Programming and Organization of Training

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Abbreviations used in the Text

CAR: The current adaptation reserves of the organism. The organism's specific, limited capability to respond to external influences with adaptational reconstruction, in order to accommodate the training irritant.

F-max: The maximum force displayed in a specific movement.

GPP: General Physical Preparation. Conditioning exercises designed to enhance the athlete's general, non-specific work-capacity.

Is The index of explosive-strength. Usually assessed by vertical jump results.

LLTE: The long term lagging of the training-effect. A natural increase in results, following a decrease in the volume of loading in the pre-competition stage.

MOC: Maximum Oxygen Consumption. The athlete's maximum oxygen utilization during loading.

PASM: The process of attaining (literally, the formation, Ed.) of Sport Mastery. The educational-physiological process of the athlete's continued improvement in physical, technical, tactical and psychological mastery specific to the given sport.

Po: Index of absolute-strength. Usually assessed by the maximum force generated isometrically (on a dynamometer).

Q: The index of starting-strength. The ability of the organism to overcome the resting inertia of the body and/or a sport apparatus.

SPP: Special-Physical-Preparation. The training that is specific to the sport's requirements in competition. For instance, multiple standing long jumps develop the same qualities necessary for the execution of the running long jump.

TANE: The threshold of anaerobic exchange, that level of oxygen consumption at which the anaerobic processes are activated.

TE: The training-effect. The changes that occur within the athlete's body as a result of training.

Definitions

1. Complex-Training: The simultaneous (within one workout) work on several aspects of an athlete's preparation. For example, specific work on strength, speed and technique in the same session.
2. Conjugate-Sequence-System: An appropriate succession and strict sequence of inculcating loading of different primary emphasis, into training.
3. Cumulative-Training-Effect: The changes within the organism as a result of the summed affects of many training sessions.
4. Displacement: Disruptions of the organisn's homeostatic state as a result of training.
5. Dynamic Correspondance: The conformity between the dynamics of a sport exercise executed in training to the competition exercise executed in competition.
6. Hetero-Chronicity: The variableness of rates of improvement in a special quality (strength, endurance, etc.), of an organ or system.
7. Large-Stage of Training: A training period of 3-5 months duration.
8. Partial-Training-Effect: The changes produced by a single training means.
9. Training-Effect: See #12 in abbreviations.
10. Training Potential: The possible training-effect produced by a specific loading, exercise, etc.
11. Unidirectional-Training: Workouts planned to emphasize primarily one physical quality or aspect of an athlete's preparation (strength, technique, etc.).

Introduction

Programming is the regulation of the contents of training in accordance with the athlete's training objectives and the specific principles, determining the rational organization of training loads within a specific time frame. Programming is a new, better form of planning training, solving tasks at a higher scientific-methodical level and with a greater probability of achieving the goals.

The basis for programming training is acceptance of a solution, which is associated first of all with determining the general strategy of the athlete's preparation, and second, with selecting the optimal variant of training construction. The task is very complicated because of the great number of possible variables and combinations in the composition, volume, duration and organization of training loads with different primary emphasis. The practical acceptance of a solution in this situation is effected by sorting-out and assessing if not all, then many of the acceptable variants of training construction. They are fewer in number, the more experienced the coach, i.e., he has the experience to permit immediately rejecting one and thinking of another.

Consequently, the primary condition for correct selection of the optimal solution is the substantiation for preliminary assessment of the effectiveness of a particular variant. In the not-too-distant past planning was based on the personal experience of the coach; obtained by trial and error; based on his intuition and logical principles. Now we have more objective basises and premises. This circumstance makes it possible to switch to programming as a better form of planning and constructing training.

Selection of the solution to programming training is based, first of all, on the knowledge of the specific regularities inherent to the process of attaining sport mastery (PASM) and determining its systematic development over time. These regularities, as we shall show later, are revealed by the study of the peculiarities of the long-term adaptation of the organism to intense muscular work and the principal tendencies in the changes of its state; depending on the organization of the training loads of different primary emphasis, then volume and duration. The elucidation of the regularities of the PASM also contributes to the study of the peculiarities of the process of attaining sport-technical mastery and the morpho-functional specialization of the organism in the course of multi-year training.

Research in this area assures an essential enhancement of the objectivity of the preliminary assessment of the trainee's potential for the prescribed load; and consequently, the prognostical probability of the training effect it can secure. The research contributes to the construction of the most rational organization of training loads within concrete stages, providing both the optimal duration and rational interdependence of loads of different primary emphasis and their expeditious introduction into training. Finally, this research is the basis for re-understanding traditional principles of training construction.

Instead of the analytico-synthetic approach of examining training as a recruitment of separate microcycles, and its organization as a lining-up of microcycles of different emphasis in a sequential chain; consider switching to the programmed objective principle of organizing training. It is based on the formulation of concrete purposeful objectives for any stage of training and the construction of training programs and competitions to ensure their realization. Thus, the basic form of training construction is not the micro-cycle, as has always been considered, but the large training stage (3-5 months); apportioned in the yearly cycle, by taking into condsideration the competition calendar and the regularities of the athlete's adaptation to intense muscular work. This, in turn, alters the requirements for the organization of the micro-cycles; which instead of basic structural units, construction of training acquires a functional form for the regulation of those portions of the training loads to which they are allotted.

Furthermore, objective premises concerning the regulation of the contents of training are formed by taking into account the qualitative specifics of the affects of the means and methods involved. Here instead of manipulation of large, medium and small waves of the "gross" volume of the load, permitting only changes in sporting form; it is possible to direct the influence (of the training load) to the qualitative characteristics of the sportsman's state, by appropriate organization of the loads with different training effects.

Substantiation and development of the programmed-objective principle of constructing the training of highly-qualified athletes is the main theme of this book. However, before getting into it, it is necessary to dwell on some pecularities of scrutinizing it and to determine a number of limitations and the most general ideas.

Training is a multi-faceted, pedagogical process, having a specific form of organization, that transforms it into a complex system of influences on a person's personality and physical state. With respect to its contents, training provides active and systematically specialized motor activities directed at the total education of the athlete; including the acquisition of a wide range of special knowledge, habits and skills; enhancement of work-capacity; the mastering of technique and the art of competitive struggles. All of this is acquired gradually during the course of many-years training; along with a specific order to the resolution of stagic tasks and a sequentialness of the mastering of new heights of sport mastery.

Sport mastery is first and foremost, movement-skill. The sportsman's education is carried-out through specialized motor activities. Therefore, the growth of mastery is secured and at the same time, the limit physical possibilities of the organism, i.e., the ability to display the required level of force and to maintain the training necessary for the perfectioning of this ability. Consequently, pedagogical fundamentals and methodical principles of organizing training, along with the educational emphasis, ought to be considered the biological essence of the

PASM. This by no means is a call to a biological theory and method of sport training, but to underscore the specifics of sport pedagogics; which is an educational process conducted at a level of limit physical and psychological tension, and is a mysterious and by no means none other than a pedagogical process. And here, one cannot stand for amateurishness and tolerate mistakes, because the person's health is at stake.

Thus, sport activity is a very complex socio-biological phenomenon. It is in essence social, having concrete pedagogical contents and an educational emphasis; and in phenomenological expression, its form of existance and development has a biological basis. Therefore, the biological aspect should play an important role in the scientific search directed at solving the problem of rational construction and programming of training; while at the same time, it should be oriented and understood as an aspect of the pedagogical tasks, expressing the social essence of sport activities.

Hence it is obvious that the solution to the problem of programming training, in the broad sense, is only possible by combining the efforts of the specialists with the appropriate scientific profiles. However, this is only the nearest perspective. Therefore, in taking the first step of determining general theories and principles of programming training we are concerned only with those parts which chiefly concern the physical perfectioning of the sportsman and his skill to effectively realize his motor potentials in training and competition.

The concentration primarily on highly-qualified athletes is dictated by practical necessity. Experience has shown that the preparation of middle and high class athletes is significantly different. In the first case, the traditional principles of constructing training, which have taken form in the past ten years, fully ensuring the progress of mastery, are already not so effective for the second. And what is more, by not taking into account the modern specifics of training, high-class athletes often do the opposite activities they should, inhibiting the progress of mastery.

Therefore, the urgent necessity arises to reveal the specific peculiarities of preparing qualified athletes, reinterpretation and development of traditional principles; and to devise new methodical ways and appropriate forms of training them.

Finally, it is necessary to define the fundamental concepts of principal significance, such as programming, organization and management of training. In works concerning the management of complex systems' dynamics, these concepts are usually used synonomously. However, applicable to sport training, each has their own fully specific and concrete meaning.

Training is not an artificial creation of a material system or a phenomenon existing independently in nature; which can become objectively managed influences, in conformity with some criteria of effectiveness or expediency. It is necessary, first of all, to reconstruct the training ideally, creatively rethinking its course and based on the special objectives, determine its contents. Then, one should implement the practical realization of the program adopted; and finally control the course of its execution and make the necessary corrections.

So, programming is the preliminary determination of the strategy, contents and form of training; organization is the practical implementation of the program, taking into account the concrete conditions and real potentials of the athlete; and management is the control and regulation of the course of training according to the predetermined criteria of its effectiveness.

A number of problems of constructing training, examined in this book are discussed repeatedly in the literature and are resolved in accordance with today's theoretico-experimental knowledge, when these problems are placed before the specialists. Therefore, let's turn to those problems, which are not raised for novelty's sake.

Chapter 1

Theoretico-Methodical Attempts at Programming and Organization of Training

Programming and organization of training requires multi-faceted and in-depth knowledge of the essence of training; its contents and structure; the regularities determining its construction and changes in its emphasis with the growth of sport mastery. Such knowledge should, first, include the achievements of practical experience and the entire complex of scientific data dealing with the affects of training on the athlete's body and personality; and second, be systematized such that it secures the working-out and reasoning of those methodical principles and tenets which directly determine the practical resolution of the problem of programming and organization of training. This requires an objective assessment of the peculiarities of the modern stage of sport development and a determination of those knotty problems around which the accumulation of knowledge should be concentrated.

1.1 Pecularities of the Present Stage of Sport Development

A number of peculiarities are inherent to the present stage of sport development. They have a significant affect on the organization of athletes' training and confronts coaches and athletes with very complex tasks and requirements which compel them to search for appropriate forms of training organization.

1. Raising further the high level of achievements of modern athletes requires cardinal perfectioning of both the system of preparing highly-qualified athletes and the entire organizations-methodical system of multi-year preparation.

2. The exceptionally high stress of competition is associated with the increasing compactness of the achievements of participants at crucial competitions; the extraordinarily high requirements for quality, stability and reliability of technical and tactical mastery, moral-volitional preparedness and the psychological stability of athletes under conditions of frequent and crucial competitions.

3. Qualified-sportsmen achieved such high levels of special-physical-preparedness, that raising it further becomes a very complex task. It is necessary to find reserves for raising the effectiveness of special-physical-preparation and associated with this, to rationalize the system of training construction as a whole.

4. The significant increase in the volume of training accentuates the problem of its rational distribution during the yearly cycle and its separate stages. Furthermore, there is the obvious necessity to regard critically the "mechanical*' raising of the volume as a way of increasing the effectiveness of training. It became necessary to search, first, for the most effective ratio of loads of different emphasis; and second, for new forms of organizing training, providing optimal conditions for the full realization of the sportsman's adaptational potential; based on the rational interdependence between the expenditure and restoration of energy resources.

5. The growing role of science in the methodics of training. The training of highly-qualified sportsmen is associated with very substantial influences on the life-preserving functions of the organism's systems and the introduction of these influences at such a high working-level, that without scientific knowledge (relying only on common sense and intiution), it is already impossible to solve the complex problem of modern training.

If we were to rely on traditional principles and forms of training construction, established many years ago, then it is obvious that they have lost their (in the old days) progressive significance and do not meet the requirements of preparing today's qualified athletes. Progressive coaches understand this well, and, in collaboration with their pupils find new ways of perfecting and raising the effectiveness of training; along with the potential for perfectioning of traditional principles and forms of training construction. That this search is fruitful, is indicated by the athletes' high achievements.

Let's look at some characteristic (for the modern stage) tendencies in the organization of training, which as yet are not principles, but are definitely known and are well recommended. The search for ways of intensifying training and enhancing competition mastery was conditioned by the expediency to utilize a method extensively, which can be characterized as "modeling the competition activities under training conditions."

The essence of this method consists of the integral execution of the fundamental sport exercise (in training) at a high intensity and taking into account the conditions and rules of competition. This method adequately prepares the organism for competition and enables one to effectively prepare the athlete functionally, technically, tactically and psychologically. In the not-too-distant past it was considered inappropriate to execute the fundamental sport exercise at full strength in training, for results or with competition emphasis. This was explained as an extraordinary expenditure of nervous energy, a negative influence on technique, unnecessary fatigue, etc. Therefore, in speed-strength types of sports they recommended the use of a wide range of special exercises, in cyclic sports — distances shorter or longer than the competition; and overcoming them faster or slower than the competition.

However, the latest data shows that there is nothing more special than the fundamental sport exercises, executed under conditions close to the competition conditions. For example, the results of three groups of cyclists doing experimental training on a stationary bike at 1 km in the competition period (May - August). The group that utilized the method of modeling competition (1), showed the largest improvement (2.5 sec); displayed lesser displacement in cardio-respiratory systems during standardized loads and had higher functional indicators during maximum loads (figure 1). The groups that trained according to traditional methods (2 and 3) made less improvement (2.1 and 0.3 sec respectively). Group 3 having smaller competition loading than group 2, displayed lowered functional indicators.

Separate workouts for skiers, middle distance runners, kayakers and canoeists devoted to the regime of energy-securing

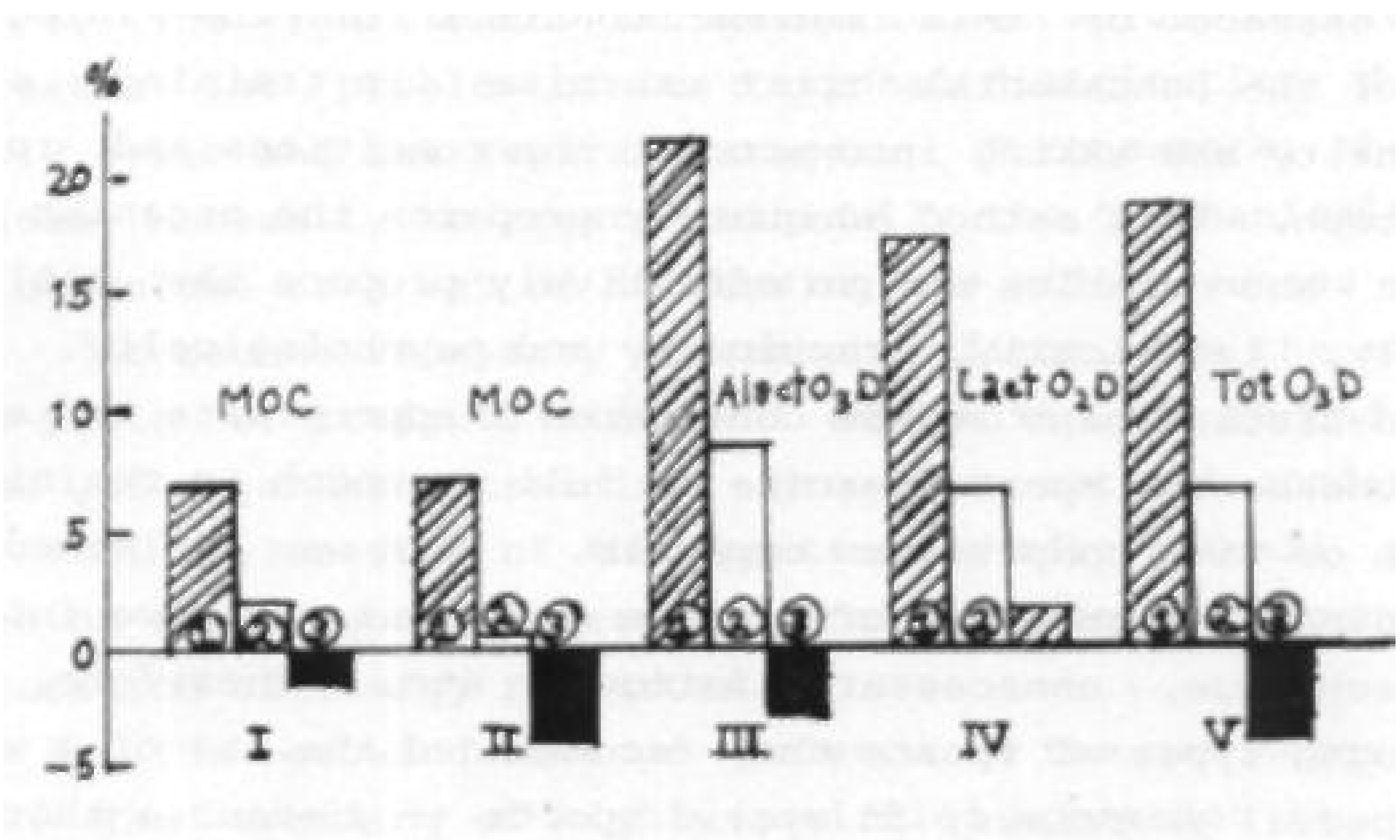


Figure 1. Changes in maximum consumption of 02 (I), maximum O2 pulse (II), alactic (III), lactic (IV) and general acidic (V) debt in groups of cyclists (S. S. Semashko, 1972).

work that is nearest to competition conditions has been demonstrated to be quite appropriate (T. M. Budykho, etal, 1978; A. Yakimov, 1980; N. P. Chagovyets, etal, 1980). The effectiveness of increasing the volume of training work for perfectioning technical mastery under conditions closest to competition (in speed-strength types of sports), has been corroborated; for example, executing long jumps, pole vaults or triple jumps with a full run-up (Y. V. Verkhoshansky, 1967; V. M. Yagodin, 1975) or hurdling at high speed or distances close to the competition (Z. S. Struchkova, 1980; V. V. Balakhnichev, 1982).

In boxing, the most intense aerobic exchange is brought about by special training means, close to competition conditions, — shadow boxing and sparring (P. N. Repnikov, 1977). Thus, no selection of special and assistance exercises can prepare the athlete for competition as effectively as the fundamental sport exercise. One should not confuse ways of modeling competition activities in training with previously accepted courses, estimates, control of training, etc. The latter were intended as the main way of controlling technical mastery and checking on the sportsman's preparedness for competition. However, they were not regarded as a specialized form of preparing athletes for competition.

In speaking of the advantages of modeling competition, in training, it should be emphasized that this is only one method of preparation and one of the ways of intensifying training. It is impossible to overestimate its role, but one can only utilize it when working with highly-qualified athletes and without losing one's sense of proportion, only when the athlete has good technical and special physical-preparedness.

Lately, a tendency to increase the portion of uni-directional training loads has been observed in the training of highly-qualified athletes. In this case, the training program stipulates the means and methods oriented to resolving primarily, one concrete task. For example, this task is the perfectioning of technical mastery or the development of a certain motor ability.

Uni-directional training loads as a methodical way of training organization, previously did not further the traditional complex preparation principle; in accordance with which, it is considered appropriate to resolve simultaneously (parallel) a number of training tasks in one workout as well as in the long-term stages of training. However, with all of its advantages, which have been demonstrated in the training of middle and high classification, the complex method (traditional meaning) is already unsatisfactory.

There is a noticeable tendency, in practice, to concentrate uni-directional training loads in certain stages of the yearly cycle. This indicates that coaches, in searching for ways of raising the effectiveness of training are overcoming established traditions (especially, based on a formal understanding of the principle of complex preparation) and are finding more rational variants of training organization. There are as yet still obvious errors in the organization of training of highly-qualified sportsmen. The reasons for these errors are associated with a lack of extensive, general, practical experience; and coaches who are insufficiently informed as to the achievements of sport science.

1.2 Training as an Object of Management

As already emphasized, programming and organization of training require in-depth and comprehensive knowledge of the essence of training. It is appropriate, therefore to examine programming from the stand-point of management categories.

In the most general terms, the essence of management is expressed in the changes of state of the managed object (systems, processes) in accordance with some tasks; the criterion of effectiveness is its functioning or development. Consequently, for practical realization of the idea of management, it is first of all necessary to concretize notions about the structure of the managed object and about the regularities of transferring it from one state to another. Satisfying this requirement depends on the scientific, just proportion of the theory of management; concreteness; a sense of the strictness of the conceptual apparatus, and finally, its practical effectiveness.

Let's look at the logical scheme of training organization for classifying and characterizing the object of management in sports (figure 2). Training is organized in accordance with specific, purposeful tasks, which are concretely expressed by a set increase in sport results; and are conditioned by the necessity for their realization in the training program. Thus, the amount of improvement in sport results is the criterion of the effectivenss of training. Sport results are the product of the organization of the complex of the sportsmen's external influences. In other words, this is the product of such an organization of movements and displacements of the athlete, which secures for him the effective utilization of his strength and motor potential for resolution of the specific motor tasks.

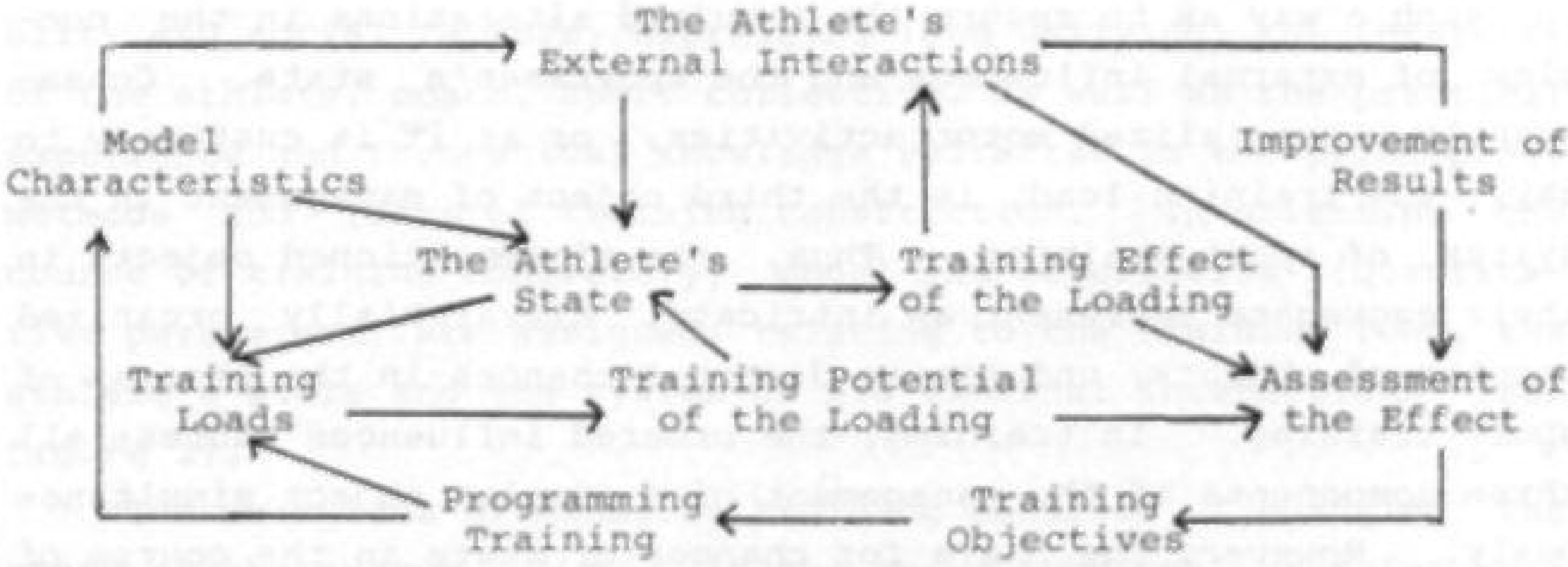


Figure 2. A logical Scheme of Training Organization

An ordering of the external influences and an increase in the portion of those forces which directly contribute to the resolution of the motor tasks is an important condition for the progress of sport mastery; realized within the confines of technical and tactical preparation. Therefore, the complex of the athlete's external influences inherent to competition, should be classified as the first object of management in the system of sport training.

