

THEORETICAL ASPECTS OF TRAINING CONTROL FOR HIGHLY QUALIFIED THROWERS

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The continuous improvement of athletic performances, which is a logical consequence of the widening and deepening of the knowledge of sports training, has contributed to the development of the theory of sport as a relatively independent discipline in the framework of the general theory of physical culture.

The main problems which must be addressed in modern top-level sport concern:

- Competition and training,
- The cybernetic and “technological” aspects of the optimal realization of top level goals (principles of prognosis and modeling, talent selection, perspective training planning, complex control, etc.)
- Non-competitive and non-training components of sport preparation (L.P. Matveev, 1984).

Most scientific investigations in the area of sport theory cannot fulfill the requirements of sport practice since they are extremely specific. The dialectic relationship between theory and practice makes the necessity of the development of a universally applicable system of scientific knowledge of sport perfection necessary.

One of the central problems of sport science is sports training, which in a general sense can be defined as the control of the changes of the athlete's physiological and psychological state caused by the effects of training and competition loads as well as methods of recovery.

Sports perfection can be defined as the development of the athlete's organism to a higher level through physical exercises.

In recent years, specialists have always tried to clarify the physiological mechanisms of the development of sports performance using sports training. Special attention has been given to the problem of adaptation to physical loads.

With regard to the fact that sports training is a controlled process, some principles of the theory of control mechanisms (cybernetics) have also been taken into consideration. The study of the regularities underlying sports perfection is therefore based on a triad consisting of:

- sports pedagogy,
- physiology,
- cybernetics.

This way of looking at things has determined our approach to the development of a training concept for highly qualified javelin throwers. We started out from the assumption that the training process can only be improved if the coach has a perfect knowledge of the athlete's reactions to the dynamic conditions of sports activity. Furthermore, the coach should know the athlete's potential for perfection. Physiological control methods must have a firm place in the framework of training.

The most acceptable quantitative methods of examining the whole organism in the course of athletic training are taken from cybernetics.

The methods for controlling the training process proposed by us serve the solution of the following tasks:

1. Determination of the sufficient number of performance parameters or characteristics of sports activity which determine or limit the achievement of optimal results.
2. Determination of the possible meaning of these variables in their original state and the influences they have on one another.
3. Determination of the regularities of the changes in the athlete's organism brought about by training and recovery.
4. Determination of the training goal and the athlete's target condition, i.e. prognosis of the athletic result and development of corresponding norms of performance ability.
5. Modeling of the process of perfection leading to the performance goal and target condition of the athlete.
6. Programming of training and recovery parameters, i.e. development of a training plan.
7. Control of the process of perfection and correction of parameters.

The complex and many-sided process of athletic preparation in the throwing events requires the development of prerequisites for the realization of special movements which, finally, lead to the athlete's maximal performance. These special movements are the central element in the system of preparation, and all the athlete's activities in the course of the training process must be directed to a permanent increase in the effectiveness of movement execution. In other words, the systematic acquisition and perfection of specific movements are decisive factors of the athlete's target-oriented preparation. Various manifestations of the athlete's performance ability guarantee the effective execution of special movement actions - in this case: throwing.

This has the following consequences:

- The direction of throwing training is determined by the specificity of this form of activity.
- The level of athletic achievement depends on the athlete's training state.

Top level athletic performances can only be achieved if the systems and functions of the athlete's organism are adequately developed. This adequate development of the organism characterizes the athlete's total performance ability as far as quantity and quality are concerned. The athlete's total performance ability can be divided into his:

- Physical;
- Technical;
- Tactical;
- Psycho-physiological, and;
- Intellectual performance ability.

These partial abilities are universal as they are characteristic of the structure of performance ability in various sports and determine the athlete's performance potential. For the clarification of the concrete significance of indispensable components of performance ability, factors which are connected with the morpho-functional development of the organism as well as with the athlete's psycho-physiological condition must first of all be considered. It is particularly important that the specificity of the adaptation reactions is the decisive limiting factor of athletic ability.

