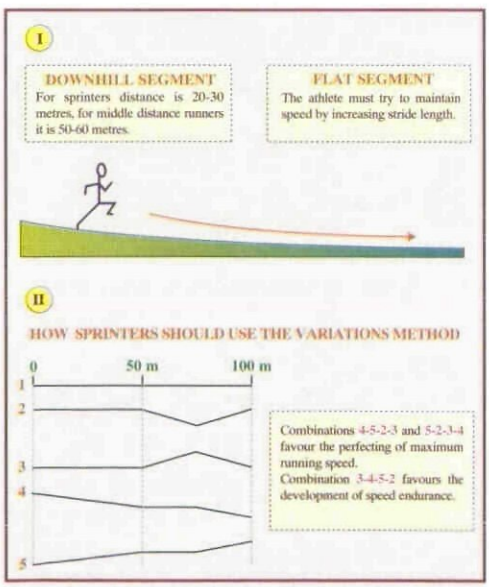


Figure 5: Some examples of the variations method in training speed

There are quite a number of ways to change the conditions. In the case of sprinters, for example, it is advisable to use not too steep downhill runs (30-40m), followed by a level stretch over which the athlete should maintain the same speed by increasing stride length (*Figure 5.1*). This method is very efficient also for middle distance runners, but the downhill run should be short (50-60m) and the level run longer. Experiments have shown that this method is particularly effective for sprinters (cf. *Figure 5.1*). The training effect is achieved by varying the combination of runs: the combination 4-5-2-3 and the combination 5-2-3-4 favour maximum speed, while the combination 3-4-5-2 favours speed endurance (*Figure 5.2*).

A number of methods have been perfected to improve swimming speed. For example, swimming against the resistance of an elastic rope, stretching it as far as possible (10-15 arm strokes) and then swimming a short distance (10-15m) at high speed. This combination is repeated 6 to 10 times. Another, very efficient method is swimming short distances (15-20m) at high speed, alternating the use of an elastic rope and of a towing system (speed 110-120%).

Experiments in canoeing, in which exercises at high speed were combined with exercises using a hydrodynamic brake, produced an increase in speed of 9.0% over a distance of 100m. In the control group, which exercised under normal conditions (without the hydrodynamic brake), the increase in speed was 5%. In cycling it is advisable to use different gears. During a 2 year experiment, the combination of 100 metres high speed exercises, performed under normal and more difficult conditions, produced an increase in speed equal to 6.8% over 100 metres and 6.5% over 200 metres. For the control group the increase was equal to 4.3% and 3.8% respectively. An increase in speed has been observed in soccer players and in women 400 metres runners who used the combination of uphill runs, level runs, downhill runs.

As regards events requiring speed strength, this method is widely used by throwers, who alternatively employ lighter and heavier than normal implements. Lighter implements favour an increase in movement velocity, and the sensory-motor image is transferred to the same exercise performed under normal conditions. Heavier implements favour an increase in the strength effort applied to the standard implement. In order to increase the velocity of the implement it is advisable to vary the work frequently. In the case of shot putters for instance, a standard shot is alternated with a lighter one.

3) Modelling competition specific conditions during training. This method is used in particular phases of the annual training cycle; it aims at intensifying the organism's high velocity work regimen, by coming as close as possible to competition specific conditions. The essence of this method is to perform the whole exercise at high intensity (as high as the athlete's condition allows), taking into account also the rules of the event. The effect is similar to that of a real competition and is efficient in terms of speed training. For example, *Figure 6* shows the results of an experiment with three groups of cyclists (1km standing start sprint) carried out during the period from May to August. The group who used the modelling method (1) achieved a greater improvement in performance (2.5sec), showed less changes in the cardiorespiratory system with competition type loads, and the highest level of functional parameters with submaximal loads. The groups using traditional methods (2 and 3) achieved a smaller improvement in performance (2.1sec and 0.3sec respectively). Group 3, who used a lower training load, showed a reduction of the functional parameters.

Experiments have shown that it is appropriate to increase the work volume in competition specific conditions. For instance, it is advisable to perform long jumps, triple jumps, pole vaults and hurdle runs at high speed and over the complete competition distance.

4) The control method combines an intense, specific speed training effect with the evaluation of the athlete's degree of preparation for this work regimen. It implies the performance of the complete exercise, a simplified variation, or an exercise that is similar in terms of motor structure and energy requirements. The characteristic features of the movement must be maintained and the exercise should be performed under normal conditions. This allows an objective evaluation of the progress of an athlete's speed capacities and of the body's functional reactions. As opposed to normal tests, where only the result is taken into account, this control method monitors also the main functional parameters.