The higher the sportsman's motor potential, the more effectively the complex of external interactions can be organized. That is to say, over a period of many-years training, athletes work at perfectioning their motor potential and increase their specific work-capacity. Therefore, the athlete's state, as a current characteristic of his motor potential, should be classified as the second object of management in the system of sport training.*

The complex of external interactions and the sportsman's state are established in the necessary direction, as a result of the systematic specialization of the motor activities. The latter provides a number of specific training influences, organized in such a way as to secure the required alterations in the complex of external influences and the sportsman's state. Consequently, specialized motor activities, or as it is customary to say, the training load, is the third object of management in the system of sport training. Thus, the aforementioned objects in their aggregate represent an intricate, hierarchially organized complex of objects, undergoing directed changes in the process of sport training. In training, the ordered influences address all three components of the management of a complex object simultaneously. However, the basis for changes of state in the course of training is a specific, cyclical sequence of events. The dosage of the training load is assigned, under the influence of which, changes in the sportsman's state occur; which in turn, entails changes in the complex of external interactions of the athlete and a corresponding increase in sport results.

When the planned results are achieved, the subsequent magnitude of increase and new, higher characteristics of the sportsman's state are set. Based on this, the program and the organization of the loading are determined for the next stage of training; and, the sequential execution of the aforementioned conditions are repeated at higher qualitative and quantitative levels. The cyclicalness of this process in accordance with acceptable (in each type of sport J periodization, makes-up the contents of the sportsman's preparation.

Completion of the tasks, executed at the separate components of the complex object of management level, gives rise to an intricate dynamic complex of cause-effect relations between them; which ought to be considered the structure of the managed object; securing its functional integrity. Thus, the aggregate of the components of the complex object of management, with the cause-effect connections inherent to it, is represented as a managed system (i.e., as a phenomenon, possessing all of the features of the whole, existing and changing as a whole).

As management begins -- the system which is the key to its development is the training program; consisting of all of the tasks of training, motivation, direction of the athlete's personality and social factors, expressing (and unifying) the interests of the athlete, coach, sport collective, as well as the practical experience and theoretical knowledge refracted in the principles, methods and forms of training construction. In orienting the course of training concretely, model characteristics (quantitative parameters) are assigned, relating to the training load, the athlete's state and the system of his external interactions (see figure 2).

The main idea of managing training consists of changing the state of the system, i.e., in the uni-directional transfer to a new, higher (and planned earlier), functional level. Control of the course of this process is accomplished by assessments of the effect, achieved primarily at two levels of management — at the state of the athlete level (control of the affect of the loading on state) and at the external interactions of the athlete level (control of the change in their characteristics as a result of changes of state). Based on a comparison of effects, achieved at the levels indicated with model characteristics, suitable solutions are begun to later tactically manage the course of training.

Now let's sum up an analysis of the contents and organization of training.

1. First of all, the role of transmission of functions between the components of the complex managed object is executed by the training potential and the training effect of the loading. The training potential of the loading is understood to mean its potential to provoke a functional accommodative reaction from the body, and corresponding changes in its state; and consequently, in the complex of its external interactions. The training potential of the loading is a relative concept; it should be examined and assessed in accordance with the sportsman's current state. Assessment of the training effect of the loading means one envisions that training-effect, the loading can produce in each concrete case. The training-effect is identified with relatively stabile functional displacements within the organism, achieved as a result of any training program. The basis for the training-

effect is the generalized (cumulative) traces within the organism, remaining from the entire complex of training influences.

The substantive meaning, encompassed by the concepts of "training potential" and "training effect" of the loading has principal significance for programming training. This will be examined in more detail later.

2. The connection between the entrance and exit of management systems is an extraordinarily complex mediation. The extent of this connection is determined primarily by the effectiveness of the operations at two interdependent outlines of regulation (see figure 2): "the training load — the training potential of the loading — the sportsman's state" (outline A) and "the sportsman's state — the training effect of the loading — the external interactions of the athlete" (outline B). Assessment of the prognostical reliability and the probability of success of regulation at each outline, shows one can be certain that the lower the first ones (A), the weaker the link in the management system.

3. Necessity in management arises when there is a selection problem. In such situations success depends on the degree of probability of adopting the optimal from the multitude of possible solutions.

The coach is confronted with the necessity to take a number of important strategic steps, relative to programming training, its organization, method of control and in case the necessity arises, correcting its course. He has to objectively assess the specific situation, analyze everything in-depth, and, based on innumerable variables, foresee the possible outcome of each and to select the most useful. It is easy to present the complex responsibility of adopting solutions according to the positions indicated; each of which, in its turn suggests the acceptance of a complex of more partial solutions.

The complexity of accepting solutions is associated first of all with the very weak basis that the coach is disposed to analyze all of the possible variants. Therefore, frequently he needs to accept a solution based on vague assessments of the situation; and the low probability of prognosing its outcome; which naturally, has a very low guarantee of success. To overcome this difficulty it is necessary for the coach to be armed with a complex of knowledge which should be oriented first of all to solving the problem of programming training.

1.3 Scientific Prerequisites of Programming and Organization of Training

Our outline of the general traits of the concrete sphere of requirements for theoretical knowledge, which is an obligatory condition for a successful solution to the problem of programming and organization of training, cannot be secured only by the synthesis of achievements of various scientific disciplines or the results of individual, fragments of research. A uni-directional, complex search is required, oriented to the creation of concepts about PASM (the Process of Attaining Sport Mastery, Ed.), and the elucidation of those objective, necessary conditions, which determine its development.

A preliminary examination of the problem, which arises in connection with programming and organization of training, already enables one to determine the goal of the task and the fundamental direction of the necessary scientific search; as well as the specifics of the knowledge required (figure 3).

We will not describe the scheme in minute detail. Its meaning and contents are sufficiently clear and their analysis is another matter. We emphasize only that in the vertical sections of the scheme, the fundamental direction of the scientific search (programming, organization and management) in the area of training construction, corresponds to those scientific sections and the sections on theory of training construction, require study. The disposition of these directions along the horizontal, reflects a certain logical sequentialness and continuity in the study and the practical solution of the problem. As a whole it foresees the formulation of general theories of training construction, its concretization, in view of partial conceptions for different types of sports; and principles of individualizing the training of athletes.

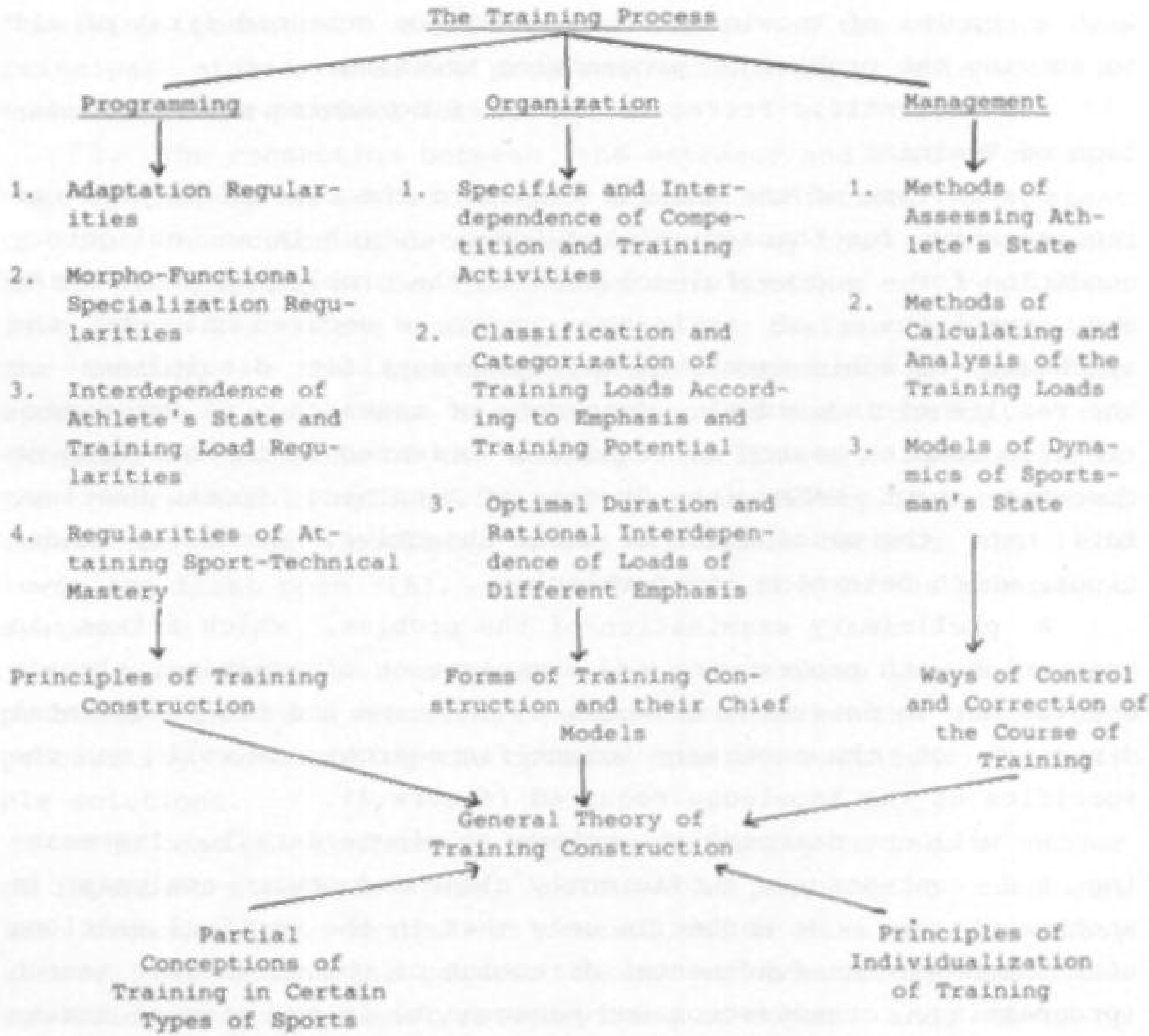


Figure 3. Scheme of a General Theory of Training Construction

It is important to point-out that the directions of the scientific search represented by this scheme require other, in comparison with the past, "visions" of objective research and the correct methodical orientation to study. Such objects are the unity of the integral core of regularities of the process of attaining sport mastery in all of its individual expressions; as determined by the specific type of sport. As a result, new problems and tasks confront the specialists, emanating from the necessity to reveal the factors which determine the integrity of this process and the causual conditions determining it. All of this requires a complex approach to the organization of research, without allowing those methodical errors which, unfortunately were the assumptions of the preceding 10-years.

In sport physiology especially, a certain differentiation of professional interests of specialists takes-place, which divides the human organism into two parts. Some of these specialists limit their study primarily to the neuro-muscular apparatus and the mechanism of its regulation from the stand-point of the CNS; selecting as a model object speed-strength and complex-technical types of sports. Others focus their interests on the vegetative systems and metabolic processes conditioning success in primarily cyclic types of sports.

Such specialization is quite natural for science, but is effective and accessible only in the presence of unified theoretical-methodical conceptions, which first, organize and orient the scientific search and second, assess, summarize and integrate the factors obtained. The lacking of such conceptions and independent activities in the organization of research strongly unifies the achievements in the area of sport physiology and not always statisfies practice, especially in those instances where general methodical principles or recommendations are formed based on the results of partial or fragments of research.

More than anything, the scientific-methodical fundamentals of the development of endurance suffer. On one side, attention is centered on the mechanism of energy-acquisition, ignoring the specific morpho-functional specialization inherent to the muscle apparatus (as the immediate executor of work); and endurance results are considered exclusively as a function of the respiratory potential of the organism. Therefore, physiologists experienced some confusion when information was revealed about the decrease in MOC (Maximum Oxygen Consumption) during the competition period; and the astonishingly low MOC levels in representatives of cyclic sports. However, this would not have been unanticipated if in the words of N. A. Bernstein, they "stepped down to the engine room" and carefully examined what happens with the contractile and metabolic qualities of an athlete's muscles who specializes in endurance sports.

The methodical area of sport training theory also is not without superfluous expenditures. Here there is a similar division in the interests of specialists, who give preference primarily to speed-strength or cyclic types of sports. Such a professional (but nevertheless justified) specialization cannot be condemned, unless those and other specialists limit their theoretico-methodical generalizations to "their" types of sport. However, since only they decide to form general training principles, the one-sidedness of this approach affects those to whom it is addressed.

A definite weakness in the methodics area of modern sport training theory is the result of an underestimation of undoubtedly important information, obtained as result of physiological and biochemical research in sport; as well as the result of the little scientific volume, low informativeness and reliability of that factual material, from which is drawn the basis for generalization and formation of methodical principles. Up to now this was the chief way of analyzing the volumes and the dynamics of training. This was called generalized practical experience and up until now such works undoubtedly played an important role in furthering the development of established principles and training methods; as well as for stimulating the creativity of coaches. However, since the regularities of training construction were developed solely from this material, the scientific significance of the principles and recommendations issuing from this were significantly underestimated.

Methodological errors are apparently, natural in the formation of such a complex applied-science as the theory of sport training. However, in the future and especially when theories and methods of programming training are being developed, errors are not permitted. Therefore, the best way to avoid such errors in the future is to study the causes for them.

1.4 Classification of Sports

The working-out of principles and rules of programming training requires a clear-cut determination of the limits of generality and specificity with respect to individual sport disciplines or their homogeneous groups. To do this it is necessary to classify types of sports based on established principles in order to solve the problem of programming criteria.

Athletics is associated first of all, with the necessity of rational spatial-time organization of the athlete's movements, which is determined by the rules and conditions of competition on the one hand and by the necessity to effectively utilize one's motor potential for executing the motor tasks. In all cases, this requires the perfectioning of the central-neural mechanism controlling movement, a raising of the functional potential of the muscles and the system of energy-acquisition. Since the character of sport activities is extraordinarily diverse with respect to the organism's work regime, it is appropriate to seek for the criteria for the classification of sports in the particular organization of the athlete's movements and the primary role of those or any of the organism's functional systems in securing their working-effect.

The more prolonged and the lesser the intensity of muscular work, the greater the role of the aerobic processes; the greater the functional specialization of the muscles to more fully utilize oxygen. The role of the glycolytic mechanisms of energy acquistion grows as the length of work decreases and the power of muscular work increases. The muscles adapt to work conditions of an inadequate supply of oxygen and to the rapid removal of lactate during the execution of this work.

The overloading of the support-apparatus and the power of "explosive" effort increase significantly during brief acyclic work. Under conditions of high, dynamic-overload, athletes must overcome significant external resistance; which they must accomplish in only a very short time (tenths and even hundreths of a second). This complicates movement coordination significantly and at the same time requires the organization of a rational and reliable biodynamic structure. Under these conditions, the neuro-muscular apparatus improves intra-muscular regulation and increases the power of anaerobic sources of energy-acqusition.

Thus, one can divide types of sports into two large groups; which combine acyclic and cyclic locomotion. The first is characterized by a complex organization of motor components and a high concentration of working-effort, displayed briefly under competition conditions. Such sports have an inherently stabile biodynamic movement structure and a definite morpho-functional specialization of the neuro-muscular apparatus, which encompases the perfectioning of its abilities to display powerful explosive-effort and the enhancement of anaerobic power; primarily through the alactic mechanism of energy-acqusition.

The second group is characterized by multiple (prolonged) repetition of stereotypic work cycles of relatively simple organization and not requiring limit muscular tension. The energy acquired for such work comes primarily from the oxygen required during the work and the restoration of energy resources, relative to their expenditure. One of the most important conditions for increasing mastery in this group of sports is the morpho-functional specialization of the muscles, aimed at perfectioning the ability to oxidize metabolites, as well as to increase the capacity of the metabolic processes and economicalness of energy substrate expenditure during work.

One should subdivide types of sports in each group, having specific peculiarities of movement organization and energy-acquisition. Thus, in the acyclic group — this type of sport requires powerful, brief, explosive-efforts or a fine dosing of efforts and spatially precise movements. In the cyclical group there are types of sports where the work is executed under conditions of full oxygen satiation or inadequate oxygen acquisition.

And finally, one should designate a third group of sports, characterized by changing competition situations and the necessity to preserve a high work-capacity-level under conditions of compensatory fatigue. These types of sports are combined according to the peculiarities of the organization of motor activities and energy-acqusition, primarily inherent to the aforementioned two groups. The determining characteristics of these are the biodynamic structure of the technical means and at the same time, their wide variability; creating the necessity of extensive adaptation of the entire technique arsenal to constantly changing situations. With respect to the shifting intensity of the competition activities, as well as the sequencing of high motor activeness with full rest pauses, energy-acquisition is of a mixed aerobic-anaerobic character, with the greater part secured by glycolytic reactions.

So, we come to classification, dividing types of sports into three groups as already outlined by V. S. Farefel (1969):

-- acyclic, in which the perfectioning of the motor-apparatus for precise regulation of movements and the ability to execute working-efforts of great power have the primary role;

-- cyclic (primarily submaximal and of moderate power), primarily associated with the achievement of muscular work through oxygen-acqusition (aerobic, Ed.);

-- combined (complex), where there is characteristically a high variability of motor actions under conditions of compensatory fatigue and shifting intensity of work; basically sport games and single-combat (boxing, etc., Ed.).

When classifying types of sports it is necessary to consider the specifics of competition as well as training activities. This is important, because in a number of cases the latter consist of work regimes that are far removed from those which are inherent to competition conditions. This is due to the necessity of multiple and qualitative reproduction of the competition regime in training. In practice, they speak of special {speed, jumping, strength) endurance in such cases. For example, the shortest sprinters' distance in track and field (100 meters) is covered in 10 seconds, or as they say, in one breath. The effort expended to do this does not result in a high oxygen debt, and oxygen-acqusition is not a factor. However, in order for a sprinter to prepare himself to effectively display such effort, he should execute training loads that develop his aerobic and expecially, anaerobic potential. We will examine general tenets and principles of programming training in conformity with the aforementioned groups of sport types later on.

Chapter 2
Regularities of the Process of Attaining Sport Mastery

Elaboration of theories and practical methods of programming training, as has already been said, are only possible with knowledge about the regularities of the process of attaining sport mastery (PASM) and the conditions securing the uni-directional, conscientious realization of these regularities. Therefore, returning to the scheme presented in figure 3, let's examine the general regularities of the long-term adaptation of the human organism to intense muscular work, as well as some quantitative-time characteristics of the adaptation process; having direct relevance to the problem of programming training. Then we'll look at the specific regularities of the morpho-functional specialization of the organism as a concrete external expression of the organism's long-term adaptation to intense muscular work. Finally, we'll look at some of the regularities of the formation of sport-technical mastery in different types of sport, characterizing the process whereby the athlete masters the skill to rationally utilize his motor potential in athletic events.

2.1 General Regularities of the Athlete's Adaptation to Intense Muscular Work

In a broad sense, adaptation is understood as the organism's accommodation to natural, production, domestic and other conditions. These general term designates all types of accommodative activities occurring at the cellular, organ, system and organism levels; commensurable by the prolonged, with the existance of a number of generations, life of the individual or its separate periods (F. 2. Meerson, 1973; G. I. Tsaregorodtsev, 1975; A. G. Kuznyetsov, etal, 1979; V. P. Kaznacheyev, 1980).

Adaptation, as a phenomenon of accommodation, characterizes the organism's entire reaction, reflecting the specific features of the external influences. However, along with the differences resulting from specific influencing factors (cold, hypoxia, intense muscular work, etc.), the mechanism of adaptation is characterized by an expressed generality (F. Z. Meerson, 1973; V. P. Kaznacheyev, 1980). This generality is as follows; one and the same displacement arises in the cells of many physiological systems — a deficit of energy rich phosphorus compounds and an increased potential for phosphorylation. This activates the genetic apparatus of the cells and causes a strengthening of the synthesis of nucleic acids and protein. As a result of the increased power of the mitochondrial systems, the manufacture of adenosinetriphosphate (ATP) increases and the deficit of ATP is eliminated.

Later on, biogenic activation of all the cells of the physiological systems develops, which leads to a decrease in the intensity of their functioning, i.e., a decreased consumption of ATP by the unity of cell masses. A stabile adaptation develops as a result of structural alterations; which provides an increase in the power of the transport systems, utilization of oxygen and resynthesis of ATP. The chain of events discussed is presented as a fundamental, general-link-mechanism of adaptation to the basic factors of the external surroundings. Adaptation has its own "cost", since the synthesis of nucleic acids and proteins, comprising the foundation of adaptation; means there is a significant expenditure of the organism's structural resources. Therefore, to control the adaptational processes the correct dosage of factors to which the organism adapts is of principal significance (F. Z. Meerson, 1973).

The character of the "unfolding" adaptive process has its own peculiarities, which can be described by two extreme variants (V. P. Kaznacheyev, 1980). In one of these variants, the organism is capable of powerful physiological reactions in response to significant, but brief, fluctuations in the external surroundings. The regeneration-synthesis processes (the restoration reaction) will join in after "freeing" the organism from the extreme influences. However, physiological reactions can be maintained at such a high level only a relatively short time. Such organisms adapt poorly to prolonged physiological overload of even moderate magnitude, with respect to external factors. In people whom such an adaptation strategy predominates, the simultaneous combination of the work and restoration processes are expressed weaker and a sharper rhythmicity is required for the processes indicated (breaking-down over time).

In the other case the organism is less stable to brief, significant fluctuations of the surroundings, but has the qualities to maintain the physiological loading for a long time. The organism's adaptive reconstruction is determined by the timely joining in of the regeneration-synthetic processes, their expressiveness and duration. In people with such adaptive strategies the work processes combine easier with the restoration processes, which permits prolonged loading.