Research has shown that speed, strength and coordination are the most important factors of the specific performance ability of throwers and that the level of general physical performance ability no longer limits the achievement of top level athletic results. Instead, the decisive factor is the athlete's ability to use a

rational throwing technique as well as a high level of technical and coordinative ability.

On the basis of the examination of the dynamics of the state of the organism and the characteristics which guarantee the athlete's concrete performance ability, a control model was developed taking into account the effects resulting from the process of sport preparation. The concrete quantitative contents of this model are the characteristics of the special physical performance ability, i.e. speed strength in the framework of the basic movement skills (this expresses itself in the execution of a special throwing exercise with the competition implement, with ancillary implements or in special test exercises). The characteristics of the technical performance ability are the quality of the throwing technique and the abilities that are necessary for executing this technique reliably and consistently. So, in this case, we are dealing with a special movement programme and the coordinative abilities required for its execution under different conditions. With regard to coordinative performance ability, the ability of the execution of the spatial, temporal and strength components as well as the athlete's ability to keep his balance are assessed. The athlete's psychological readiness manifests itself in the characteristics of his psychological activity, the control of his emotional state, as well as in the index of his psychomotor regulation and some other factors of his psycho-physiological state.

When developing the system of the characteristics of the athlete's optimal performance ability, we attached particular importance to the analysis of the mutually determining effects of individual manifestations of performance ability.

It is absolutely natural that - on the basis of the current level of scientific development - the determination of the structure of performance ability and the finding of essential requirements for the achievement of record performances are relatively difficult. It is therefore useful to look at the logical fact that the goal of training is the achievement of a maximal throwing distance.

The prerequisites for the achievement of this goal are particularly:

- The existence of an optimal throwing technique, and;
- The ability of realizing this technique with a maximal exploitation of one's individual physical capacities.

I.P. Pavlov distributed human movement into:

- Voluntary movements (main motor reflexes), and
- Involuntary movements.

A different movement classification would be that into target-directed and natural movement reflexes.

Movement control is aimed at the solution of a movement task and the reaching of a goal. As far as the throwing events are concerned, the movement task consists of the acquisition of elementary prerequisites that determine the maximal throwing performance while keeping to the competition rules. The movement goal is a system of variables (in particular of the kinetic and dynamic movement characteristics which develop according to certain laws) that is reached using control forces.

The laws underlying the change of variables (sequence of the elements in the total system, organization of motor sequences, qualitative and quantitative basics of the realization of movement actions using the combined action of control forces) are reflected in the “motor image” or in the motor programme.

A consequence of this is that, in such a complex activity as throwing, certain basic training tasks must be determined:

1. Improvement of the programme of movement actions.
2. Improvement of the coordinative abilities for the execution of movement programmes.
3. Increase in the speed strength potential with regard to the specific movement activity ‘throwing’.

If the athlete has at his disposal a corresponding level of general readiness, the successful solution of these tasks guarantees the achievement of the planned athletic result. It should be noted that it is not correct to treat the athlete’s motor performance ability and technical skills as equal. On the basis of the extremely complex structure of learning and perfection, the following terms must be differentiated with regard to athletic exercise: actual throwing technique, general technical skills and coordinative ability. Furthermore, the coordinative ability can be divided into general and special coordinative ability.

Technical skill is identical with special coordinative ability.

Currently, sport science devotes great attention to the problem of the perfection of athletic skills. V.M. DJACKOV (1972) defines technical ability as: “Perfect mastering of the most suitable structures of athletic exercises.” Thus it becomes obvious that the movement structure of sport exercises (which is identical with sport technique) and technical skills (i.e. the ability to master technique completely) are independent categories. This separation between technique and technical skills is extremely important because it provides a clearer definition of the tasks of athletic perfection as well as of the tasks of the scientific examination of this problem.

For the setting of the training goal and the programming of the perfection process the determination of the initial state or level of the throwers performance ability is of decisive significance. Since we are dealing with the system of preparation of throwers for record performances, we must take into consideration the characteristics of the performance ability of current top level throwers for the characterization of the initial state.