We may use as an example the control model for a 500 metres exercise in canoeing. During the performance the speed index and the movement time of the system athlete-canoe were continually recorded (*Figure 7*). The athletes were asked to perform this control exercise during training and try to maintain as long as possible the pre-

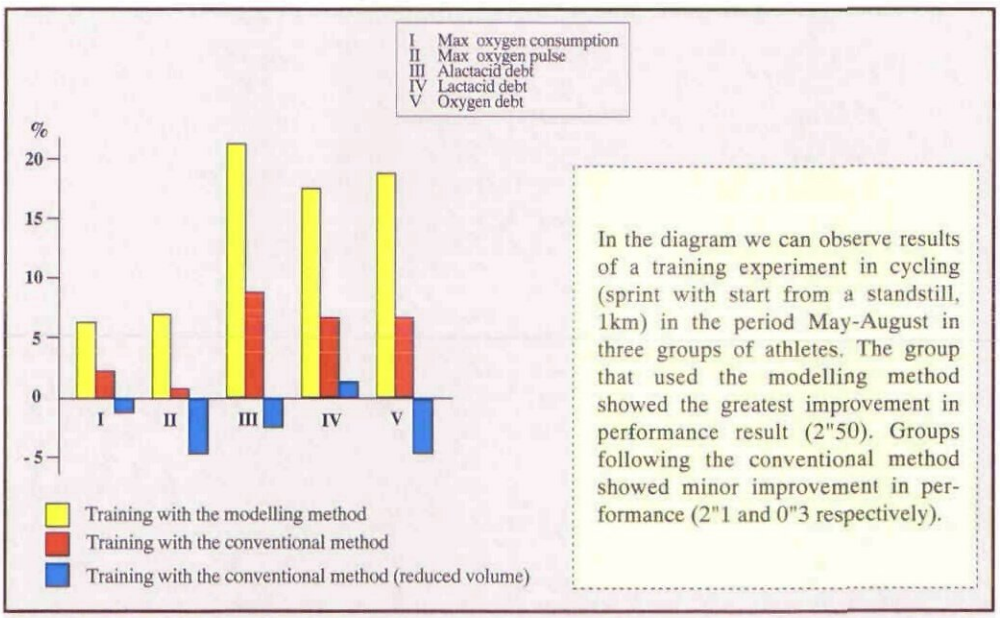


Figure 6: How to reproduce the competition model in training
Dynamics of parameters in 3 groups of cyclists

scribed speed. This was primarily a means of developing the athlete's specific speed and speed endurance, but it also highlighted his weaker points – deviations from the prescribed model parameters – and thus it was possible to make the necessary corrections in the training process.

In the past, the prevailing opinion was against performing full effort trials of the specialised event during training. It was thought that this would entail the expenditure of nervous energy, a deterioration in technique, and excessive fatigue. Thus, for speed strength disciplines, it was recommended that the distances used should be shorter or longer than the competition distance, and that they should be performed at a speed that was also higher or lower than the competition speed. It is now clear that no group of specific or subsidiary exercises can be as efficient in preparing an athlete for competition as the competition specific exercise itself.

It is important to emphasise that these modelling and control methods may be used only after the athlete's organism has been adequately prepared for this type of work and when there are no problems with technique. They can, therefore, be employed only in particular phases of the annual training cycle.

3 *Methods of intensifying the work for speed*

These method are:

1) Sensory stimulation.
2) Emotional stimulation.
3) Stimulation of the motor cortex of the brain.

1) **Sensory stimulation** signifies the use of visual, acoustic and mechanical signals that enable self-monitoring of the speed of execution.

It has been shown that, in sprinting, visual self-monitoring (indication of speed changes) produces a much higher initial acceleration (3.4%) than that achieved under normal conditions. In the case of young athletes, this training method favours a significant increase of maximum speed (10.6%), of stride rate (4%) and stride length (6.8%). The use of a luminous indicator is very effective in achieving these results.

2) **Emotional stimulation** intensifies a high velocity work programme by directing the athlete's preparation towards an improvement of his motor skills. A very efficient method is immediate feedback, which provides extremely effective motivation towards better performance. For example, swimmers who immediately received data concerning technique and arm-stroke rate showed a speed increase of 4.4%; twice that of athletes who did not have immediate access to this information.