A person's affinity for a certain type of adaptive strategy is predetermined by genetics, climato-geographics and other factors. For example, athletes from the Siberian and far eastern regions withstand brief and prolonged physical loading differently than European athletes; apparently, this is due to the different types of energy exchanges peculiar to them (D. S. Timofeyev, 1974).

Our own data (1979) on the aforementioned types of adaptive strategies, typical of athletics, indicates they are determined by the athlete's qualification and the specific type of sport. Thus, we find the first type of strategy primarily in highly-qualified athletes and chiefly in speed-strength types of sports (figure 4, A). As a result of using load volumes requiring intense mobilization of energy resources (figure 4, dark arrows), a lengthy and extensive disruption of homeostasis occurs, and as a consequence a prolonged decrease in functional indicators (f). Then after the volume has been decreased, and as a result of activation of the plastic resources (figure 4, broken arrows) they (functional indicators) should rise sharply.

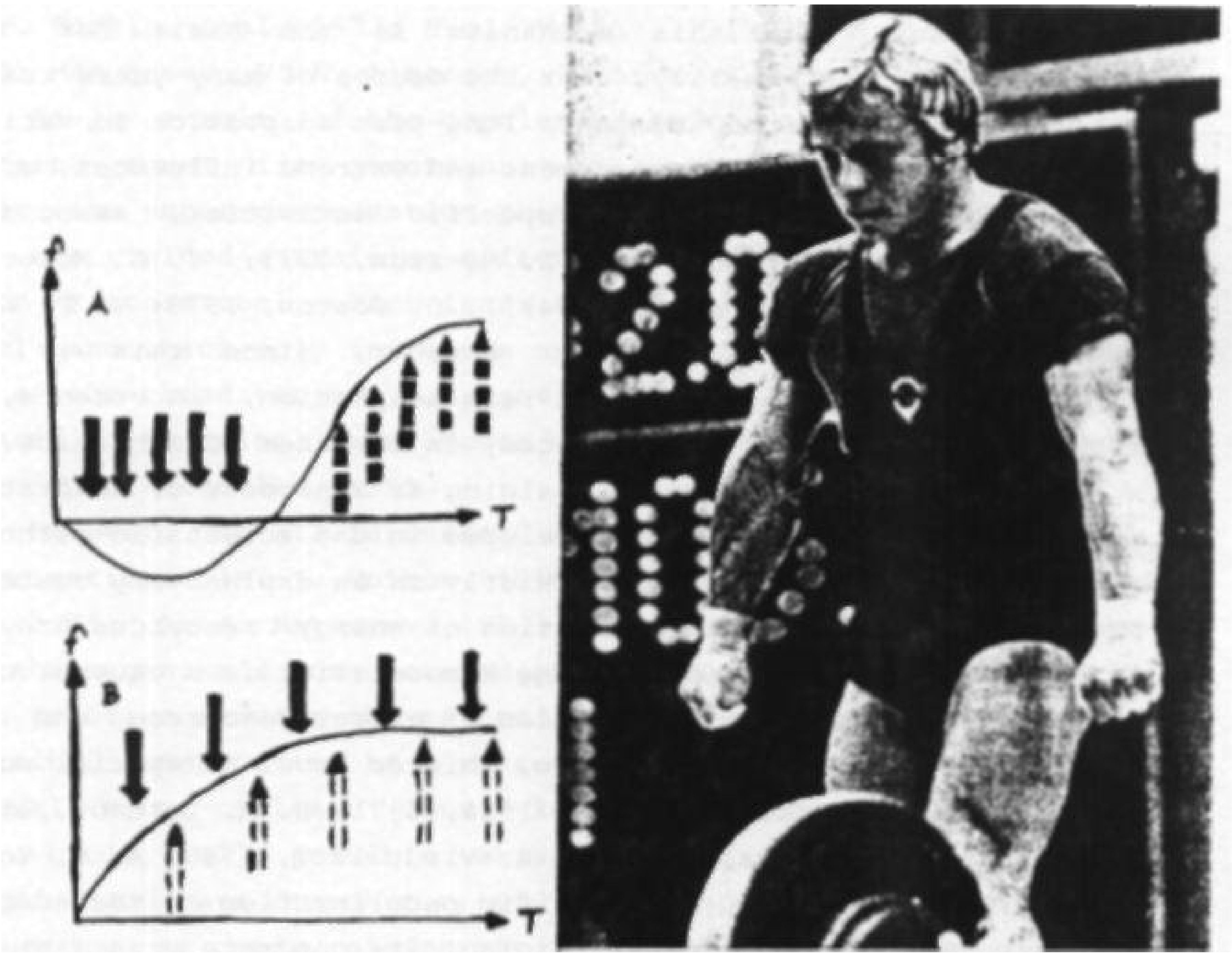


Figure 4. Two types of the organism's adaptation strategies to loading depending on its time organization.

The second type of adaptation stretegy is typical of athletes of middle-qualification and chiefly for cyclic types of sports, single-combat and sport games (figure 4, B). In this case, with the gradual increase in the loading, there is a place for periodic, brief disturbance of homeostasis where there is an alternation in the activation of energy and plastic resources. The current expenditure of energy resources is compensated for by some excess from the initial level; and the organism's functional potential gradually increases.

Thus, in general terms, the chief biological mechanism of adaptation has been given enough space. There is sufficient reason to assume that this mechanism is the basis for the development of trainability, over the course of many-years training. Specialists, studying man's long-term adaptation to various factors of the external environment and extreme influences, often turn to athletics as models of specific activities, associated with intense muscular work (F. Z. Meerson, 1973; Y. A. Motorin, 1971; D. S. Timofeyev, etal, 1974; I. D. Postov, 1979; V. P. Kaznacheyev, 1980, and others). However, since this is not surprising, the problem of long-term adaptation, in essence, is still not a subject of special study in the area of athletics.

True, the view of sport training as a process of adaptation to physical loading has been developed in the scientific-methodical literature repeatedly, but chiefly in an explanatory context. It is assumed, that the exhaustion of energy resources brought on by physical loading (disturbing homeostasis) is a causual condition of the surplus restoration of energy resources and the transfer of the organism to a new, higher level of special work-capacity (N. N. Yakovlev, 1953, 1958, 1971; S. P. Letunov, 1966; L. Y. Yevgenyeva, etal, 1975; A. A. Viru, 1977, 1960; A. N. Vorobyev, 1977). However, the specific peculiarities of the adaptation process over many-years training, its concrete quantitative-time characteristics, dynamics and primary emphasis, still require their own explanation.

In athletics, extensive experimental data has been accumulated, *concerning the nature of the restoration processes and* the organism's functional reaction after brief training influences (the "urgent" training effect). It has been shown that the after-effect of large loading is not limited to the restoration of expended-energy-potential, but leads to super-restoration, quantitatively exceeding the initial level. This phenomenon (Weigert's law of super-compensation) originated with G. V. Folbrot (1941, 1952, 1958), and has been studied by various specialists. A principal and in separate cases a quantitative connection between the processes of exhaustion and restoration provoked by individual or a series of physical (training or competition) loads has been established (N. N. Yakovlev, 1955, 1975; M. Y. Gorkin, etal, 1973; N. I. Volkov, 1975; V. M. Volkov, 1975; V. D. Monogarov, V. N. Platonov, 1975; Y. P. Sergeyev, 1981).

As a result of the popular practice of correlating the training times (in accordance with which loading is repeated after the super-compensation phase from the preceding work which has not yielded a training-effect) under conditions of incomplete restoration, which leads to a lowering of the functional level and which only increases as a result of super-restoration. Use of the third variant was considered to be a rational form of organizing training; the second variant was considered unacceptable (N. N. Yakovlev, 1955).

However, in all fairness, this practice and its subsequent moderizations (N. I. Volkov, 1969; V. D. Monogarov, V. N. Platonov, 1975; L. P. Matveyev, 1977) did not contribute to exposure of the organism's long-term-adaptation mechanism. Furthermore, this practice reduces the methodical resolution of the problem of training construction to a narrow fragment, limited to one or several micro-cycles. Thus, keeping within the limits of a micro-cycle, all possible variants of organizing training with large loads are drawn-up, but the indispensable conditions of preserving or even raising the level of special-work-capacity begins in the next micro-cycle. This kind of approach leads us to take for granted the following methodical premises:

— it is necessary for the athlete to preserve such a state during the course of training, so that it is possible to execute the fundamental sport exercises effectively;

— repetition of training loads when the organism is in a state of insufficient restoration is undesirable, although this is permissible in certain instances;

— special-work-capacity should rise steadily during the course of training; a decrease in special-work-capacity at certain stages of training is indicative that training is incorrectly organized.

Undoubtedly, all of these methodical premises were, in their time, progressive. To a certain extent they are still true today. However, modern training requirements point to the necessity of altering the main approach to solving the problem of training construction. Practice and common sense indicate that the fundamental unit of training construction should be the large (prolonged) stage of training and not the micro-cycle. An extensive study of the regularities of the long-term adaptation of the organism is required for this. The practical usefulness of this study will be felt only if one can see the concrete dependence of the dynamics of the sportsman's state on the training loads executed; and one can determine the quantitative and time characteristics of the adaptation process.

The initial results of this research already has convincingly demonstrated its scientific and practical value. This is especially applicable to material related to group types of sports, requiring the display of explosive-effort.

General ideas about the development of the long-term adaptation process are an outcome of observations of the dynamics of an athlete's special-physical-preparedness indicators over the course of many-years training.

The data presented is an example of two-year observations of athletes using two-cycle (long jumping, figure 5) and unicyclic (decathlon, figure 6) periodization of yearly training, as well as the tendencies in the dynamics of speed-strength indicators of middle-qualified jumpers (triple jump), who become masters of sport in the third year of training (figure 7). The training loads were recorded simultaneously in all the examples presented.

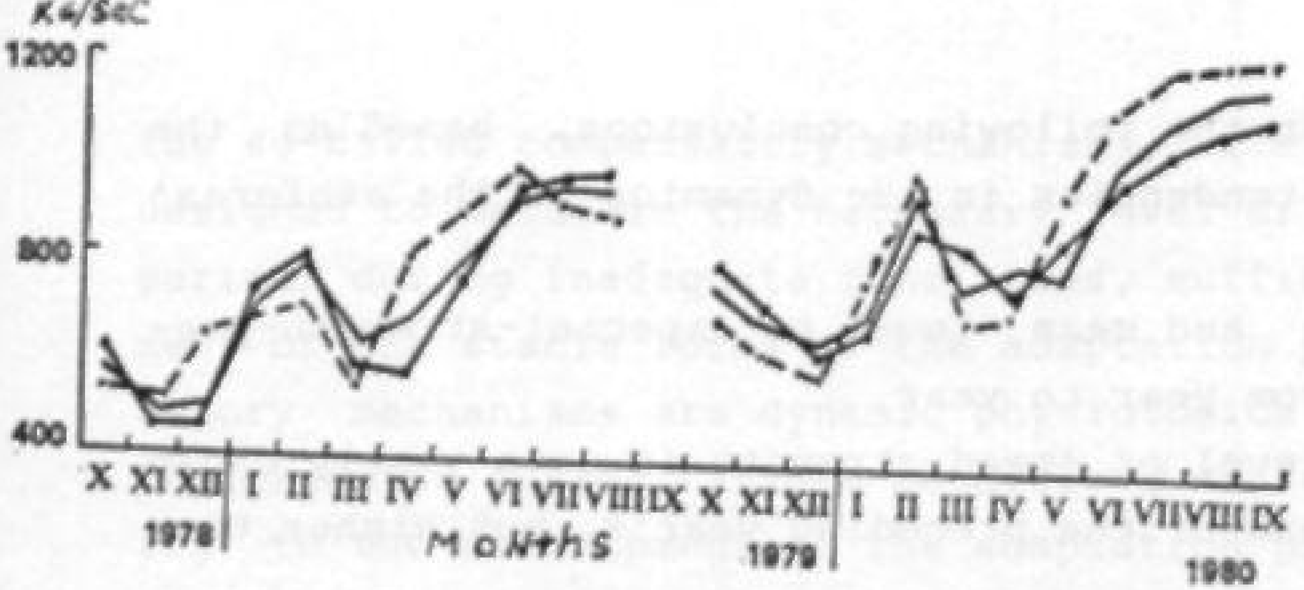


Figure 5. Dynamics of explosive-strength (thigh extension) of three highly-qualified women long jumpers (T.M. Antonov)

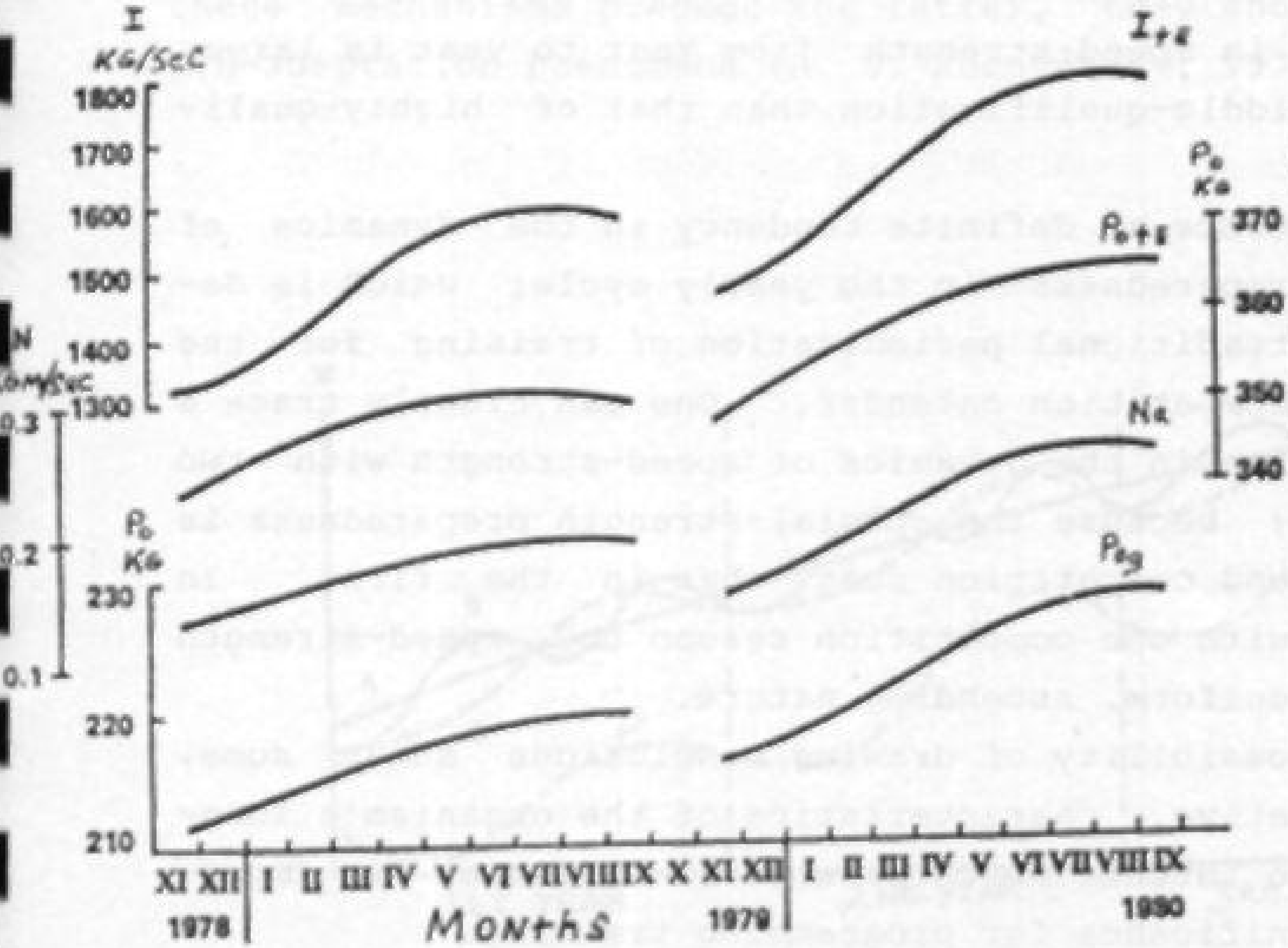


Figure 6. Speed-strength Dynamics of Highly-qualified decathletes (mean for three athletes, O.A. Khachatryan): Po_{te}- absolute and I_{te}- explosive-strength (thigh extension), N_a- arm extension power, Po_g- absolute strength of the gastrocnemieus muscle

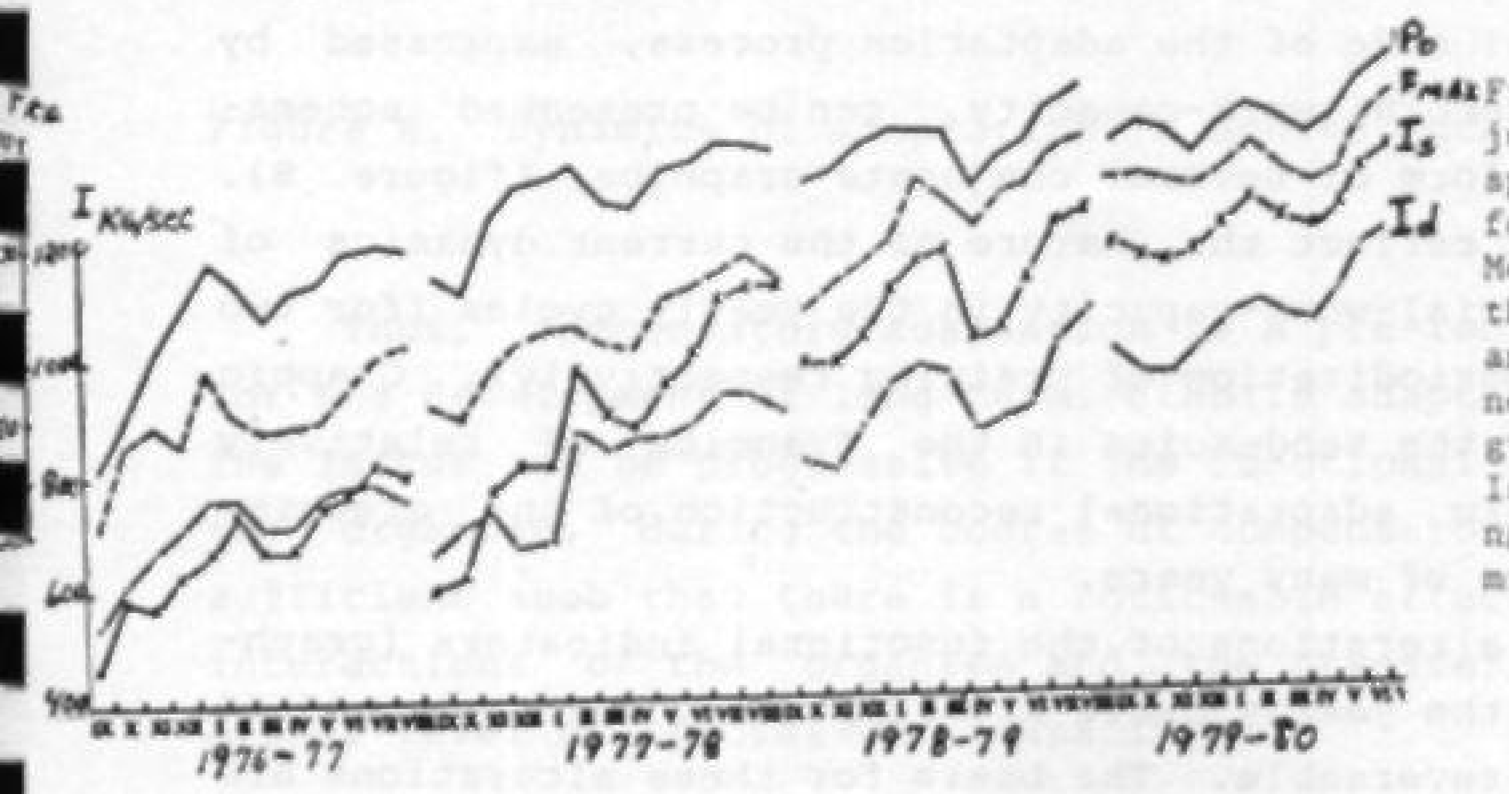


Figure 7. Dynamics of a jumper's (triple jump) speed-strength during a four-year training cycle. Mean extension force of the thigh and foot (for right and left leg, I.N. Mironenko): Po- absolute-strength, Fmax- maximum force, Is and Id- explosive-strength in isometric and dynamic regimes

One can arrive at the following conclusions, based on the research data of the tendencies in the dynamics of the athletes* state:

1. The absolute and mean level of special-strength-preparedness increases from year to year.

2. The initial level of speed-strength in each yearly cycle is lower than at the end of the preceding year's, but higher than at its beginning.

3. The rise in speed-strength from year to year is larger for athletes of middle-qualification than that of highly-qualified athletes.

4. One can trace a definite tendency in the dynamics of special-strength-preparedness in the yearly cycle; which is determined by the traditional periodization of training for the type of sport and competition calendar. One can clearly trace a two-peak disposition in the dynamics of speed-strength with two competition stages; because the special-strength preparedness is higher in the second competition stage than in the first. In types of sports with one competition season the speed-strength dynamics are of a uniform, ascending nature.

Thus, the possibility of drawing conclusions about some, especially quantitative, characteristics of the organism's long-term adaptation to intense muscular work in athletics has important practical significance for programming training.

The external side of the adaptation process, expressed by the dyanmics of special-work-capacity, can be presented schematically in the form of several conjugate graphics (figure 8). Graphics B and C reflect the nature of the current dynamics of the athlete's special-work-capacity in the yearly cycles (for two and unicyclical periodization of training respectively). Graphic A characterizes the tendencies in the dyanmics of relatively stabile, long-term adaptational reconstruction of the organism over a time period of many years.

The current alterations of the functional indicators (graphics B and C) in the yearly cycle are temporary, unstabile and to a certain extent reversable. The basis for these alterations are the so-called compensatory mechanisms, i.e., priority reactions, designed to maintain the necessary level of functioning for brief periods during inadequate conditions, sufficient for the development of the stable forms of the adaptation process. The compensatory mechanisms are dynamic physiological means of repairing the organism during extreme conditions and gradually fade according to the development of the adaptation process. In so far as these mechanisms precede the latter, they should be designated pre-adaptation phenomena (A. G. Kuznyetsov, 1979).