The next step in the framework of the development of the preparation system is the definition of the training goal and the target state of the system that is required for the achievement of the performance goal.

The operative solution of the given task consists of:

- Performance prognosis;
- The development of necessary norms of performance ability, and;
- The modeling of the preparation processes for the achievement of the athlete's target condition.

The development of adequate models of these processes - in particular the training process - which correspond with the current demands and theoretical principles and are suited to the concrete conditions of preparation make the planning and programming of training, competition and regeneration possible.

In the theory of sport pedagogy various models are presented that can be divided into two main groups: The first group consists of models which characterize the structure of competitive activity and represent the main areas of performance ability as well as morpho-functional systems of the athlete's organism. The second group of models concerns the actual process of preparation: training programmes in various phases of preparation - from four-year plans to one training unit or even training exercises (training means and methods, dosage, etc.). The modeling, however, is only justified if, first of all, the essential system variables, their initial level and the laws underlying their interrelationships are determined. Furthermore, the following aspects must be considered:

1. The quantitative determination of the level of variables determining or limiting the reaching of the planned performance, and;
2. The modeling of the perfection process and the athletic (particularly: competitive) activity, i.e. the modeling of the function of the system or the development level planned with the goal to identify the possible result and to make a decision as far as the organization of the preparation process is concerned.

A generally valid model is understood as a simplified schema of any phenomenon or object, which can be represented in a reduced or enlarged form.

Modeling, however, is an examination using models of those processes that cannot be examined under natural conditions.

With regard to the regularities of the function of a controlled biological system, the term “control objective” is used in the bio-cybernetic literature for the description of a control result as far as content is concerned. In this context, objective is understood as the structural or functional target state of the system.

Therefore, even when using the terms “model”, “model characteristics” etc. in their traditional meaning, it must be taken into account that one is dealing with different hierarchical goals of the athlete’s organic systems, which develop during the process of athletic perfection. In this context it is more correct to speak of them as norms or normative demands whose fulfillment is demonstrated by the execution of the athletic performance planned. Such a useful method as modeling must be applied purposefully for the examination of the functioning of organic systems of different levels.

It has already been mentioned that, when developing the system of control of athletic perfection, three levels are differentiated:

1. Competitive activity,
2. Qualitative performance ability, and
3. Morpho-functional development.

The differentiation of the model levels of top class athletes as far as meaning and content are concerned must be done on the basis of a division into:

- The competitive activity as a reflection of the outer state of the general characteristics of the special physical, technical and tactical performance ability (pedagogical aspect);
- Characteristics of the functional and psychological performance ability and the morphological peculiarities as a reflection of the inner state (medical-biological aspect).

In our opinion, the characteristics last-mentioned are the essential ones.

In the following, aspects of the programming of the preparation process in the yearly training cycle are dealt with.

The programming of the preparation is mostly regarded as a necessary didactical system that allows the planning and standardization of the activity of both coach and athlete. Fundamentally the programming of the training process is based on the laws that are characteristic of the perfection of athletic ability, i.e. long-term adaptive changes of the organism caused by the effects of training load and

means of regeneration. In this context, concrete goals must be set and training programs must be developed that guarantee the realization of these goals. Furthermore, training loads must be controlled taking into account their qualitative effects on the athlete's organism.

Programming can be defined as the distribution of means and methods of training over the yearly training cycle depending on the tasks for ensuring the performance dynamics planned. Consequently, when programming the preparation in the yearly training cycle, the first step is the development of the dynamics of athletic performance.

The athletic performance planned must be realistic, it must be maximally high, and it must be achieved at the most important competition of the season. It is dependent on the level of the athlete's initial state and training effectiveness.

In the following, the most important theoretical prerequisites that should be taken into account when planning athletic training are discussed.

When examining the dynamics of the increase in performance in the several years training plan, generally the following conclusions can be drawn: In the initial phase of preparation, during the period of non-specialized training, the increase in performance ability does not yet, of course, result in an increase in sport performance. In the further process, the increase in performance is most often characterized by permanently positive dynamics which is a consequence of many-sided training. Later, when the level of high athletic ability has been reached, the increase in performance slows down. Often, even a standstill takes place, and the only task of training is to maintain the performance level already achieved.