The emotional component in high velocity work depends on the psychological motivation provided during the training process – the use of games, competitions, especially handicap competitions, relays, the modelling of competition specific conditions (Ozolin 1970; Kudinov 1983; Platonov/Valzechovsky 1985).

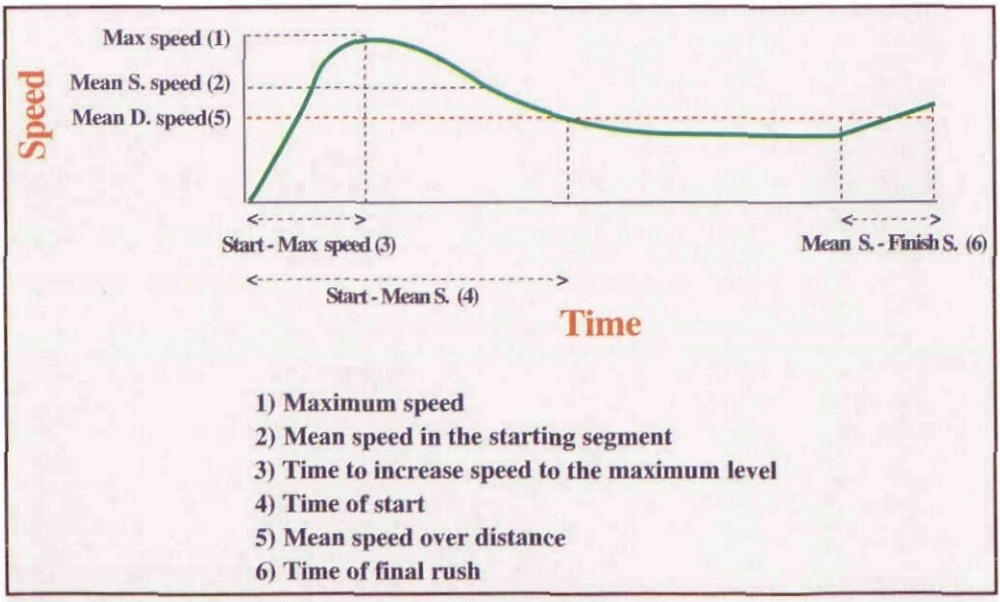


Figure 7: How to reproduce the competition model in training
Parameters of the control results for a 500 metres canoe exercise

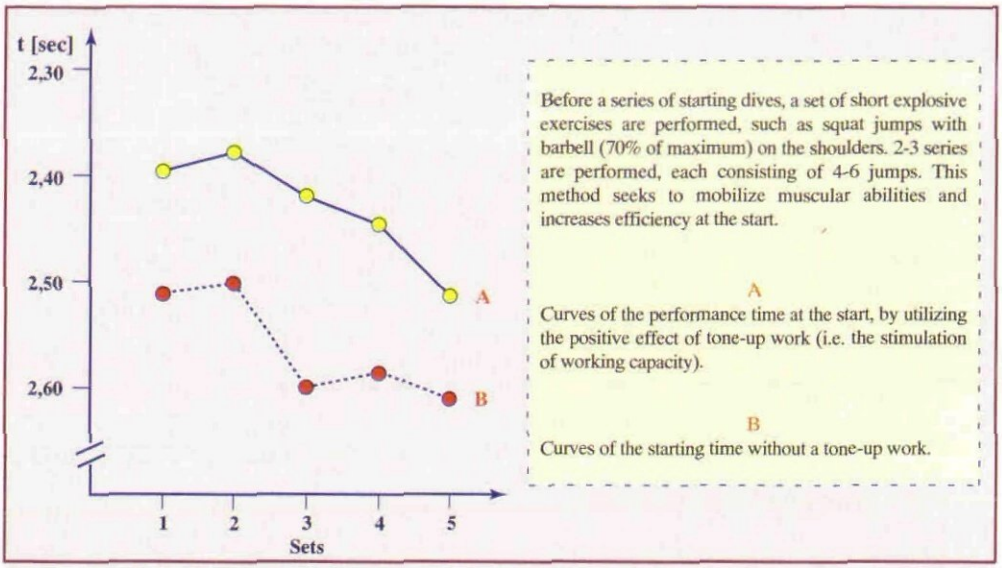


Figure 8: Method to stimulate the locomotor area of the central nervous system

For instance, in the pre-competition phase, it is recommended to use long accelerations trying to catch up with another athlete who is given an earlier start. This should be carried out during the maximum velocity section, with no alteration of movement technique.