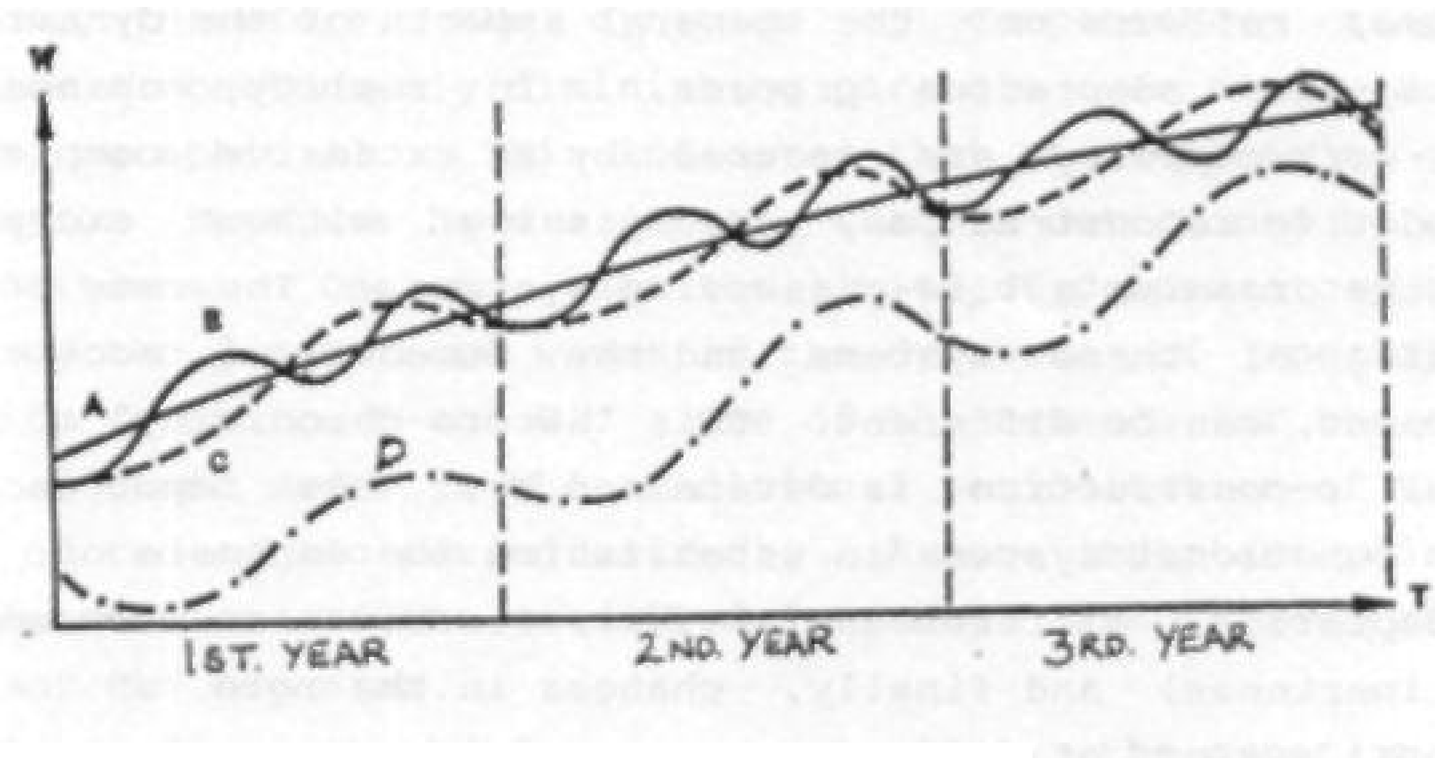


Figure 8. Dynamics of Adaptation in Sports Conditions.

Thus, compensatory adaptation is a pre-requisite condition for the development of long-term, stabile adaptation {graphic A). The latter can be progressive if the functional reconstruction of the organism, during the course of compensatory adaptation, is sufficient such that there is a noticeable affect on the external interactions of the organism and the transferring of it to a higher level of special-work-capacity.

One should add, that the essence of adaptation in athletics consists not only of increased motor potential, but the enhancement of the athlete's skills to effectively, i.e., more fully, utilize this potential for coping with concrete motor tasks (graphic D).

In light of contemporary ideas, adaptation cannot be considered an equilibrium process. Adaptation is the active maintenance of a definite level of disequilibrium between the organism and the environment which is the fundamental reason for the origin and development of accommodative reconstruction within the organism (E. Bauer, 1935; N. A. Bernstein, 1966).

Figure 8, as already mentioned, contains quantitative-time characteristics of the changes in special-preparedness; and therefore, reflects only the general aspects of the dynamics of the long-term adaptation process. In reality, changes in special-work-capacity are secured by an extensive complex of accommodative reconstruction, encompassing, without exception, all of the organism's life-preserving systems. The rate of perfectioning of these systems and the moments of accelerated development, can be different. This "hetero-chronicity" of adaptational reconstruction is determined by: the importance of certain functional systems in establishing the emphasis of long-term adaptation, differences in their reactiveness (or adaptational inertness) and finally, changes in the role of certain functional systems at different stages of long-term adaptation.

In endurance types of sports a clear picture of the "unfolding" of long-term adaptation, as in "explosive effort" types of sports, has not been observed. And here, it is not a matter of some specific differences in the adaptation process, but the ability to observe it, or more precisely, in the functional characteristics utilized for observation. The indicators of aerobic and anaerobic output are a reflection of the dynamics of the general (external) level of the organism's special-work-capacity (endurance); but they do not express alterations in its internal relationships, associated with adaptation to intense cyclical work. Based on available data (N. N. Yakovlev, 1975; A. A. Viru, 1977, 1981; N. V. Susman, 1978; V. S. Finogenov, 1979), one should look for these alterations at the endocrine system level, and at neuro-hormonal mechanisms and psycho-physiological indicators. The correctness of this supposition will be revealed in the near future. Until then one can assume that long-term adaptation to endurance work is developed by the same, aforementioned chief mechanisms, but at another level of the physiological systems. It is easy to offer a rich prospective "cut-out" for perfectioning training methods in cyclic sports, when specialists study this mechanism.

Compensatory adaptation, with respect to the long-term, cannot continue indefinitely. The affect of compensatory adaptation on the special-work-capacity diminishes with each repetition; therefore, the dynamics of compensatory adaptation describe a monotonously diminishing parabola over time (see figure 8, graphic A). This indicates that an athlete's general adaptation reserves have a limit, that is determined by genetic preconditions. One can judge the limits of compensatory adaptation by the presence of waves in the dynamics of special-work-capacity (graphics B and C). One of the reasons for the appearance of these waves is the traditional periodization of training (one or two-cyclic periodization). A more important reason is the exhaustion of the so-called "current" adaptation reserves (CAR) of the organism.

One can assert that at any one instant, the organism has a definite reserve potential, i.e., a capability to respond to external influences with accommodative reconstruction and transfer itself to a new functional level. The capacity of these adaptational reserves is limited by definite, appropriate restrictions and to a significant degree, these restrictions determine the absolute level of the organism's adaptational reconstruction. Hence, the strength, volume and duration of the training influences are necessities for the full realization of the organism's CAR, as well as having their own corresponding, quantitative significance. If they are below the necessary magnitude, the organism will not realize its CAR; if they exceed it.

exhaustion of reserve potential will occur. And in that, and other cases, the training-effect will be low.

Assumptions about the presence of a definite adaptational reserve within the human organism and the expeditiousness of constructing training by taking into account its realization, were discussed earlier. The adaptation process was divided into three phases, based on observed changes in a number of functional indicators and the corresponding dynamics of sport achievements: a) the growth of trainability, b) sporting form, c) loss of trainability (S. P. Letunov, 1952) and a) adaptation, b) the highest sport work-capacity and c) readaptation (L. Prokor, 1959). In the latter case, readaptation is understood as the loss of the highest work-capacity with respect to exceeding the limits of adaptability, i.e., expending adaptational energy.*

So, one can consider this training organization effective, when it provides the fullest realization of the organism's CAR, by means of the necessary volume of loading. Hence, alluring prospects with respect to programming and organization of training appear — by divising ways of assessing the organism's CAR in each concrete case and the appropriate criteria for determining the contents and the volume of the training influences, necessary for its realization. This is quite a workable task although it requires great effort. The possibility of a quantitative approach to determine the organism's "reserve strength" has already been discussed in the literature for quite some time. It is based, in particular, on assessments of a number of biochemical indicators of the exchange processes (E. L. Beckman, etal., 1961; N. N. Yakovlev, 1977). Research in our laboratory used the exhaustion of the organism's CAR as a criterion of departure for the specific-work-capacity to plateau; under the influence of systematic training influences (Y. V. Verkhoshansky, 1973, 1978).

*Subsequent methodical interpretations designated these phases as acquisition, preservation and brief loss of sporting form (L. P. Matveyev, 1964).

Two forms of compensatory adaptation, associated with the realization of the organism's CAR, as a result of systematic influences, differing in volume and in the organization of the training loads, have been revealed and studied; with respect to the aforementioned criterion, in "explosive effort" types of sport (figure 9). The first form is characterized by a gradual increase in functional indicators and is associated with a moderate volume of continuous loading. In this case periodic brief disturbances of the organism's homeostasis occur and the current expenditure of energy resources is compensated, during the course of training, through some predominence in the supplying of lost energy. This form of compensatory adaptation conforms to traditional ideas about the development of trainability and is typical for sportsmen of middle classification in modern training conditions.

The second form of compensatory adaptation is associated with the use of a large (concentrated) volume of special-physical-preparation means, concentrated in the first half of the training stage. These large volumes provoke a profound and prolonged disturbance of the organism's homeostasis, which is expressed by the stable decrease of the functional indicators and then, after the volume of the load is decreased, their increase is accelerated, and they exceed the level achieved during the first form of compensatory adaptation. This way of organizing loading in the large preparation stage has been devised for highly-qualified athletes (Y. V. Verkhoshansky, 1977) and as subsequent research showed, is effective for all types of sports.

The methodical aspects of utilizing this form of conpensatory adaptation in actual training conditions will be dealt with later. Let's dwell here on some practical results of research, the purpose of which was to study compensatory adaptation and search for methodical approaches to full realization of the organism's CAR in the big training stage.

First of all, the optimal duration of the training influences was determined; an objective necessity for full realization of the organism's CAR. It is with respect to this, that the

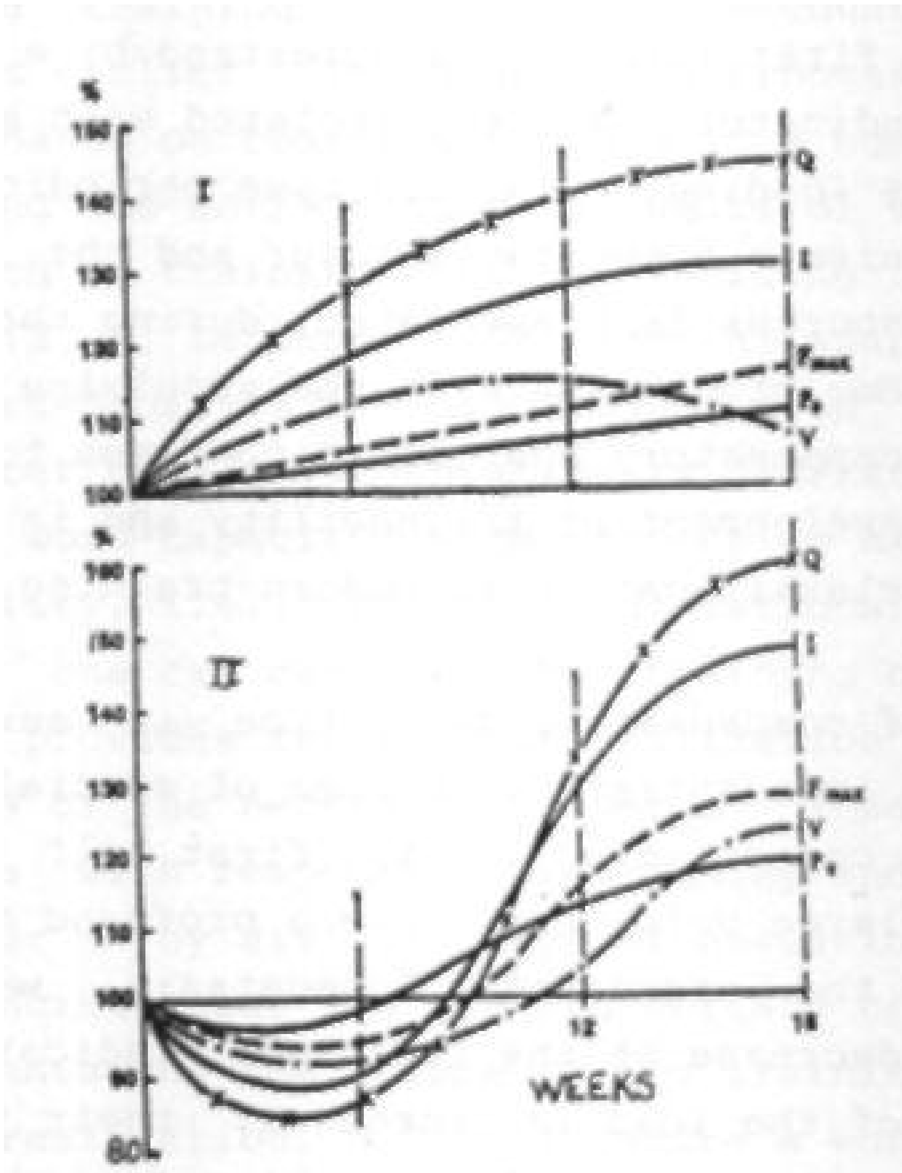


Figure 9: Two forms of the athlete's compensatory adaptation in the large preparation stage: Po - absolute, I - explosive, Q - starting strength, Fmax - maximum explosive-effort, V - speed of movement.

the question as to what is an acceptible length of continuous training was answered — 5-6 weeks, and with a concentrated loading — 3-4 weeks; after which a rehabilitation period is necessary for activation of the compensatory processes. It was revealed as well, that the trained athlete is able to withstand three (3) such sequential "portions" of loading, separated by short (7-10 days) rehabilitational pauses. Then a longer rehabilitation period is necessary, associated with stabilization at the new level of functional reconstruction. Thus, the time intervals necessary for exhaustion of the organism's CAR is within the range of 18-22 weeks (see figure 9). These periods coincide with observational data (in natural conditions), of highly-qualified athletes, training in different types of sports, including cyclic (S. V. Zhikharevich, 2976; V. A. Sirenko, 1980).

In order to apply the data presented, it is necessary to examine it in the following way: the organism cannot respond to training influences positively with adaptive reconstruction indefinitely. There are definite time limits, during which the organism is able to react positively to continuous training loads of large volume. One can designate three such limits which are necessary to take into account for programming training.

The first limit is determined by the "single-moment portion" of continuous (following each other) training and is restricted by that volume and length of loading, the exceeding of which already does not ensure the rise in functional capability and can lead to negative effects. The second limit is determined by the optimal duration of the training stage, providing full realization of the organism's CAR. The contents of this stage should be restricted to a series of three "single-moment portions" of continuous training influences; separated by rehabilitation intervals. The third limit is determined by an acceptable series, including "single-moment portions" of training influences. There can be two such intervals (taking into account the rehabilitation invertal between). A long rehabilitation period is required after this.

It is necessary to bear in mind that the aforementioned limits, are restricted by the duration of the training influences, and relate only to conditions in which a large volume of loading is undertaken. The limitations, with respect to the length and quantity of repetitions and series of "single-moment portions" of training loads, are based chiefly on the creation of optimal conditions for sequencing training influences, and not from the organism's potential limits. Trained athletes are able to maintain a significantly larger volume and duration of loading. However, it is inappropriate to subject the organism to extreme energy exhaustion. This requires a longer rehabilitation and has a negative affect on the subsequent stages of adaptation.

In research, oriented to revealing rational ways of realizing the organism's CAR, we found visual corroboration and received practical elaboration of one of the most important regularities of adaptation; associated with the extensive disturbance of the organism's homeostasis. The more extensive and longer the exhaustion of the organism's energy resources due to concentrated loading in the large stages of training (naturally, within reasonable limits), the higher their subsequent restoration, the longer the new functional level is maintained.

Presented in figure 10 are the dynamics of explosive-strength for a 5-month training stage of six highly-qualified women athletes (long jumpers). It is quite obvious that the larger the drop in explosive-strength during the stage of concentrated strength loading (November), the higher it subsequently increased (February). In another experiment for a period of four-weeks, on 5-groups of highly-qualified athletes, the effectiveness of different programs of special-strength-training was verified (figure 11), Group five's program was the most effective; it caused a more extensive disturbance of homeostasis and provided a hgher level of subsequent compensation of energy resources. It is important to point out that group four's program was not sufficiently intense for the athletes and this caused a disturbance in the adaptation process.

Indispensable conditions of training organization which provide extensive and relatively prolonged disturbance of homeostasis, are the precise dosage of loading, as well as rehabilitation stages necessary for triggering a compensatory reaction, elimination of the hetero-chronicalness phenomenon in the dynamics of the various functional indicators and stabilization of the organism at the new functional level. The general volume of the load should be decreased at this time and GPP (general physical preparation) means introduced in training, which contributes to the intensity of the compensatory reaction. The more extensive and prolonged the disturbance of homeostasis the more prolonged

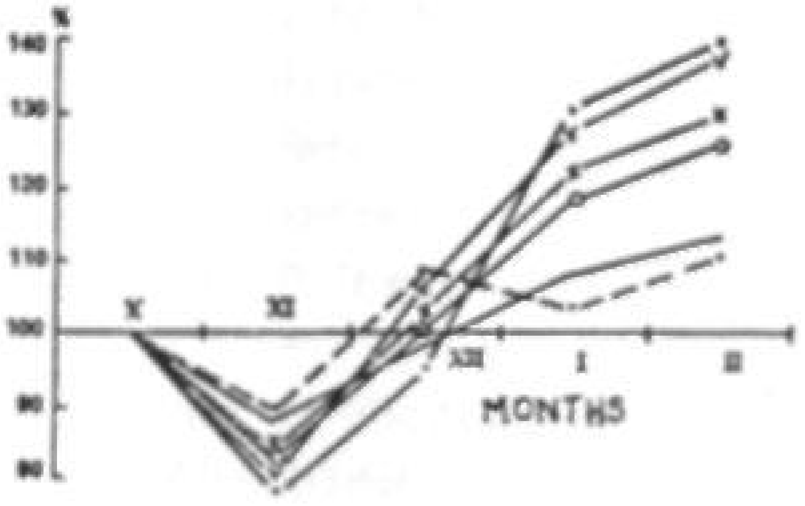


Figure 10. Explosive-Strength dynamic (thigh extension) of six women long-jumpers (T. M. Antonov)

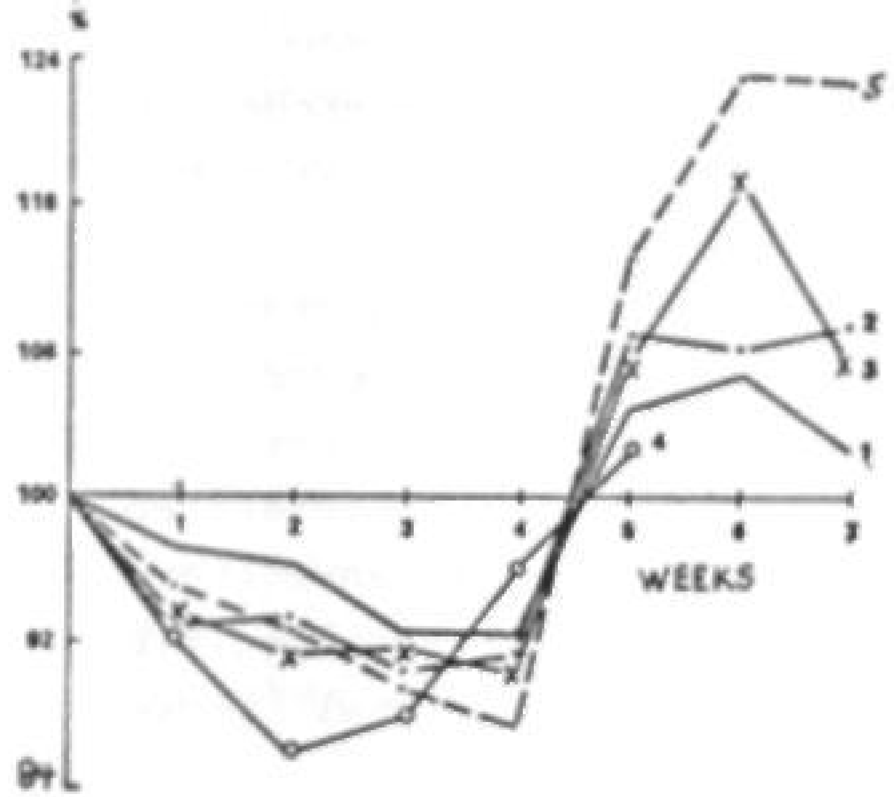


Figure 11. Power of thigh extension dynamics of both legs, in the experiment (V.P. Nedobyvailo, 1981)

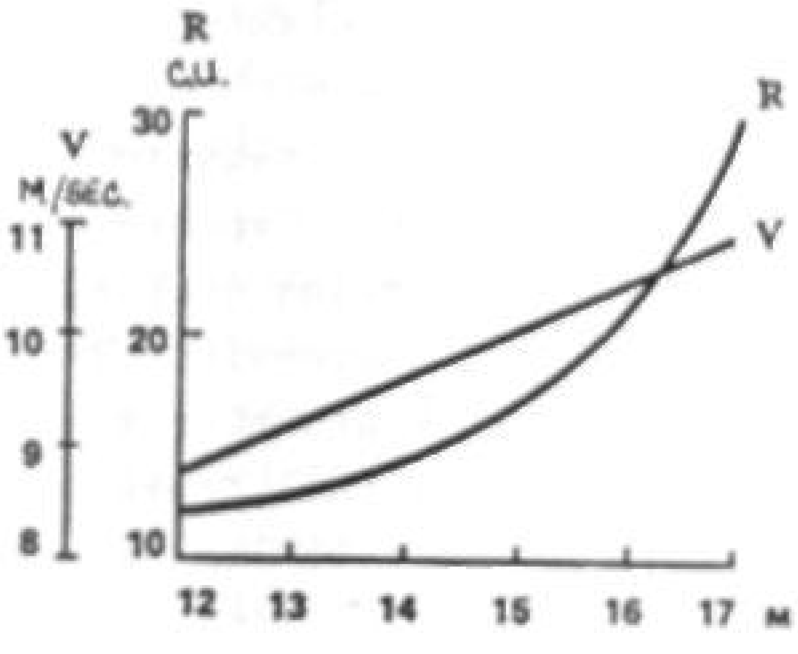


Figure 12. The rise in reactivity (R) of the muscles and running speed (V) along with the increase in triple jump results (Y. V. Verkhoshansky, 1964)

the rehabilitation stage should be. The concept of CAR and the peculiarities of the organism's compensatory adaptation have great practical significance for programming training and especially for rational periodization of yearly training.