The basics of the perfection of the morpho-functional organic systems is the bringing about of adaptive changes, whose non-existence is obviously the cause of athletic performance stagnation. The stagnation or even reduction of long-term adaptation processes is possible because of:

1. The reduction of the effectiveness of training stimuli (stabilization of the functional load)
2. The exhaustion of the organism's adaptive reserves, i.e. the reduction of the volume of the functional activity that stimulates adaptive processes.

While in the first case this problem can be solved by the change of the character of exercise and a load increase, the second case is much more complex. The whole several 12 years training process must be planned under consideration of the economization of those functions that are influenced by training. The objective of this process is that during the period of top level achievements the

increase in performance ability and athletic performance can be guaranteed on the basis of the adaptation reserve of the systems not actively trained.

The individual peculiarities of athletes and in particular the characteristic effects of physical loads as well as the developmental dynamics of the adaptive changes determine the cycles of the preparation in the sports season.

In any case the planned dynamics of sports performances is the determining factor of training programming. For guaranteeing positive performance dynamics in throwing, a sufficient level of physical development must be achieved. The general and special speed-strength characteristics, general and special coordination and special endurance are especially important.

The second main task is technical perfection, the perfection of the abilities for realizing the physical speed-strength possibilities with regard to the specific movement using coordinative or motor abilities that are particularly important.

When programming training, the following principles must be taken into account:

1. In the course of the years, the level of performance abilities undergoes significant changes.
2. The dynamics of the changes of the performance ability or training state is particularly dependent on the peculiarities of athletic training.
3. Sports training is the main instrument of the control of the athlete's level of performance ability. The main components of training are training forms and methods.
4. The improvement of the training state caused by the application of physical exercises is based on the regularities of adaptive changes in the athlete's organism.
5. The system of sports training is continually improved.
6. The increase in training effects is mainly done on the basis of training intensification (execution of exercises with maximum intensity).
7. The share of special training is increased, whereas the general physical preparation is reduced (this is particularly typical of top level athletes).
8. The whole volume of traditional training loads is actually not decisive for training success and sports performance.

The whole training process of top level throwers shows that the general readiness of athletes is determined by their technical and coordinative ability. The most important demand made on the training process is the increase in

training effectiveness through the improvement of training and competition influences, the optimization of the phase structure of the yearly cycle and the target-oriented use of regenerative measures.

The training of throwers basically consists of two groups of exercises:

- Special exercises (mainly throwing and imitation exercises);
- General physical exercises.

Furthermore, the training exercises are divided into competition-like throws, throws with training implements and non-specific ways of throwing. The general physical exercises consist of:

- Barbell exercises;
- Exercises with weights;
- Play, acrobatic and gymnastic exercises;
- Jumps and jumping exercises, and;
- Running and running exercises.

As far as quantity is concerned, the training exercises are distributed as follows:

- Specific and non-specific throws: 40%,
- Barbell and weight exercises: 43 %,
- Play exercises, running and running exercises, jumps and jumping exercises:
17 %.

In the preparation system of throwers, the training loads and their rational structure are extremely important for the achievement of high athletic performances. The maximal increase in parameters is characteristic of load dynamics since only such exercises cause intensive and permanent adaptive changes that come close to the functional limits of the possibilities of the athlete's organism.

The distribution of training loads throughout the years of the Olympic cycle is a wave-like process. The increase in training volume in the Olympic year is conspicuous. The number of training units and the volume of strength training have been significantly increased in the two last Olympic cycles. However, in the different throwing events, the volume of special throwing training has not much changed (stabilization of training quantity in some events and increase in quantity

in other events, e.g. hammer throw). In spite of this, it is obvious that the average volume of throwing training has decreased. In order to find out the basics of the organization of the training process of top level throwers (distribution of training loads of different type over the yearly cycle, determination of their optimal dosage with regard to micro-and macrocycles, their combined action and interaction, etc.) special investigations which were mainly based on the determination of the mutual effects of different components of preparation and performance ability were carried out. It has become obvious that the increase in performance during the last years has mainly been caused by the increase in special speed strength ability. The quantity of the general training loads in the yearly cycle, on the other hand, does not correlate with performance.