3) **Stimulation of the motor cortex of the brain** is designed to take advantage of the positive effect of previously performed work (tone-up) on the subsequent special speed training. This method may be used within a single training session (immediate effect) or within a macrocycle. In the latter case the 'tone-up' work should be carried out one or two days before the high velocity work (delayed effect) is undertaken.

The following are 'tonification' exercises used for events requiring speed/strength: exercises with high overloads, depth jumps, isometric tensions, intensive jumping exercises. The work volume should be low and individually tailored. Throwers, for instance, should perform two sets of 2-3 squats with a barbell (90% of maximum load), followed by relaxation exercises and then a full effort throw.

Exploiting the positive effect of 'tone-up' work is also appropriate for cyclic disciplines. It has been observed, for instance, that sprinters increase acceleration and speed after intensive jumping exercises. Performing a number of short, explosive strength exercises for the leg muscles, before the training series (5 starts in swimming) considerably improved the efficiency of the start (*Figure 8*).

It has been established that 3 sets of bounds over 100 metres, with rest intervals of 1.5-2 minutes, improved the speed of middle distance runners in the main portion of the training session, both in terms of achieving higher speed over short repetitions and of maintaining a relatively high speed over longer repetitions. Exploiting the effect of 'tone-up' work (swimming with an elastic rope, swimming with a towing system and with large flippers) increased speed over short distances by 4.7%.

Taking advantage of the positive effect of 'tone-up' work to increase speed with a limited

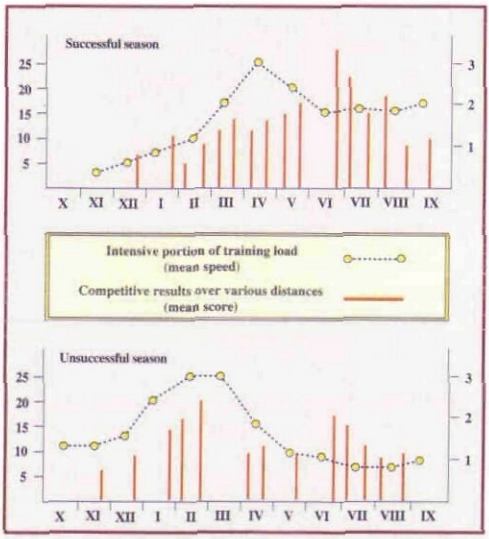


Figure 9: Comparison of curves of training load and competitive results of a middle distance runner in 2 consecutive seasons

work volume offers interesting possibilities for improving the efficiency of speed training.

4 Conclusions

It must be emphasised that high velocity work can be efficient only if the athlete is adequately prepared for this type of work. In other words, high velocity work must not induce debilitating reactions (physical exhaustion due to excessive effort) or produce a deterioration of the rational structure of the movement (*Figure 9*).

Therefore, intensive high velocity work can be begun only when the motor apparatus, the central movement regulators, movement co-ordination and the energy supply mechanisms have been sufficiently developed by means of special physical conditioning training.

Many coaches, in particular sprint coaches, make the mistake of using maximum speed efforts during the preparatory phase, when the athlete's functional preparation is not yet sufficient. In this phase of the training process, speed should always be at an optimal level. Moreover,