2.2 General Regularities of Morpho-Functional Specialization in the Process Attaining Sport Mastery

Morpho-functional specialization is understood to be those stable, accommodative acquisitions that are conditioned by the specifics and conditions of athletics. The qualitative characteristics and quantitative significance of such acqusitions graphically express the adaptational process which is the basis for the physical perfectioning of man. At the same time they characterize the specifics of adaptation, conditioned by the types of sport activities, as well as the peculiarities of its development over time.

All of the life-preserving systems of the organism, without exception, take on adaptive reconstruction. However it is not difficult to notice that those systems that are of chief importance for success in athletics undergo an accelerated rate of functional perfectioning. In this circumstance there is a convenient possiblity for studying the general and specific regularities of the development of the adaptational process in athletics.

We noted (1977) already, that the specifics and the dynamics of the athlete's accommodative reconstruction is determined primarily by two factors — the work-regime in sports and the gradual, but steady complication of the organism's external interactions accompanying the rise in sport mastery.

For example, improvement of the triple jump requires perfectioning of the ability of the support-motor apparatus to display working-effort of great power. Increasing jumping distance (which is accomplished first of all by increasing running speed) is associated with a significant complication of the athlete's interaction with the support at each of the "take-offs"; this requires significant improvement of reactive ability, as characterized by the power of work (figure 12).

Cyclic locomotion, to a great extent, requires perfectioning of the power and the capacity of the organism's systems, crucial for energy-acqusition of muscular work. Energy expenditure increases proportionally to the square of work-power and even greater with the increase in movement speed. For example, oxygen requirements increase during running, consequently energy expenditure is almost proportional to the fourth power, of running speed (Sargent, 1926). Such a "rising cost" of running speed is associated with a strengthening of the portion of the anaerobic reactions for the general energy of work (F. Henry, 1951; R. Margaria, 1963).

We distinguished between two forms of functional perfectioning of the organism in the PASM — organ specialization and ability specialization (1971). The most expressive organ and ability specialization appears when comparing the functional perfectioning of the organism in different types of sports. In one of them, one observes a functional hypertrophy of the motor apparatus (mainly in acyclic locomotions) with the emphasis on perfectioning of the energy-acqusition systems, with the emphasis on aerobic or anaerobic productivity. In the third (combined) there is an intense functional perfectioning of both the support-motor apparatus and the energy-acqusition system.

However, it is important to emphasize that in the first two cases one is not talking about a one-sidedness, but about the chief emphasis of the organism's functional specialization. One can successfully develop a high level of explosive-strength in acyclic locomotion only when one possesses sufficiently high aerobic productivity. At the same time, perfectioning of the energy-acqusition systems in cyclic locomotion should be based on highly developed muscular-strength and local muscular-endurance.

Let's turn now to a number of concrete examples, illustrating the dynamics of the organism's functional specialization during many years of sport training. Presented in figure 13 are alterations in speed-strength of decathletes accompanying the growth of sport mastery. Absolute-strength (Po and Fmax) increased linearly at the same time as the explosive-strength (I and Q); and their increase accelerated along with the rise in sport mastery. This can be explained as the result of the rise in the intensity of muscular contractions with the growth of sport achievements, as well as an increasing portion of intense strength work in the general volume of the training load.

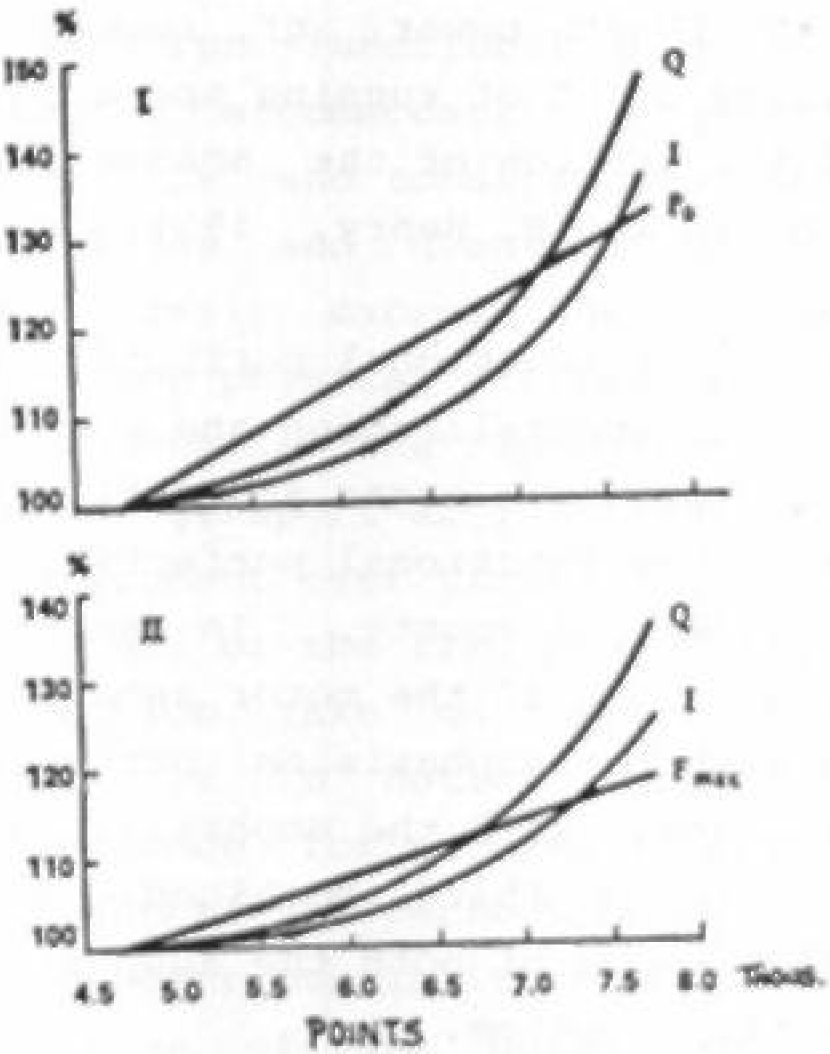


Figure 13. Alterations in decathletes' speed-strength accompanying the growth of mastery. Thigh extension in the isometric (I) and dynamic (II) regimes (O. V. Khachatryan): Po- absolute-strength, I- explosive-strength, Q- starting-strength, Fmax- maximum explosive-effort

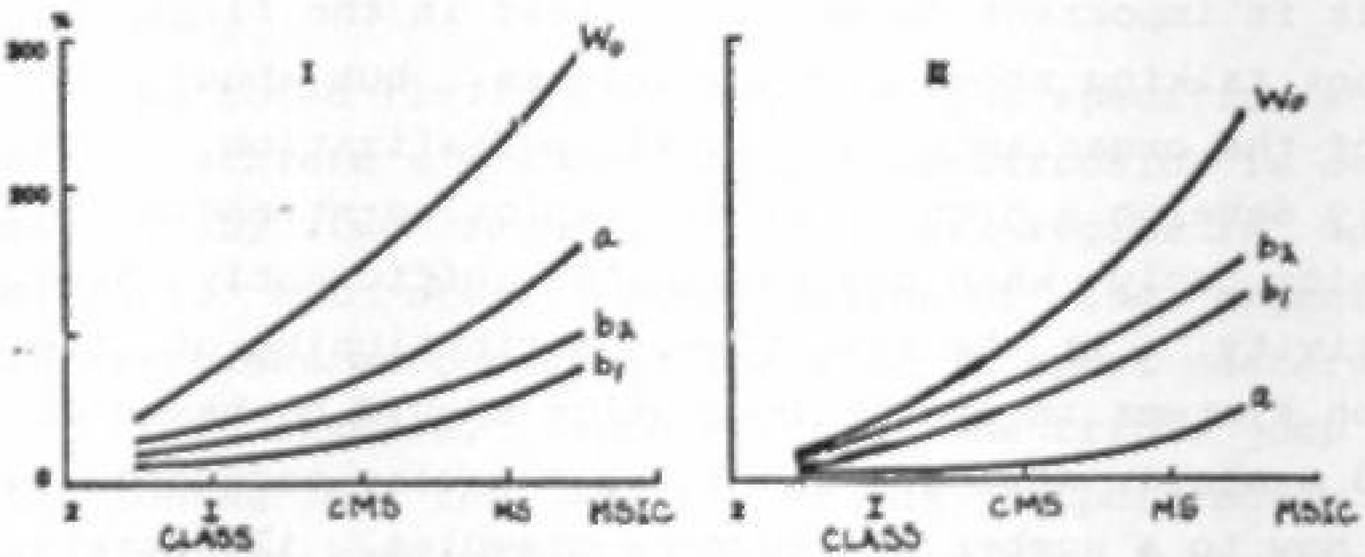


Figure 14. Changes in ergometric work-capacity indicators accompanying the growth of mastery (I- sprinters, II- hurdlers; A.A. Vankov, 1978):
Wo- anaerobic power, a- anaerobic capacity, b^- aerobic criteria of power, b_2- maximum anaerobic power

Accelerated growth of specific-work-capacity at the high mastery level is also typical for cyclic types of sports. The dynamics in various types of sports are approximately equivalent although there are some qualitative and quantitative differences associated with specific types of sports. Thus, swimmers (sprinters) have higher rates and developmental levels of anaerobic productivity, whereas the same is true for aerobic productivity of distance swimmers (figure 14). This is determined by the emphasis of the training.

In the multi-year training of sprinters, up to class I-CMS, the chief emphasis is on the development of general (aerobic) endurance and speed; whereas at the MS-MSIC level the emphasis is on perfectioning speed (anaerobic) endurance. In the training of distance people of all qualification levels, the chief emphasis is on the development of aerobic productivity; and at the MS-MSIC level, the emphasis is on the perfectioning of anaerobic productivity (A. A. Vankov, 1978).

Presented in figure 15 are the general tendencies of the multi-year dynamics of the functional indicators of skaters; it is indicative of the accelerated increase in functional indicators at the high-sport-mastery level. Likewise with swimmers, the magnitude and rate of increase of aerobic and anaerobic productivity are different depending on the athlete's qualification. The largest magnitudes and rates of the 02-consumption are typical for multi-event athletes and distance people; the least are for sprinters. Furthermore, 1500 meter runners and speed-skaters had the largest increase in maximum 02-debt. Multi-event distance athletes were discovered to have the lowest maximum 02-debt (V. S. Ivanov, 1970).]T

The comparable differences among speed-skaters depend on the distance of specialization and were found to be in the speed-strength indicators (table 1). Sprinters differ from distance people by a more expressive ability to develop power in leg extension. Multi-event athletes are in between the two.

Table 1

Speed-Strength Characteristics of Speed-Skaters
for Leg Extension

Specialization	Speed-Strength Characteristics						
	Po	Fmax	I	Q	tmax	tp	N
Sprinters	102	100	281	682	0.36	0.08	62.7
Distance	99	95	217	482	0.48	0.12	49.2
Multi-Event	102	99	246	611	0.41	0.10	57.9

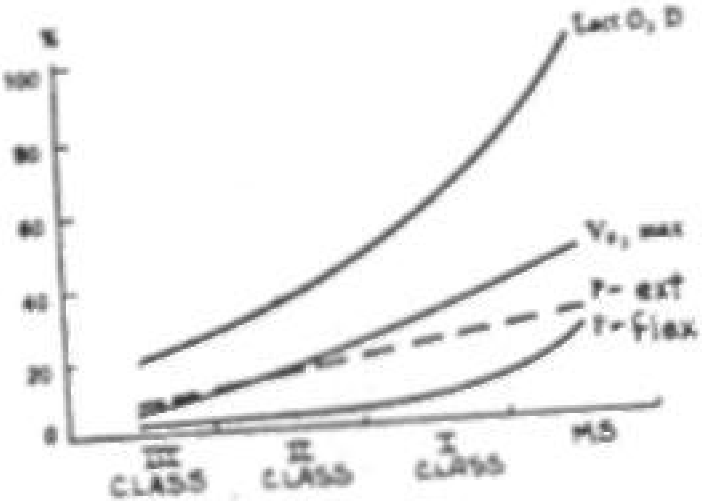
Po - absolute strength, I - acceleration strength, Q - starting strength, Fmax - maximum explosive effort and the time (tmax) of its achievement, time of developing force equivalent to the athlete's bodyweight (tp) and power developed (N).

strength, Fmax - maximum explosive effort and the time (tmax) of its achievement, time of developing force equivalent to the athlete's bodyweight (tp) and power developed (N).

Strength-preparedness, expressed chiefly by the so-called strength-endurance, plays an important role in cyclic types of sports. Available experimental data indicates that with a relatively moderate increase in muscular strength, along with the rise in the athlete's qualification, dynamic-strength-endruance (T) and power of work (N), accelerate the increase in strength (figure 16).

The process of functional specialization is characterized by one important peculiarity; there is a definite sequentialness (heterchronicity) in the development of accommodative reconstruction; the necessity of which arises according to the complexity of the athlete's external influences and the rise in the training intensity accompanying the growth of sport mastery. In other words, the organism responds to external influences with accommodative reconstructions only when they become objectively necessary for the further growth of sport mastery, and only those systems whose functions satisfy all the ensuing requirements.

Research enables us to define three basic tendencies in the dynamics of special-physical-preparedness, relative to sport results (figure 17). The first (A) is characterized by a linear



.igure 15. Changes in the functional indicators of skaters accompanying the growth of mastery (G.M. Panov, 1970; T. L. Sharvovy, 1973)

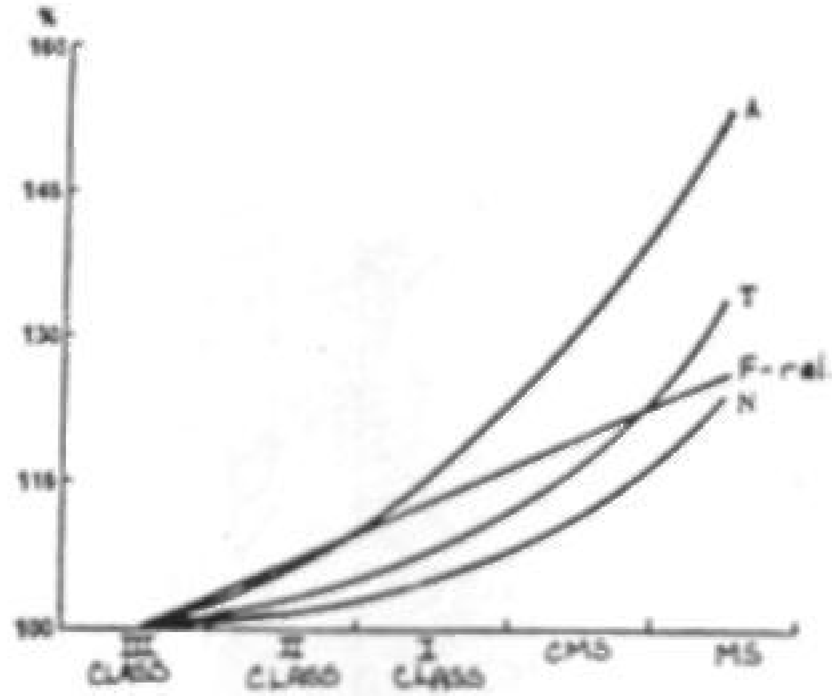


Figure 16. Changes in the ergometric indicators of special-work-capacity (A), dynamic strength-endurance (T), power of work (N) and relative strength (Frel) of women middle distance runners accompanying the growth of mastery (A. Zhurbinoi, 1978)

connection to sport results. The integral indicators of special-work capacity, associated with the first tendency, have a high correlation with sport achievements. The second tendency (B) is characterized by an enhanced rate of improvement in the functional indicators along with the sharp increase in their correlation with results, with respect to the improvement of results. These functional changes chiefly enhance the growth of the athlete's special-work-capacity (A) at the high stages of sport mastery. And finally, the third tendency (C) is characterized by a monotonously slow increase in the functional indicators along with a gradual weakening of the connection with sport results. These functional changes began by rendering a significant affect on the growth of sport achievements; then they play a role in accelerating the increase in the specific indicators of the athlete's special-work-capacity (B).

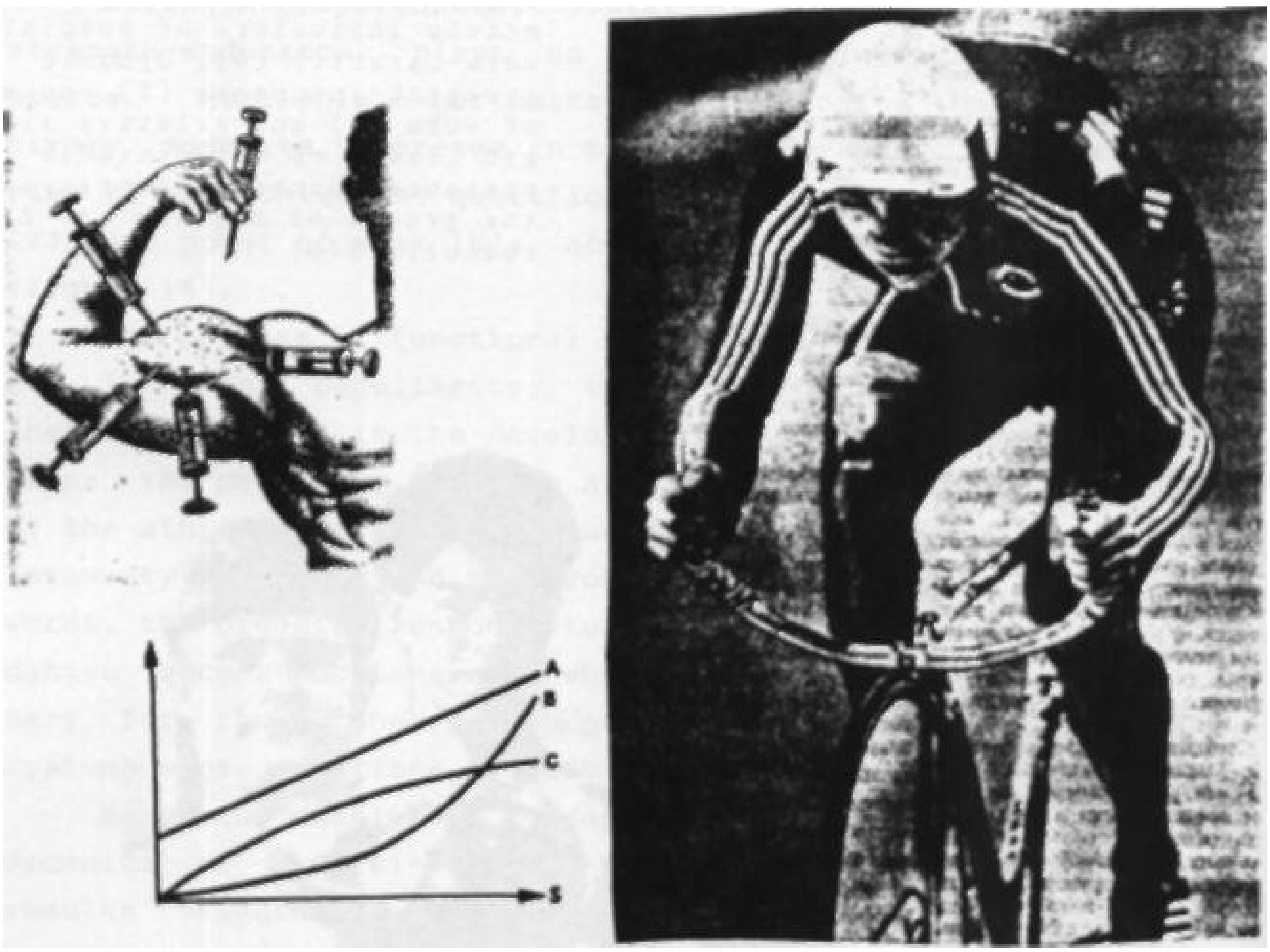


Figure 17. Dynamics of Functional Indicators, Relative to Sport Results
S- **sport results**

The multi-year functional specialization of the organism is closely connected with its corresponding morphological reconstructions. These reconstructions leave traces of the training influences on the organism for long periods of time and are the material foundation of its functional perfectioning. These traces have been studied sufficiently at the muscle tissue, cardiac muscle, skeletal bone structure, cardio-vascular levels and other systems. Exhaustive information concerning this, can be found in the special literature. Further study of the multi-year regularities of morpho-functional specialization in concrete types of sports has important practical significance for the formation of principles of programming training.

2.3 Structure of Special-Physical-Preparedness

The aforementioned regularities of functional specialization during the course of many-years training are associated with specific accommodative reconstructions at the vegetative systems and neuro-muscular levels and with the perfectioning of the central mechanisms that regulate their activities. Therefore it is natural, that the concepts concerning the emphasis of functional specialization and peculiarities of the interaction between the organs and systems, crucial for the steady rise in special-work-capacity, are of great importance for programming training. With respect to this, let's examine, first of all, the question of the so-called physical qualities of a person and their physiological nature.

Characteristics of man's motor abilities (strength, speed, endurance, etc.), established through practice, were convenient for classification and regulation of all the diverse training means and for planning training. However, there was a gradual turn towards, as if, inherent to man, "physical qualities", based on the criteria of the qualitative motor functions of strength, speed and endurance. The second assumption followed the first, which acknowledged that a special physiological mechanism secured each of these qualities. From here, clearly logical, speculative conclusions about the synthetic nature of the structure of physical preparedness were already not far off. It was assumed that one could develop each "quality" separately, then synthesize each of them or other abilities and obtain some derivative from them. Unfortunately, at that time physiology and biochemistry unreservedly interpreted similarly established notions and restricted, relative to them, explanatory functions; furthering, the very same analytico-synthetic methodical conceptions of the physical perfectioning of man, which were held, up to now. At the same time, the foremost practical and scientific achievements in recent years all the more persistantly persuade one that such traditional concepts are slightly antiquated. Therefore, in the interests of resolving the problem of programming training it is necessary to examine this question from several different positions.

In reality, we find those end characteristics of the working-effect of sport movements comprehensively reflect the resulting sum of the functional manifestations of the organism's systems. These will obviously be, in any case, such characteristics as the speed of movement realization or the speed of the athlete's movement. Regardless of whether one is a sprinter or distance runner, a boxer throwing a punch or a thrower accelerating his apparatus, sporting success depends upon the speed of execution. Nevertheless, this does not mean, by a long shot, that some speed quality is the basis for their success. In "pure" forms, speed is displayed in simple, unloaded single-joint movements (for example tapping and swinging the arms and legs in different planes) and is expressed in such relatively independent forms as motor reaction time, individual movement time, ability to begin a movement quickly and maximum movement frequency (F. Henry, et.al., 1960-1968; N. V. Zimkin, 1965; M. A. Godik, 1966).