The main tendency of the preparation of top level throwers is the increase in training effects through intensification and specialization. A reason for this is that, in the case of top level athletes, the adaptation reactions are very specific and the adaptation effects are very small or do not occur at all. A consequence of this is that the improvement of the athletes training state is very difficult. It is therefore necessary to train particularly those systems that cause specific changes of the athletes training state.

When developing a great number of methods for the control and analysis of performances produced, the following levels have turned out to be obligatory objects of complex control:

- The level of the realization of the physical and technical performance ability (pedagogical test batteries, methods of evaluating technical skills);
- The functional level of adaptation (medical and physiological control of the cardiovascular system, etc.);
- The activation and information level of adaptation (psychological control of motivation structure; level of emotional excitement, etc.).

The control of training effects and competition activity is one part of the system of complex control, that takes into account the special characteristics of the respective throwing event and the specific tasks of each preparation phase.

This has led to an improvement of the system of training control, and performance prognosis while the scientific establishment and individualization of the methods of recovery in the training process have been made possible. Although the system of complex control takes into consideration all levels of adaptation mentioned, it has been adapted to the peculiarities of the sports event and the individual training methods and means.

The perfection of the structure of sports training is not possible without the exact control of the energetic state of the organism. This control is based on phase-related biochemical examinations of the athlete.

The control method most frequently used is the evaluation of the utilization of energy sources, e.g. the acid base equilibrium of the blood.

The method for the determination of the acid base equilibrium makes possible a fast and informative assessment of the regeneration of the energy balance of the organism after physical loads.

The control of the cardio-vascular system is done using ECG analysis, blood pressure and pulse rate measurement. The functional state of the nerve-muscle apparatus is assessed on the basis of the changes of muscular properties and electrical activity.

For the assessment of the functional state of the muscles the seismo-myotomographic method is used. The data acquired characterize the mechanical muscle characteristics (tension parameters). Tests of muscle state should be done in all phases of preparation. This makes an early load correction and determination of regeneration methods possible. Furthermore, by doing these tests, injuries can be prevented.

When analyzing and controlling sports technique, the objects of investigation are spatial, temporal and strength characteristics of the specific movements. Technical skills are based on the complete mastering of the most rational movement structure or on a highly developed organization of movement skills.

The definition of the term “coordinative ability” (general and special) points to the necessity of finding a solution of the problem of the athlete’s perfection. The means and methods of the perfection of the general as well as the special coordinative ability must be determined. Accordingly, in the system of complex control, adequate means and methods for the diagnosis of the development level of these aspects of throwers’ performance ability must be included. When assessing the athlete’s level of development, the examination of the stato-kinetic stability is of great significance (maintenance of balance under different conditions, organization of the specific movement activity with regard to temporal, spatial and strength parameters).

From the variety of elements of the throwing technique:

- The speed rhythm relationship between the support and support-less phases of the throwing movement;
- The angular characteristics of the members of the body;

- The dynamic characteristics of the support reactions, and;
- The forces of interaction between athlete and throwing implement are best suited for control;

The movement structure of the exercises and technical skills of athletes were analyzed kinematically. For the determination of the dynamic movement structure tensometric methods were used.

The physical performance ability of throwers was examined using specific exercise tests.

The psychological component was examined mainly with regard to emotional excitement (electrical skin resistance) and emotional control (myokinetic psychodiagnostics). Emotions and motives were examined using a seven-point scale (self-assessment of the training state and attitude towards training). The method of subjective scaling makes the assessment of the athlete's motivation structure as well as his attitude towards training and its correspondence with the goal of the respective preparation phase possible. The assessment of the competition activity was done using special questionnaires (motives of competition activity etc.). The psycho-physiological state of the athletes was examined using various tests.

The result of these examinations and tests was the establishment of a system of complex control that is used in the framework of the scientific-methodical and medical care of throwers during training.