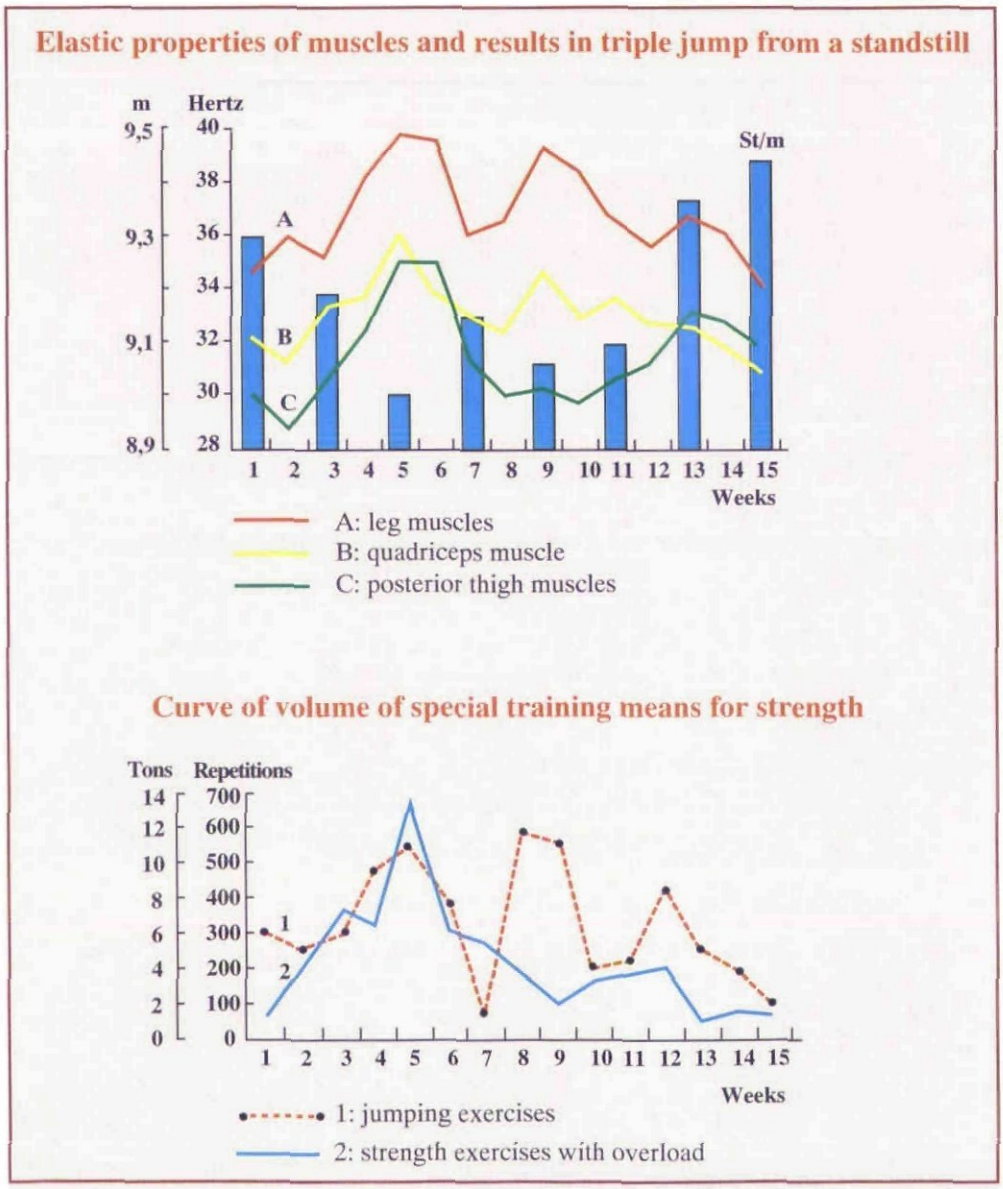


Figure 10: Relationship between volume curves of special training means for strength and sprinting performance

the use of excessive speed activities is not consistent with the special physical conditioning training carried out in that period. Therefore, neither objective will be fully achieved; sometimes the fulfilment of one will hinder the achievement of the other, especially in the pre-competition phase, where the accent is on speed training. Indeed, my collaborators have found that jumping exercises with overloads performed by sprinters during the preparation period, even when the work volume is optimal, induce an increased muscle rigidity, a reduction of the muscle relaxation capacity and a decrease of speed.

Figure 10 shows the correlation between muscle rigidity and the work volumes of special strength training, jumping exercises and control test triple jumps from a standing start, performed