However, the speed of similar, simple acts has nothing in common with the speed of executing sport movements. The lack of a correlation between characteristic, elementary forms of speed and the speed of movement in cyclic sport locomotion is especially indicative of this (V. S. Gorozhanin, 1976). Immeasurably more complex neuro-physiological mechanisms of regulation and the metabolic processes providing their realization, are the basis for speed of movement in cyclic sport locomotion. For example, a number of qualities determine sprinting ability; they include: explosive-strength of the muscles extending the body; quick acceleration ability at the start; the development and maintenance of maximum running speed as well as resistance to fatigue (F. Henry, J. Trafton, 1951; V. G. Semyonov, 1966; Y. N. Primakov, 1969; V. I. Lapin, 1971). The speed with which one overcomes longer distances is secured through expanding the organism's energy resources and the effectiveness of their utilization (U. S. Farfel, 1939, 1949; N. I. Volkov, 1966; V. V. Mikhailov, 1967; R. Margaria, 1963; P. 0. Astrand, 1956). The speed of execution of acyclic locomotion is determined by the muscles' ability to overcome significant external resistance (U. S. Farfel, 1939; N. V. Zimkin, 1955; D. D. Donskoi, 1960).

Speed in sport movements comes primarily from strength and endurance, although this is conclusive it does not repudiate the presence of "quickness" as a functional quality of man's organism. The latter is as inherent to man as is strength and endurance, but is displayed fully, only in those instances where the external resistance of the movement does not exceed 15% of the limit strength (Y. V. Verkhoshansky, 1973).

In comparison with strength and endurance, theoretical ideas concerning speed, and consequently, methodical aspects of its development have undergone significantly less development. This is especially true of the attempts to correlate speed of movement with the lability of the neural processes (lability of the nervous system); and the reasons why it stabilizes at so-called "speed barriers" (dynamic stereotyping), which occurs as a result of monotonous reproduction of movement with maximum effort; for which they have not found convincing experimental corroboration nor practical, useful resolution.

However, experimental data has accumulated which characterizes genetic and physiological factors which determine and limit speed and its potential realization due to training. Therefore, based on data from the study of the neuro-dynamic mechanisms determining the speed of cyclic locomotion of animals (G. N. Orlovsky, 1970), and their general similarity to man's striding movements (with respect to angular amplitudes, speed and acceleration of joint movements) the assumption is made that very fast sprinters are distinguished by a more effective organization of the systems of locomotion management. This is expressed principally by the connection ("rigidity") between neuro-reticulo-spinal systems and their high impulsation frequency (U. S. Gorozhanin, 1973, 1977).

Man's speed of movement is to a large extent associated with the fast and slow fiber composition of the muscles, which possess different contractile and metabolic qualities (P. 0. Astrand, K. R. Rodahl, 1977; P. V. Komi, 1979). It has been established (H. Rusko, 1976; D. L. Costill, et al., 1976; A. Forsberg, et al., 1976; P. V. Komi, et al., 1977) that people who possess a large quantity of fast fibers in their muscles, under equal conditions, display greater movement speed and ability to generate force (figure 18). It has been shown that sprinters' muscles contain more (up to 75%) fast-contractile fibers (P. D. Gollnick, 1972; A. Thortensson, et al., 1977) and that long-distance runners have more (up to 90%) slow contractile fibers (D. L. Costill, 1973).

And finally, available information indicates that strength of the nervous system is a factor determining and limiting individual speed level (B. I. Teplov, 1961; V. D. Nebylitsyn, 1966; V. I. Rozhdestvensky, et al., 1969; V. M. Rusalov, 1972). It has been shown that people with low strength of the nervous system (i.e., easily excitable, impulsive) are distinguished by great speed of movement (V. S. Gorazhanin, 1977; N. A. Sultanov, 1979; Y. B. Ilin, A. V. Malchikov, 1979; B. I. Tabachnik, et al., 1978).

So, speed, as a characteristic of man's motor potential has a level that is to a great extent, predetermined by genetics, and its perfectioning in training is restricted to the limits of this level. Therefore, the preparation of high-class sprinters is associated not so much with the absolute development of speed as it is with the selection of genetically gifted people and the

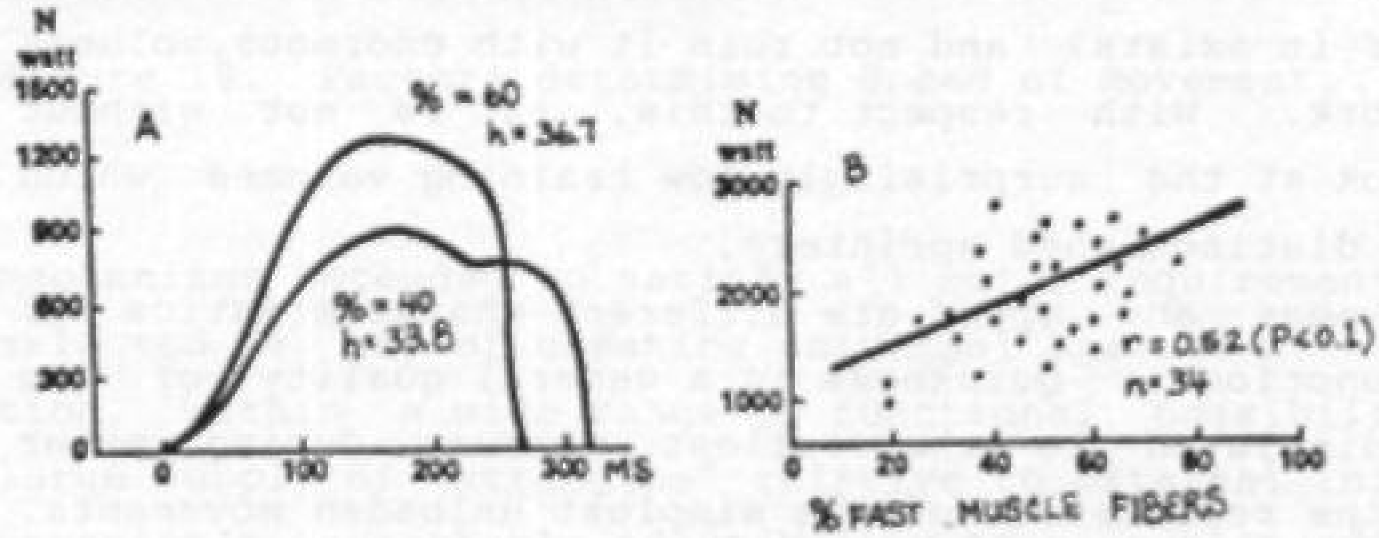


Figure 18. A-F(t) curve of the vertical jump take-off of athletes with different muscle fiber ratios.
B-ratio between the power of the take-off and % of fast muscle fibers during the take-off (P. V. Komi's data. 1979).

rational organization of training, such that it enables one to effectively utilize one's natural ability. The halt in improvement of results in sprinting is not due to a "speed barrier" but an exhaustion of the individual limits of a person's speed potential.

New experiments are necessary before all of the factors determining man's speed of movement are ascertained. However, based on available data, it is necessary to be critical of unjustified hypothesis that for many years forged the creative initiative of scientific search to sport-physiology, and mislead sport-practice.

It is important to point out that maximum speed can be realized only if the corresponding movement has sufficient energy for its execution. Consequently, in those types of sport where man achieves high speeds, needs to overcome significant external resistance or resist fatigue, it is necessary to look not so much at the development of speed, but the perfectioning of those functional systems of the organism, which, in each concrete case, make it possible to execute the motor task with the greatest speed possible. It is a question of the strength potential of the muscles and the effectiveness of the metabolic processes determining their capability to do endurance work. In those exclusive instances where speed of movement does not require strength or endurance, it is necessary to approach this quality cautiously (if it exists) and not ruin it with enormous volumes of useless work. With respect to this, it is not without interest to look at the surprisingly low training volumes which are typical of distinguished sprinters.

So, quickness and speed are different characteristics of man's motor functions. Quickness is a general quality of the CNS; it is displayed to the fullest measure during motor reactions and the realization of the simplest unloaded movements. The individual characteristics of quickness in all of the forms in which it is displayed are conditioned by genetic factors, and therefore the potential for its development is limited.

Speed of movement or displacement is a function of quickness, strength, endurance as well as the athlete's skill to rationally coordinate his movements, depending upon the external conditions under which the motor task is to be executed (figure 19). Unlike quickness, there is unlimited potential to perfect speed of movement.

Now it is important to turn one's attention to the fact that different conditions in sport require a working-effect of movement secured by the same chief organ (the support-motor apparatus) and the same regulatory centers, during the active participation of all the functioning systems of the organism. Evolution has not provided man a collection of narrow-specialized

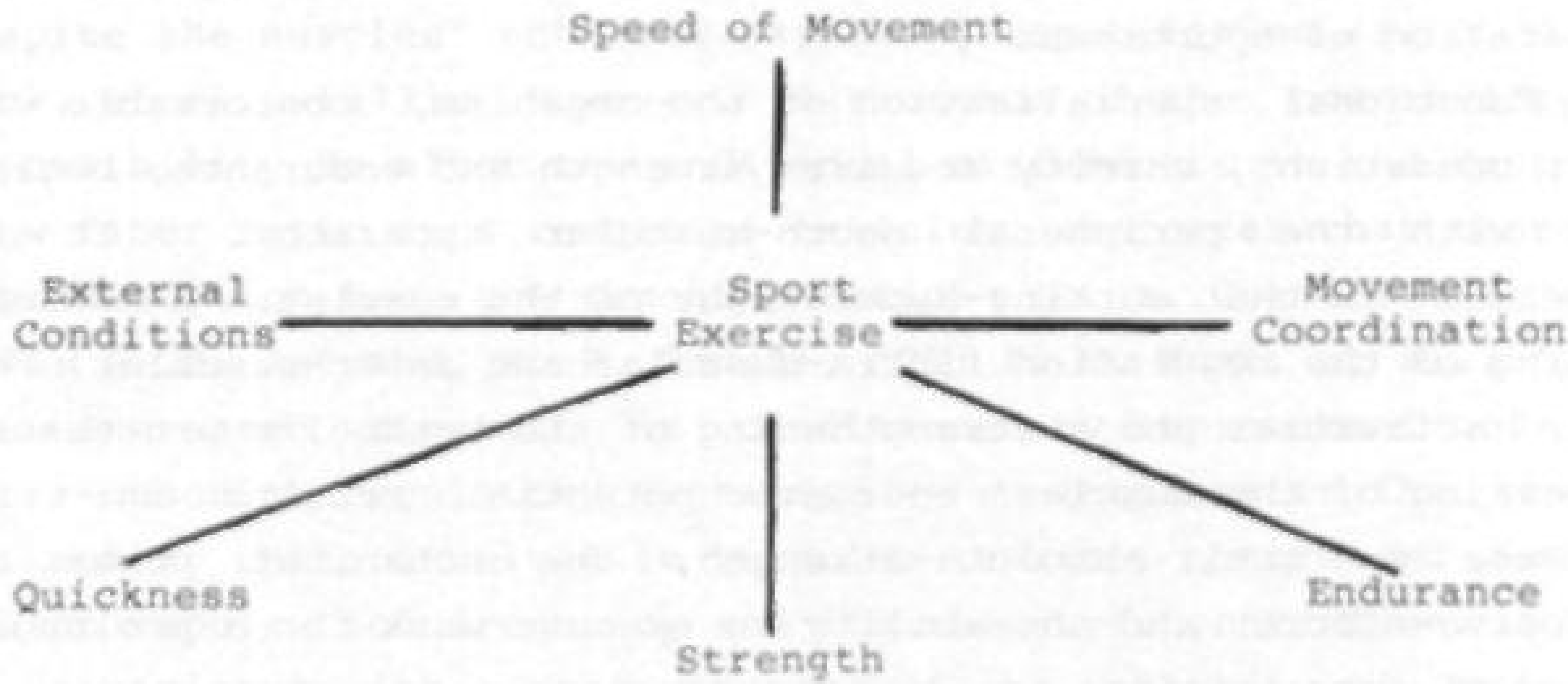


Figure 19. Factors determining Speed of Movement.

mechanisms intended to satisfy all motor requirements. Evolution selected a way of creating universal systems of life-preservation, within a wide range of functional possibilities, and a large supply of "strengths" relative to external influences. The organism's remarkable adaptability to unusual conditions in the environment comes about by means of functional hypertrophy of those of its organs and systems which directly resist extreme factors. Sport activities are perfect examples.

Consequently, some-sort-of special mechanisms, crucial only for speed, strength or endurance, do not exist. Any sport activity is procured by the same functional systems of the organism. However, as a result of systematic training, these systems specialize in conformity to the chief emphasis of the motor regime, which is inherent to the sport activity. Thus, enhancement of the athlete's special-work-capacity is associated, not with the development of "qualities", but with the functional specialization of the organism in that direction necessary for the displaying of a high degree of strength, speed or endurance. This conclusion is the basis which permits one to alter, with respect to established, traditional methods, the special-physical preparation of sportsmen.

Functional specialization of the organism, conformable to sport conditions, chiefly requires strength and endurance, beginning with the peripheral neuro-muscular apparatus. It is expressed in the working-hypertrophy of the muscles, a perfectioning of the regulation (intra-muscular and inter-muscular) of their activities and a strengthening of the metabolic processes. A raising of the muscles' energetic potential results in: an increase in their absolute-strength, the mechanical power of explosive-effort and the ability to execute work for a prolonged period of time.

The working hypertrophy of muscle is a manifestation of an increase in the physiological diameter of the muscle due to a thickening of the fibers and an increase in the number of capillaries to the muscle. When maximum or explosive-effort are required, working hypertrophy is associated with an increase in myofibril volume (i.e., the contractile apparatus proper of the muscle fibers) and primarily, an increase in the high-threshold (large) motor units. However, muscle volume may increase insignificantly because of increased myofibril-layer density in the muscle tissue.*

Thickening of the muscle fibers, as a result of endurance work, occurs through an increase in capillary volume (i.e., the non-contractile parts of muscle fibers), which results in an increase in the muscles' metabolic reserves (glycogen, creative phosphate, myoglobin, etc.) and improvement of the muscles' oxidizing qualities.

Training for strength or endurance can result in selective hypertrophy of the fast or slow fibers (B. Saltin, 1973; J. S. Skinner, T. H. McLellan, 1980). However, the percentage ratio of

* Available data indicates that an increase in muscle mass occurs not only through hypertrophy of muscle fibers, but as a result of an increase in the quantity of fibers by means of splitting of hypertrophied muscle fibers and the development of muscle fibers from muscle "buds" and cellular-satellites (V. Z. Gudz, 1968, 1976).

both fiber types and their contractile qualities do not change despite the muscles' enhanced oxidizing capabilities (P. D. Gollnick, et al., 1973). However, discussion of the possibility or impossibility to alter the individual differences in the fast and slow fiber ratio as a result of training, indicates that there is a predilection for the second position (D. L. Costill, et al., 1976; P. 0. Astrand, K. R. Rodahl, '77; P. V. Komi, et al., '77).

Increased strength is conditioned by improvement of the intra-muscular regulatory mechanism — an increase in the number of motor units involved in muscular tension, increased motor-neuron impulsation frequency and its time synchronization. This is associated with a strengthening of the intensity of the excitatory influences, to which the motor-neurons are exposed from the neurons and receptors of the higher motor levels (the motor cortex, subcortical motor centers, intermediate neurons of the spinal cortex).

Maximum strength is increased chiefly by involving large (high-threshold) motor units in the contraction; and when doing endurance work small (low-threshold) units. In the latter case it is possible to alternate their activity, which enables one to maintain work-capacity longer. Explosive-strength, is manifested by a rapid intensification of working tension; and to a significant extent is determined by the nature of the motor-neuron impulsation activating the muscles. It is chiefly the motor-neuron's initial impulsation frequency and degree of synchronization that results in a faster mobilization of the motor units.

It has been shown that the F(t) curve of explosive-effort has three components (Y. V. Verkhoshansky, 1963, 1970) and is determined by such qualities of the neuro-muscular apparatus as: absolute-strength, the ability to quickly generate external force at the beginning of working-tension (starting-strength) and the ability to intensify working-force at the beginning of movement, i.e., muscle contraction (acceleration-strength). The correctness of isolating starting and acceleration-strength has been corroborated by electro-myo-graphic research; which revealed differences in the motor-neuronal ensemble inherent to them; and recruitment of motor-units and impulsation frequency of the motor-neurons during the development of explosive-force (N. A. Masalgin, 1980). This confirms the assumption that starting-strength is to a certain extent conditioned by the innate qualities of the neuro-muscular apparatus, and in particular, the ratio of fast to slow fibers in the muscles (figure 20).

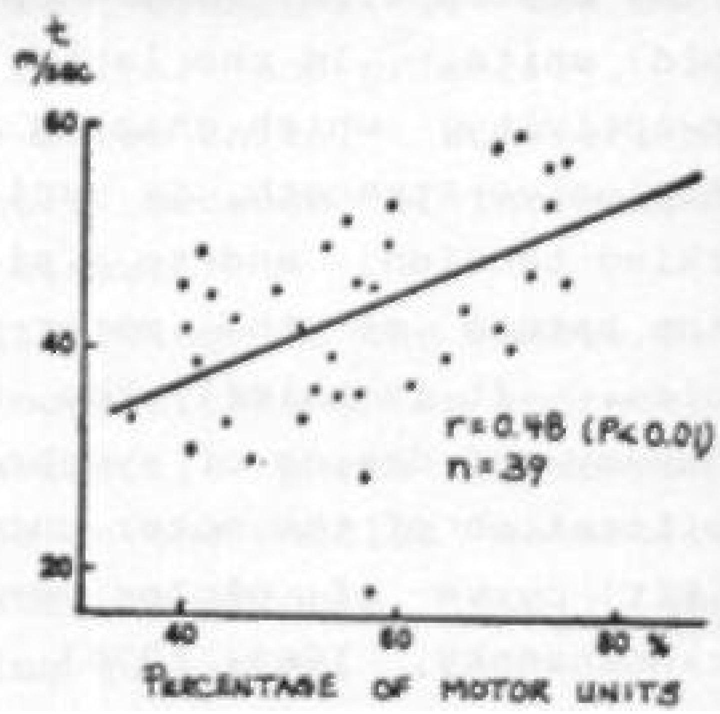


Figure 20. Ratio between % of slow motor units and time of achieving 30% of Po force (I. T. Vutasalo, P. V. Komi, 1978).

The specialization of the neuro-muscular apparatus to primarily develop absolute, starting and acceleration-strength is conditioned chiefly by the magnitude of the external resistance the athlete overcomes. Thus, as the moment of inertia of a rotating mass increases, resisting movement; in a factoral structure of explosive-strength characteristics, the roles of starting-strength and speed of movement decrease; and vice-versa, the roles of absolute and acceleration strength increase (table 2). Thus, the greater the external resistance, the larger the role of absolute-strength; its connection to body dimensions and stage of training has been confirmed indirectly.

Table 2

Alterations in Factor Structure of Speed-Strength Characteristics of Explosive-Effort (Thigh Extension) of Discus Throwers, with Increasing Resistance (in %, I. M. Dobrovolsky)

Order of Factors	Factors Magnitude of External Resistance		
	Me = 44 kg	Me = 572 kg	Me = 1143 kg
I	Absolute Strength 24.0	Absolute Strength 32.1	Absolute Strength 34.7
II	Starting Strength 15.4	Acceleration Strength 17.2	Acceleration Strength 16.2
III	Speed of Unloaded Movement 13.1	Starting Strength 12.6	Body Dimensions, Stage 13.5
IV	Acceleration Strength 12.2	Body Dimensions, Stage 10.5	Explosive Strength 11.3
V	Speed of Loaded Movement 11.0	Speed of Unloaded Movement 9.1	Explosive Strength 9.1
VI	Body Dimensions Stage 7.5	Explosive Strength 7.3	Speed of Unloaded Movement 8.4

The functional specialization of the organism, over many-years of training, is associated with the perfectioning of the metabolic processes providing the energy for muscular work, by maintaining the ATP balance. Thus, in explosive-effort types of sports or sports where there is relatively brief work of high intensity, energy-acquisition by the functioning muscles is improved by raising the power of the metabolic processes, i.e., the speed of energy liberation and restoration of ATP balance.

chiefly by anaerobic means (phospho-creatinase reactions). During prolonged work of submaximum power, more capacious metabolic processes are utilized and perfected, the basis of which is the anaerobic oxidation of carbohydrates (glycolisis). This method of resynthesis of ATP is not as powerful as the phospho-creatinization reactions, but in connection with the greater supply of oxidizing substances (carbohydrates) it has a greater capacity. And finally, during prolonged work of moderate intensity, the highest (aerobic) resynthesis of ATP capacity is utilized, where in addition to carbohydrates, lipids can be used.

The correct concepts concerning energy-acquisition for muscular work, play an important role in resolving the methodical questions of training. It has already been pointed out (see 1.4) scrutiny of the functional specialization of the organism at the vegetative and motor systems level is unacceptable, especially knowledge of the physiological mechanisms of endurance with respect to the "respiratory" functions and maximum oxygen consumption (MOC). And, since existing viewpoints of endurance are still based on such notions, improvement of modern methods of endurance development is now, particularly urgent. Let's look at this question in detail.

First, athletes who have equivalent MOC levels show different results, and vice-versa, athletes with different levels of aerobic productivity demonstrate the same results. For example, top middle-distance runners of the 40's had the same MOC indices as today's athletes, despite significant differences in sport results (J. Faulkner, 1968). There are no reliable differences between athletes of different qualification, in the development of aerobic potential; however, these differences are reliable with respect to anaerobic productivity (M. Y. Nabotnikova, 1972; B. S. Serafimova, 1974; H. Rusko, 1976 and others).

Second, the MOC levels in highly-qualified athletes stabilizes, but results continue to improve. For example, over a 4-5 year period the MOC levels of the best Soviet and Swedish skaters stabilized, although their results improved from year to year (V. A. Orlov, T. L. Sharova, 1977). MOC levels remained practically unchanged in qualified cyclists (road-racers) over many-years training, while results improved (G. V. Melenberg, et al., 1972).

Third, a reliable decrease in MOC levels has been observed in the competition period, especially in cyclists (V. A. Bakhvalov, 1974; V. M. Zatsiorsky, et al., 1974), swimmers (B. S. Serafimov, 1974; V. M. Volkov, et al., 1974; V. I. Naumenko, 1978), skiers (V. V. Vasiliev, V. V. Trunin, 1974; A. G. Zima, et al., 1975), skaters (B. A. Stenin, 1973; Y. N. Vavilov, 1977), middle-distance runners (S. A. Loktyev, 1978, E. P. Borisov, 1979; V. A. Sirenko, 1981) and hockey players (V. M. Koloskov, 1976). There is a decreasing correlation between MOC and sport results. This correlation is r = 0.7 in the preparation period and it is r = 0.4 in the competition period (V. V. Vasiliev, V. V. Trunin, 1974; G. V. Melenberg, 1981).

So, the data presented indicates that MOC, in-and-of-itself is no guarantee of high sport results. Apart from aerobic power, other factors play a role, in the opinions of specialists; such as the ability to perform work for a prolonged period of time at a level of oxygen consumption, close to the MOC and the ability to effectively utilize available energy potential under competition conditions. This concerns the decrease in MOC in the competition period; this phenomenon was explained as the detrainability of the aerobic functions or the antagonism inherent to the aerobic and anaerobic processes (V. M. Zatsiorsky, et al., 1974; N. I. Volkov, 1975).

Practical improvement of the metabolic processes in endurance sports is associated with expansion of the potential to utilize aerobic sources of energy-acqusition by raising the Threshold of Anaerobic Exchange (TANE), i.e., that level of oxygen consumption at which the anaerobic processes are activated. Anaerobic work is approximately 50% as effective as aerobic, therefore it is to the athlete's advantage to execute prolonged, intense work without the preliminary accumulation of lactic acid and to include anaerobic energy-production (E. H. Christensen, P. Hogberg, 1950).

Since TANE depends on MOC, it is considered expeditious to strive to raise MOC; and in particular, to create some "reserve" of aerobic power at the end of the preparatory period in order to avoid a decrease in MOC in the competition period (in connection with increasing the portion of anaerobic glycolytic loading) and render a negative affect on the athlete's specific work-capacity. Considering that a significant portion of the energy-acquisition of intense muscular work is realized by drawing in the glycolytic mechanism of ATP resynthesis, it is advisable to execute a specific part of the training load with a high lactate concentration in the blood.

However, recent data indicates that an increase in endurance is associated more with enhancing the muscles' ability to utilize a higher percentage of the oxygen in the blood than with increasing the amount of oxygen in the blood stream and improving the oxygen supply to the working muscles (B. Ekblom, 1969; L. B. Rowell, 1971; B. Saltin, 1974). Consequently, it is not the magnitude of MOC, but intra-muscular factors, conditioning the adaptation of the muscles to prolonged intense work, which determine the sportsman's endurance. A rise in intra-muscular energy potential, the power of the oxidation processes and the contractile (strength) qualities of the muscles, decrease the speed of glycolisis (E. A. Newshalme, P. Y. Randle, 1964; B. Saltin, J. Karlsson, 1971; P. Paul, et al., 1966; G. Grimby, et al., 1967). At the same time, there is a significant drop in the end products of metabolism, including the speed of oxidation of lactate in the working muscles (T. Jorfeldt, 1970). It is in the skeletal muscles and not in the liver and myocardium, as has always been believed, where there is a drop in lactate during and after work (T. Jorfeldt, 1970; H. G. Knutten, 1971; P. D. Gollnick, L. Hermansen, 1973).

So, the development of endurance is associated with the functional specialization of the skeletal muscles -- the enhancement of their strength and oxidation qualities; and not with improvement of respiratory abilities. Well then, the fundamental emphasis in the development of endurance should be to decrease the portion of glycolisis in supplying the energy for work and improvement of the muscles' ability to oxidize lactate during work; and not trying to get "accustomed" to high levels of lactate concentrations in the blood. In other words, the development of endurance should be oriented chiefly to the elimination of the non-conformity between the muscles' glycolytic and oxidational abilities, which is the main reason for the high concentration of lactate; and, to maximum utilization of the aerobic pathway of energy-acquisition for the organism.

Recently, hemo-dynamic factors have been shown to play an important role in the functional specialization of the organism during endurance work (V. V. Vasiliev, 1970, 1974; P. P. Ozolin, E. B. Partsik, 1970; M. S. Danilov, 1980; G. G. Kurbanov, 1977; L. B. Rowell, 1971; L. Kaijser, 1970; J. Karlsson, 1971; P. D. Gollnick, et al., 1975). The redistribution of blood and an increase in circulation to the working muscles contributes to satisfying the muscles' oxygen requirements and the removal of anaerobic metabolites.

Differentiation of the vessicular reaction providing effective redistribution of blood-flow and an optimal blood-supply to the working muscles takes place in the competition period, as a result of the significant aerobic loading executed during the preparatory period. For example, improvement of cyclists' results (in 25 km road-racing) were accompanied by a decrease in MOC in the competition period; and just the opposite, the peak blood-flow to the lower extremities increased (figure 21). At the same time, cardiac output decreased in the competition period, which is indicative of the economization of the functioning of the cardio-vascular system (N. A. Stepochkin, et al., 1970). The very same conditions creating economy of aerobic energy-acquisition, decrease the volume of glycolytic reactions and, consequently, lessen the organism's dependence on MOC for its work-capacity. In this way, it is possible to eliminate the basic reason for the decrease in MOC during the competition period; and if this is so, then the assumption concerning the existance of an antagonism between the development of the aerobic and anaerobic mechanisms can be placed in doubt (G. V. Mellenberg, M. U. Khvan, 1982).

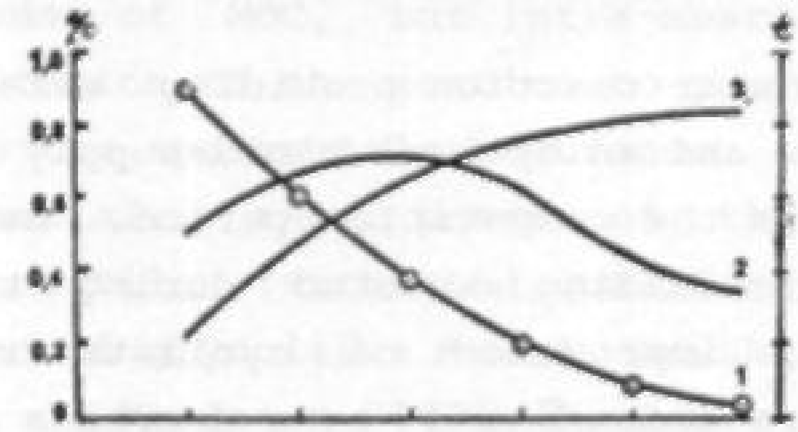


Figure 21. 25-kilometer cycling results (1) and alterations in its correlation with MOC (2) and peak blood flow to the lower extremities (3) independent of the volume of the training load in the year cycle (G. V. Mellenberg, 1981):
I - Preparatory Period
II - Competition Period

One should consider the fact that TANE and MOC levels can change independent of each other; while there is some decrease in MOC during the competition period, TANE can increase (V. M. Zatsiorsky, et al., 1974; V. A. Sirenko, 1979; A. A. Nurmekivan, 1974). Research indicates that lactate concentration in the blood can increase, as a result training, by 16%, but the MOC level in the blood increases by only 7% (C. G. Williams, et al., 1967). It has also been shown, that if the mean percentage change in MOC of qualified skaters is 5-10% in the competition period, then the reaction of regional blood-flow is altered more significantly (50-250%) [G. V. Mellenberg, 1981). This also corroborates the fact that the effect of training does not consist of raising MOC, but in perfecting the hemo-dynamic function of oxygen transport; which satisfies the oxygen requirements of the tissues and is conditioned by a decrease in the contribution of anaerobic metabolism.

Consequently, along with the rise in strength and oxidation qualities of the muscles, the redistribution of blood flow and improved local vessicular reaction are important conditions for development of the so-called local-muscular-endurance. Sport exercises are performed by specific muscle groups. And, in-so-far-as the metabolic processes in these muscles are especially intense, then it is within them that the products of anaerobic exchange accumulate; resulting in fatigue and decreased work-capacity. Therefore, the muscles' adaptation to anaerobic work is clearly, selectively local in nature. For example, if one trains different muscle groups, then one can achieve an approximately equivalent functional effect at the vegetative systems level. However, it is displayed only in specific situations, i.e., while working those same muscle groups (J. Clausen, et al., 1970; J. Holmer, P.-O. Astrand, 1972). With skiers, running and imitation skiing without poles raises the general functional level in the preparatory period, including MOC; however they do not develop that specific physical preparedness that is necessary for speed of movement on skis. Whereas imitation skiing and "skiing" on rollers with poles contribute to the development of local muscular endurance and the formation of a vessicular reaction in the muscles of the upper extremities; which lead to a rational redistribution of blood flow and an increase in special-work-capacity applicable to skiing (V. D. Yevstratov, et al., 1975).

Local muscular endurance is the athlete's ability to display the strength component of movement for a prolonged period of time. This can be demonstrated by the example of 400 meter running, especially in the alterations in the stride length (L), and the tempo (T) ratio, with the increase in sport mastery (figure 22). It is not hard to conclude that stride length is maintained during some decrease in tempo, at the high-mastery level, by local strength-endurance. In all cases, with athletes of different sex and qualification (in the fatigue state), stride length decreases to a greater extent than tempo, but the decrease in speed is due exclusively to the role of the strength factor.

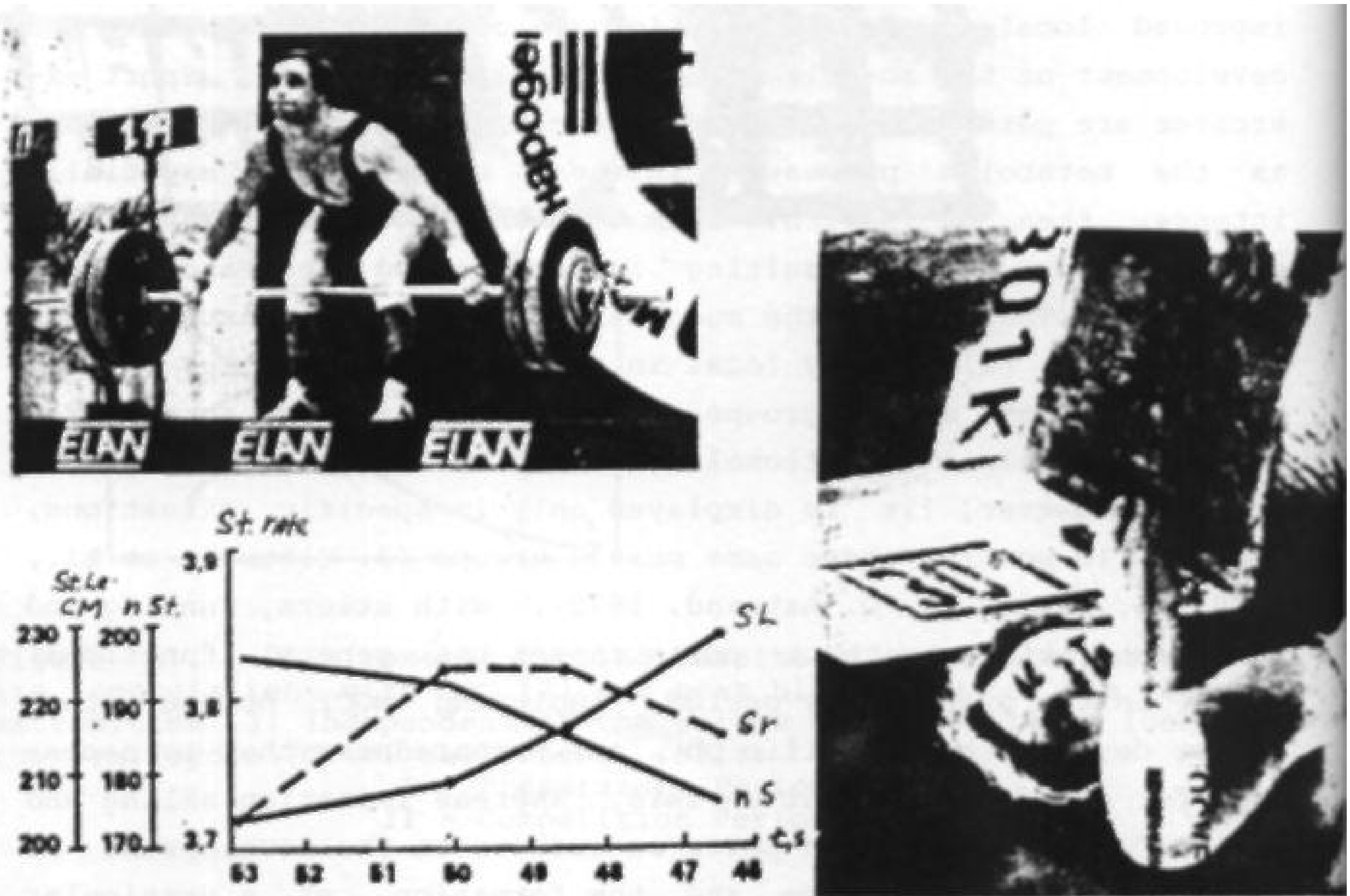


Figure 22. Alterations in stride length accompanying the rise in the speed of running 400 M (V. F. Popov, 1972).

So, the role of local muscular endurance in sports requiring prolonged maintenance of a specific work-capacity, is quite obvious. However, methodical ways of emphasizing the development of local muscular endurance still need serious experimental work. Undoubtedly, one should look for ways to intensify muscular work in those regimes, inherent to the specific sport and as means of such intensification -- to utilize special-strength exercises (Y. V. Verkhoshansky, 1977).

With respect to what has just been discussed, one should look at the experimental data that shows strength-training, to a greater extent than endurance-training, leads to a rise in hemoglobin content (Y. A. Petrov, V. I. Lapchenkov, 1978) and myoglobin (P. K. Pattengale, I. 0. Holloszy, 1967, H. Hemmingsen, 1963); and that strength-training, even in the beginning stages of training, contributes more to the largest improvements in distance sports than aerobic training (G. P. Neminushchii, V. P. Filin, 1972; V. M. Gavrilenko, V. V. Mikhailov, 1981). Researchers pointed-out the importance of local (strength) endurance for cyclic types of sports long ago (H. Reindel, 1962; F. Fetz, 1965; T. Nett, 1964; E. Asmussen, 1969; B. Cook, P. Byrnston, 1973; M. Simri, 1974; A. A. Nurmekivi, 1974). Unfortunately, in our time, its role has not been given its due. Methodical conceptions concerning endurance development were oriented chiefly to improving the vegetative functions; mainly by distance work, which are a factor in making progress in cyclic sports; especially middle distance events in running.

Furthermore, the aforementioned data justifies the important significance of solving the methodical problem of endurance, from the standpoint of where it is considered a complex of motor abilities (H. Reindel, 1962; H. Roskamm, et al., 1952; Y. Brogli, N. Antonov, 1969; L. A. Larson, P. D. Yocom, 1952; S. Posker, I. Steblo, 1967; F. Wilt, 1970). In accordance with this, the characteristics of endurance are defined as the vegetative functions, providing the oxygen the organism needs and the functional state of the neuro-muscular apparatus. From this standpoint, the development of endurance should be carried-out in a complex way, based on the inter-conformity of improvement in vegetative functions and the motor organs and a balanced regulation of their functions.

These characteristics of endurance are in accordance with the conceptions of the motor-visceral reflexes (M. R. Mogendovich, 1962) and the energy principle of the skeletal musculature (I. A. Arshavsky, 1967); in conformity with which, the effectiveness of muscular work is determined by the interdependence between the external structure of the motor act, the topography, sequentialness and the work regime of the muscles taking part on the one hand; and the respiratory, circulatory and energy reactions forming within the organism, on the other. With respect to the interdependence of the vegetative and motor functions, the latter plays the key role in-so-far-as the locomotor apparatus and the specifics of its activities determine the state of the vegetative systems, the character and emphasis of their functional perfectioning. It is necessary to point out that the functional unity and inter-amplifying role of the vegetative systems and the motor apparatus are important for improving work-capacity not only in endurance type sports but in all types of sports. Therefore, to make a distinction between them, which is quite typical in the methodics of special-physical-training, is a flagrant error.

So, returning to the process of functional specialization of the organism over many-years training; its most general features are presented in the pyramid type of scheme (figure 23). Man is endowed with an unlimited ability to resolve any motor task and to quantitatively perfect this ability. Nature has given him universal mechanisms of coordination, regulation and energy-acquisition for motor function; and accommodation for the realization of movements requiring the display of speed, strength, or endurance. These mechanisms fully ensure the success of man's activities in the conditions of daily living and have extensive adaptive possibilities (first tier of the pyramid). Alterations in everyday living conditions, brought about by sport activities, activates the motor function. The motor function specializes chiefly by emphasizing the development of the ability to display explosive force and specific endurance (the second tier of the pyramid); independent of the type of sport. Then the in-depth stage of functional specialization of the organism follows, which along with improving further its life-protection mechanisms, it forms the structure of the athlete's special-physical-preparedness (the third tier of the pyramid). The latter presents its own rational form with respect to the interaction of the vegetative and motor systems, which secure the athlete's high work-capacity in sports. Within the confines of such structures, the functional systems unify in correlational and subordinational relationships. In the first case (a correlational relationship) the form of their relationship is characterized by the effective interaction of all the systems responsible for securing the working requirements of the organism; in the second case (subordinational relationship) the productivity of one system is enhanced by the functional potentials of the others. The structure of special-physical-preparedness is definitive, in-so-far-as it is determined by the organism's specific work regime, and does not conform to conditions, inherent to other types of sport activities.

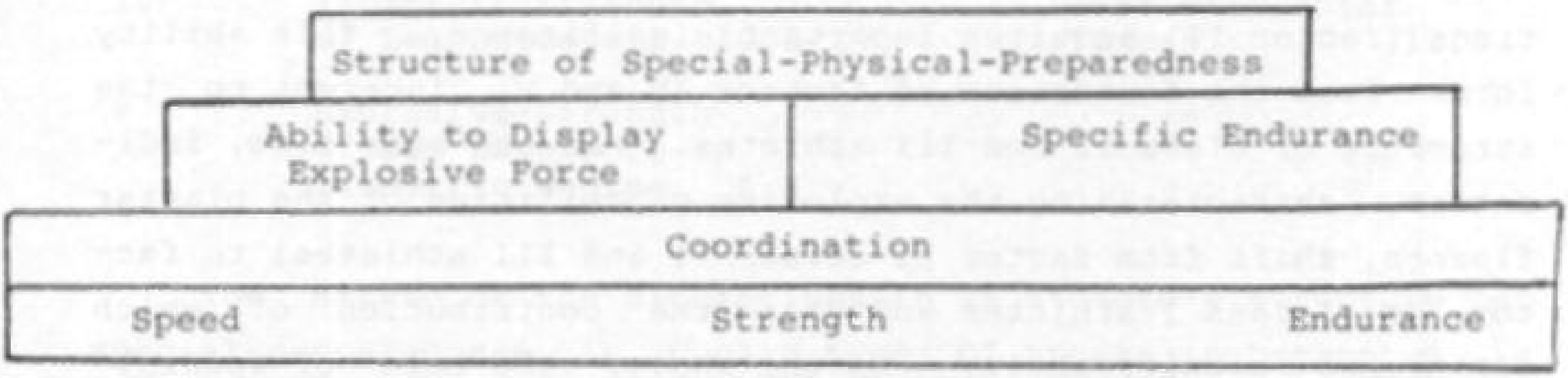


Figure 23. General Sequence of the organism's functional specialization over many-years training.

Methodical study of the structure of special-physical-preparedness is realized with the help of complex statistical analysis of a wide range of characteristics, which assess the various aspects of the athlete's work-capacity. Results of a factor analysis are especially informative in those instances when one of the composite characteristics assesses the preparedness (state) of athletes of different qualification or the same athlete at different stages of preparation.

This type of material, obtained in many types of sports, indicates that there are essential alterations in the structure of an athlete's physical-preparedness with the growth of mastery. These alterations have been observed in athletes of high and low qualification; but at the high mastery level, they appear in two forms. One of them appears in the first-grouping of composite factors and the expanding portion of contributions in the generalization of dispersion excerpts; from which acquire primary significance with the growth of mastery. Typically the formation of qualitatively new factors for the second form, replace one, usually a general factor or unify two "old" factors.

The data presented in table 3 shows that athletes (high jumpers, class I-MS), along with the growth of mastery, form the specific ability to generate powerful force during the take-off in jumping exercises (factor I) and perfect the ability to powerfully extend the body with the active participation of the back muscles (factor III). The ability of the extensor-muscles of the take-off leg to display explosive force under isometric conditions (factor II) acquires important significance. This ability forms from the foundation of factors IV and V, inherent to the structure of class II and III athletes. At the same time, indicators, characterizing the explosive capabilities of the plantar flexors, shift from factor II (class II and III athletes) to factor IV (class I athletes and MS); the contribution of which diminishes significantly. On the whole, the role of special-physical-preparedness of jumpers increases, about which the rise in the general dispersion of excerpts from 79.2 to 81.1% is indicative.

As an important practical consequence emanating from the data presented, one needs to take note that the contribution of isometric strength in the formation of the specific ability to generate explosive force in the take-off acquires great significance for athletes of high-qualification. This is due to the large loading the muscles experience in the take-off of jumping; where the support (take-off) leg acts as a lever, and converts the angular vector speed of the body, acquired in the run. Purthermore, the plantar flexors play a diminishing role, because under enormous overloading the muscles of the support leg are already unable to make a significant contribution to the dynamics of the take-off.

Table 3

Factor Structure of Special-Physical-Preparedness of High Jumpers (in %, S. V. Nikitin)

Factor Order	Factors: Class II-III Athletes		Class I - MS	
I	General Athletic Preparedness	29.6	Special Athletic Preparedness	27.4
II	Power of Plantar Flexors	19.6	Power of Leg Extension in Isometric Regime	23.4
III	Power of Leg Extension in Dynamic Regime	13.0	Power of Leg Extension in Dynamic Regime	18.5
IV	Isometric-Strength of Leg Extensors	10.5	Power of Plantar Flexors	11.8
V	Explosive-Strength of Leg Extensors in Isometric Regime	6.5	--	

The nature of the alterations in an athlete's structure of special-preparedness in cyclic types of sports is presented in table 4. One should note the sharp rise in the role of energetic effectiveness of executing special work and the multi-sided technical preparedness of athletes, concerning which these factors make an increasing contribution in the general dispersion of excerpts. One should also point out the unity of the first two factors (power and aerobic capacity of class I athletes) in one (aerobic productivity) and for MS its role decreases in the general structure of an athlete's special-preparedness. At the same time the significance of anaerobic power increases somewhat (factor III). The results presented indicate that the presence of a high level of aerobic potential is still quite insufficient for achieving high results in skating. In order to rationally and economically realize a high level of aerobic power, it is necessary to have perfect movement technique and a high level of anaerobic (glycolytic) productivity; expanding the athlete's tactical possibilities.

Table 4

Factor Structure of Special Preparedness of Skaters
(in %, E. A. Shchirkovyets, A. N. Rosovtsyev, 1977)

Factor Order	Factors: Class I Athletes		Factors: Master of Sport	
I	Aerobic Power	35.9	Energetic Effectiveness of Executing Special Work	36.5
II	Aerobic Capacity	23.3	Multi-sided Technical Preparedness	21.9
III	Power of Anaerobic Processes	16.8	Power of Anaerobic Processes	19.8
IV	Energetic Effectiveness of Executing Special Work	12.7	Aerobic Productivity	10.9
V	Multi-sided Technical Preparedness	8.9	--	

The results of factoral research is in itself a statistical model of the structure of the athlete's special-physical-preparedness. Individually this structure can have different forms which are determined by the qualitative peculiarities of the motor qualities, inherent to the individual and the organization of training. Therefore, when programming training it is necessary to take into consideration the general tendencies in the alterations of the structure of special-physical-preparedness with the growth of mastery in the given type of sport; as well as the individual peculiarities of a specific athlete and those alterations in the level and the relationship of the functional characteristics, which are for him, an objective necessity.