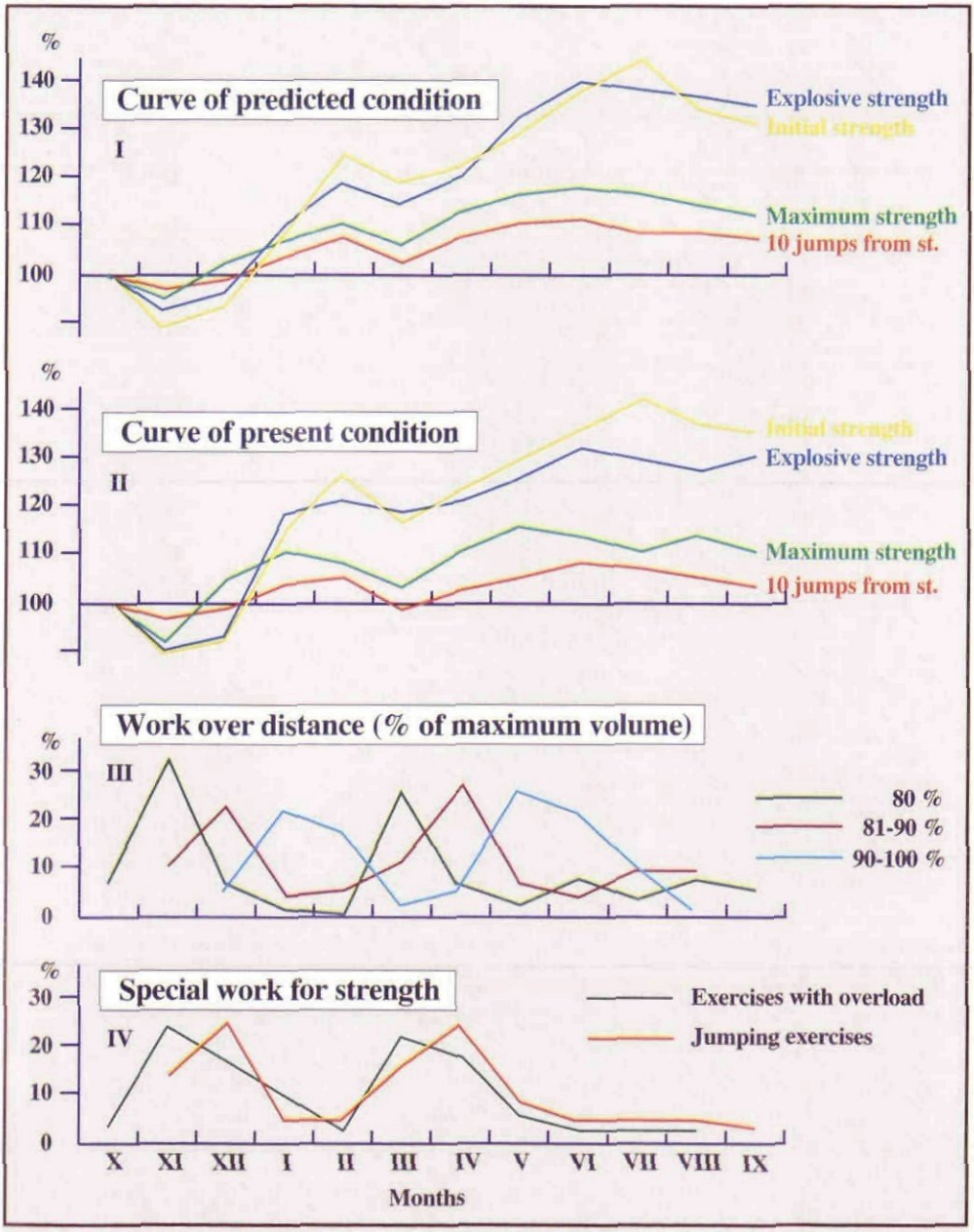


Figure 11: Curves of workload volume and control parameters during the annual cycle (High level sprinters)

by top class sprinters in the spring-summer training period. It can be easily observed that an increased load of special physical conditioning training (4-6 and 8-9 weeks) causes increased muscle rigidity and a decrease in strength. Therefore, conditions are not conducive to the improvement of running speed, just when this becomes the principal training goal. It has also been established that a too high training load (even when it is specific) causes a reduction of the speed of muscle relaxation, which, in turn, may result in injury.

Therefore, when the main training goal is intensive preparation for high velocity work, all the other loads should be brought down to minimum level. This type of work can be performed not more than twice a week. The rest of the week should be dedicated to recovery and preparation in view of the following high speed session.

Figure 11 gives a practical example of this training strategy for top class sprinters. The graphic representation (*Figure 11.1*) shows a predicted model of the functional state of the sprinters, made on the basis of observations during training and the analysis of the previous cycles.

Figures 11.3 and 11.4 represent the content and the distribution of the essential loads designed to achieve the predicted functional state.

Figure 11.2 show the functional state of the sprinters after special loads. During the basic stage it is a mistake to use very high speed running.

The coach should not be afraid to use high speed work in the pre-competition phase, when the athlete is already prepared for this type of work and when one can expect adequate recovery capacities of the organism and of the motor apparatus. Sprint specialists already understand that there are no limits to speed set by a dynamic stereotype. If performance tends to level-off, it may mean that the athlete has exhausted his speed capacity for that period or that the special conditioning training is not consistent with the speed exercises. One should not forget that speed training favours an athlete's functional condition. Therefore, in the annual training cycle, the optimal distribution of concentrated volumes of special physical conditioning training and phases primarily centred on speed training (including speed endurance) should take into account the main events of the competition calendar.