2.4 Regularities of Attaining Sport-Technical Mastery

The perfectioning of technical mastery is the most important composite part of the long-term process of the organism's adaptation to sport activities. The essence of perfectioning technical mastery, revolves around the athlete's skill to fully utilize his constantly rising motor potential for executing the motor tasks confronting him. The general aspects of this are illustrated by figure 24.

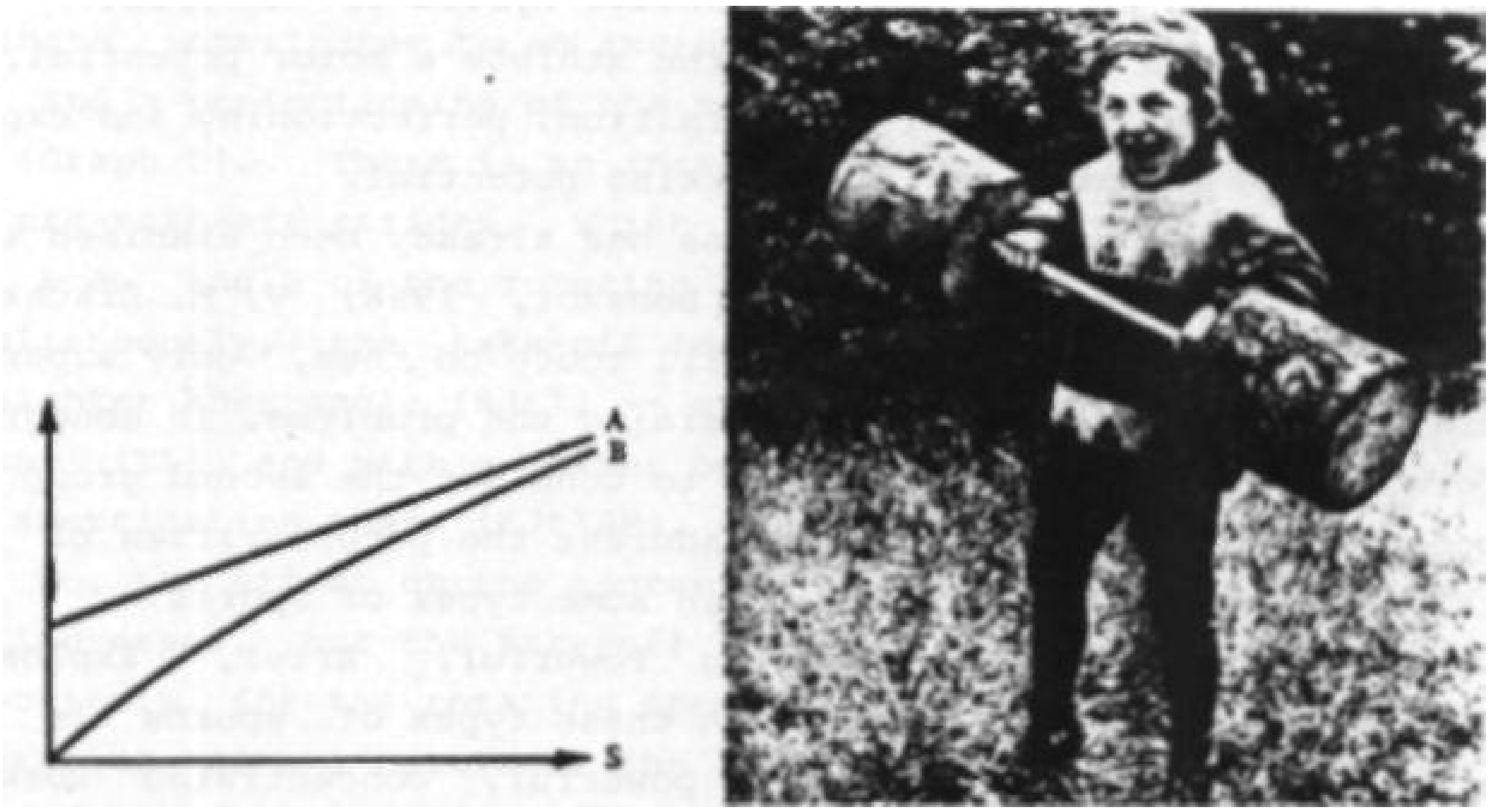


Figure 24. Tendencies in the dynamics of athlete's special-physical (A) and technical (B) preparedness.
S- sport results

Improvement in sport results (S) is produced by chiefly two factors: an increase in the athlete's special-physical-preparedness (A) and his ability to restrict his movements such that he can fully realize his growing motor potential (B). Consequently, sport technique is a constantly changing, perfectioning element of sport mastery. This perfectioning can be fruitful and effective only if it provides the formation of a bio-mechanically expeditious movement structure, conforming to the athlete's actual level of physical preparedness. Ideally, present-day technique work should take into account the subsequent rise in this level and the appropriate systematic sequence of improving its elements.

Study of the problem of attaining sport-technical-mastery over many-years training requires that one look at two fundamental groups of questions. The first group is associated with the psycho-physiological mechanisms of the regulation of man's motor functions and the transformation of a chaotic collection of movements, peculiar to novice athletes, into a biomechanically appropriate and an energetically effective system of movement. The second group is associated with the athlete's motor potential, as a necessary condition for the formation, perfectioning and expansion of the movement system's working potential.

The first group of questions has already been examined in a number of special works (D. A. Donskoi, 1968; V. M. Diachkov, 1969; I. P. Ratov, 1974), I will touch on them, only superficially. In the interests of examining the problems, in monograph form, it is far more important to consider the second group of questions. Therefore, let's address the peculiarities of attaining sport-technical-mastery in some types of sports.

Types of Sports Requiring Powerful, Brief, Explosive Efforts. The basic feature in these types of sports is the athlete's skill to display a powerful, concentrated working effort at the decisive phase of the sport action. The chief precondition for this is the formation of a stable and steady (to the disrupting factors) biodynamic structure of movement, as well as a rational organization of the preparatory phases contributing to its effective reproduction. There is a constant perfectioning of the biodynamic structure with the growth of sport mastery; a lengthening of the segments of the working-effort which directly contributes to the execution of the motor task and a shortening of the segments of inhibiting forces. This is reflected (in the external composition of the sport action) in an increase in the working amplitude and speed of movement, and their rational harmony in time and space.

The athlete's enhanced motor potential and the ability to display powerful, explosive effort within a specific time frame is the foremost condition contributing to the improvement of the biodynamic structure and an increase in the working-effect of a sport act.

The data presented in figure 25 characterizes the multi-year process of perfectioning sport mastery in the high jump. Let's turn our attention first of all to the accelerated increase in speed-strength (Graph III and IV, where Po — is absolute-strength, Fmax — is the maximum power of explosive-effort and N -- is the power of explosive-effort). An increase in speed-strength contributes to an increase in running speed (V, Graph II) and a perfectioning of the movement system during the take-off (Graph I). There is an increase in the depth of squating of the pre-take-off strides, which is indicative of a decrease in the knee angle of the rotating leg in the last stride (KJrl). Simultaneously, the take-off leg is placed on the support at a straighter knee angle (KJtl) -- at a larger angle to the surface sector (TL) and with a lesser bending in the knee joint during the amortization phase (KJtlAP).

So, the affect on the center of the body's mass in the take-off increases, but the take-off leg is utilized as a lever more effectively for the rotating speed vector, attained in the run. Alteration of the nature of the interaction of jumping from the support (Graph II): shortens duration (t); there is an increase in the vertical make-up of the working force (Fy) and a decrease in its horizontal composition (Fx), characterizing the "stopping" forces segment. The correlations between the speed-strength abilities, presented in graphs III and IV, increase.

In sport exercises associated with take-offs from a support, the nature of the interaction with the latter (the support) is determined, to a great extent, by the athlete's speed-strength development. The data (obtained in our laboratory) presented in figure 26 concerning the correlation between absolute (Po) and explosive (I) strength from some parameters of the F(t) curve.

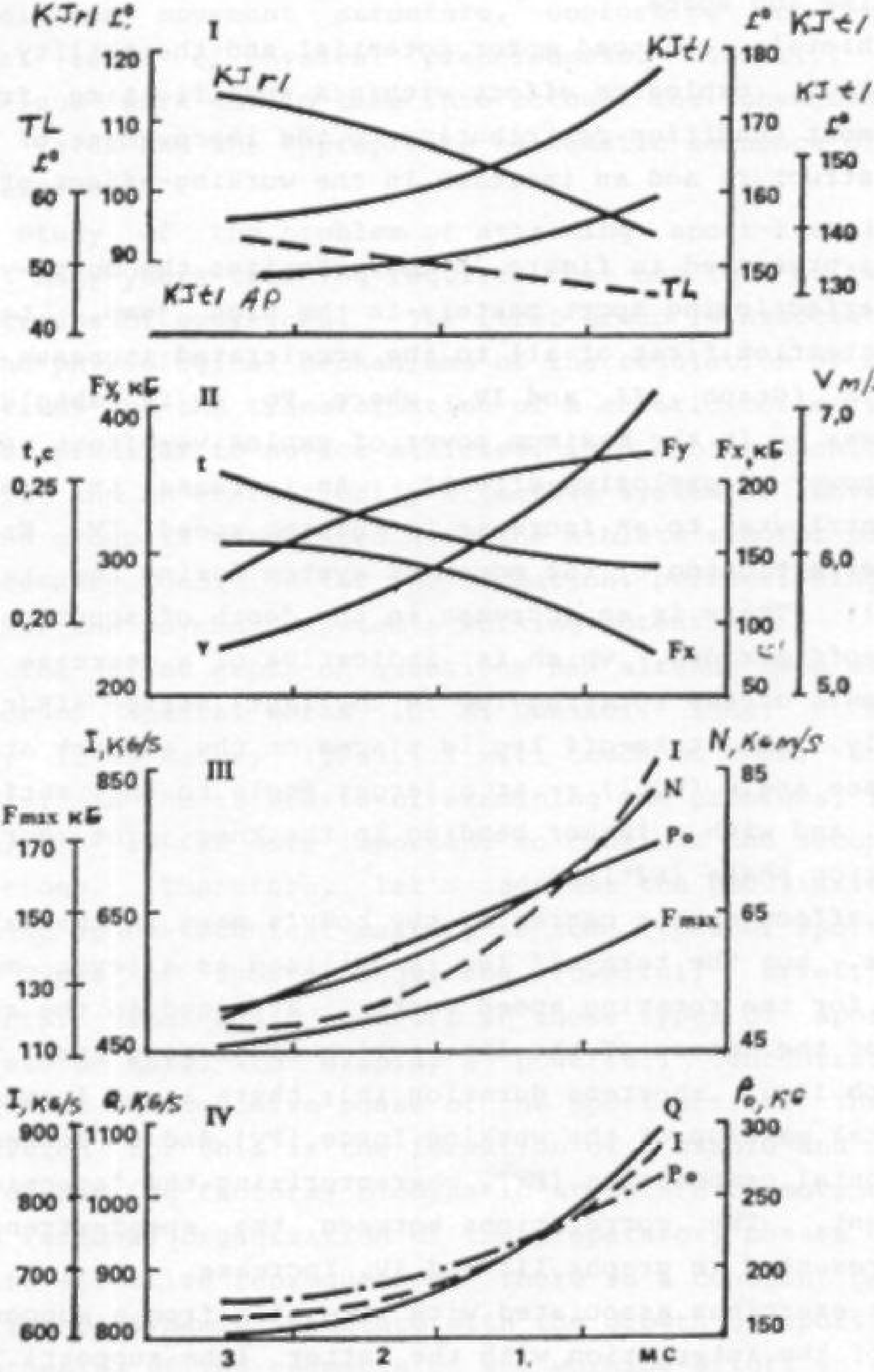


Figure 25. Dynamics of special-work-capacity indicators of high jumpers accompanying the growth of mastery (A. V. Khodyk and S. V. Nikitin): I- angular characteristics of the movemen II- characteristics of the run and the take-off, III AND IV- speed-strength characteristics of thigh extension and plantar flexion

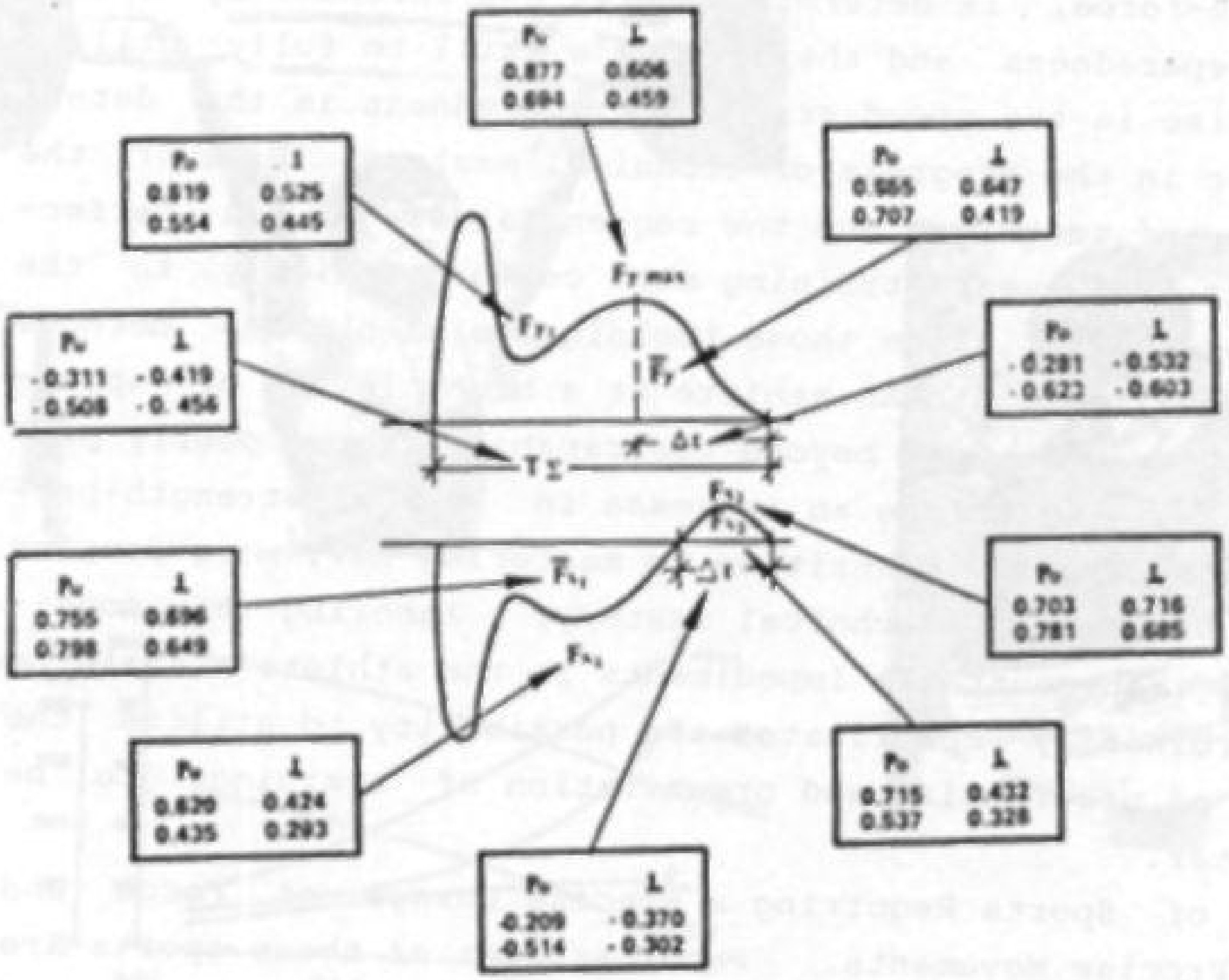


Figure 26. Correlation between the take-off dynamics in the long jump and speed-strength indicators of thigh extension (the upper r) and plantar flexion (the lower r), A. S. Sarkisyan.

was recorded during the take-off of the long jump (athletes of different qualification, n = 40). Without doing a detailed analysis of this data, look only at that circumstance where Po and I are closely correlated with the factors most essential for assessment of take-off technique, and furthest from the jump parameters of the F(t) curve.

Speed-strength preparedness plays a decisive role in the perfectioning of technical mastery of other types of sports requiring the display of explosive-force, such as weightlifting (A. A. Lukashev, 1972; B. A. Podlivayev, 1975; V. I. Frolov, 1976; V. N. Deniskin, 1979); track and field throwers (K. K. Metsur, 1975; Y. E. Lanka, 1977; B. I. Seliverstov, 1977); gymnastics (I. M. Levodyansky, Y. V. Menkhin, 1978), and others.

So, technical mastery, in those sports requiring the display of explosive-force, is determined first and foremost by speed-strength preparedness and the athlete's skill to fully utilize it. The rise in the speed-strength preparedness is the determining factor in the progress of technical mastery. However the requirements of technique and the sequentialness of its perfectioning over many-years training must conform strictly to the athlete's potential, since those technique elements and methods which are available to an athlete at a high level of speed-strength preparedness are beyond the capabilities of poorly prepared athletes. Therefore an increase in special-strength-preparedness outstrips the transition to mastering new, more complex elements or variants of technical mastery. Ignoring this condition creates insurmountable impediments in the athlete's training and extraordinarily complicates the possibility to utilize the principles of programming and organization of training, to be examined later.

Types of Sports Requiring a Precise Dosage of Force and Spacially Precise Movements. Peculiarities of these sports are the co-ordination of force and the display of the right amount of muscular tension necessary for executing the motor task. In order for technical mastery to progress in these types of sports it is necessary to create a "power reserve" of motor potential, i.e., the development of motor abilities to a level which exceeds that which is necessary for executing the motor task. This "power reserve" permits some variability in the execution of sport movements without the danger of exceeding the limits of the available motor potential.

For example, in archery technical mastery is characterized by the preciseness of reproducing a given effort, reflecting an ability to control muscular tension; and the ratio of the strength of the bow to maximum muscular strength. An almost linear dynamics between these indicators and the growth of the athletes' qualification, has been discovered (figure 27).

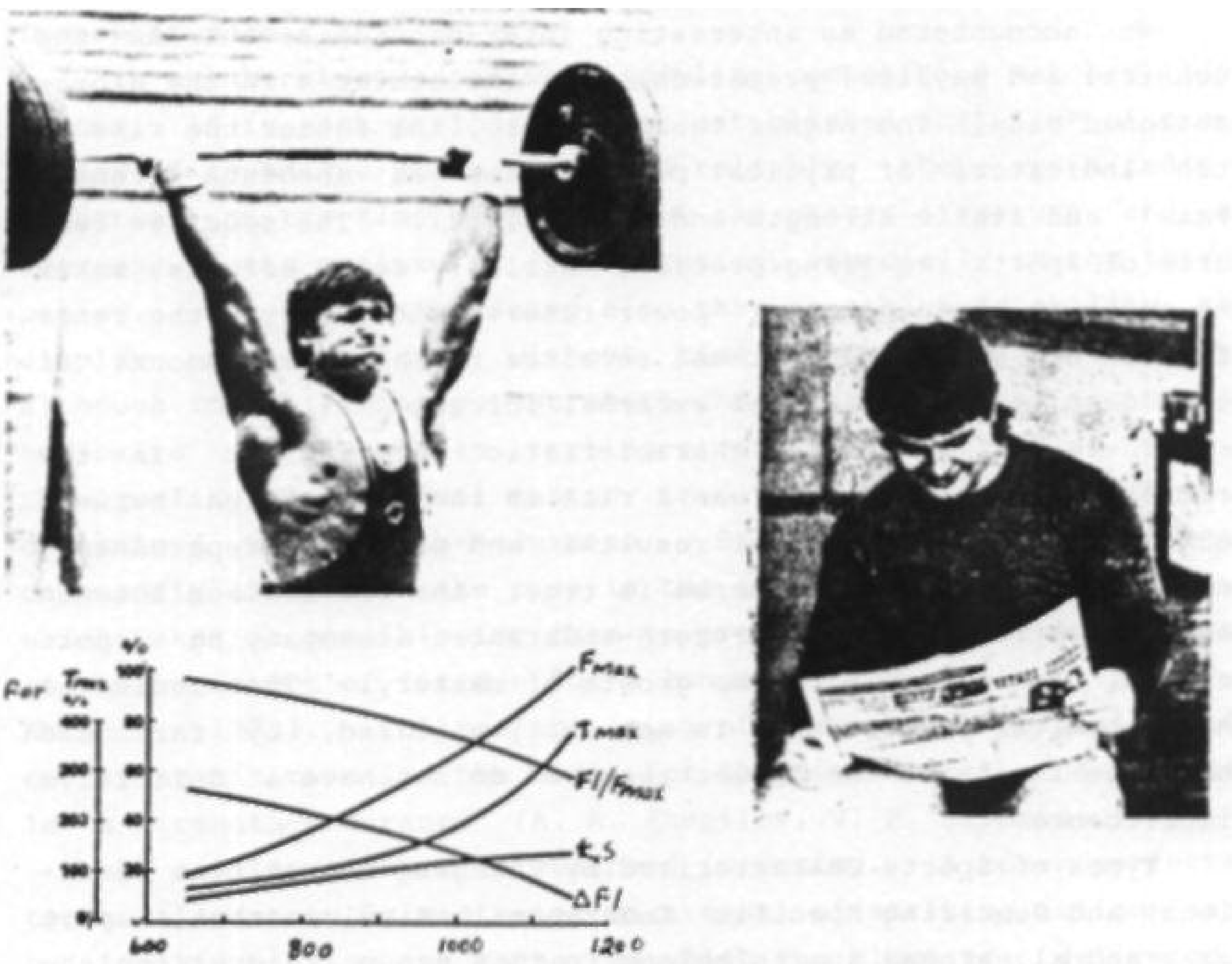


Figure 27. Alterations in technical and physical preparedness of archers with the rise in qualification (B. I. Struck, 1975): Sport results -- in points, are indicated on the horizontal.

Thus, errors in the reproduction of a given force (AFb) is six times less for a master of sport international class than for a novice; and the force applied to the bow-string (Fb/Fmax), is approximately 1/2 of their (MSIC) maximum strength, while the novices are using 3/4 of their strength. It is interesting to observe that the master of sport can hold the bow-string in a tension state approximately 4-times longer than a novice (Tmax); although the release time (tr) has little to do with qualification. The ratio of release time to maximum holding time depends to a significant extent on the archer's qualification. The release time of a master of sport is about 1/5 of the maximum holding time, whereas it is more than 1/3 for novices.

We encountered an interesting inter-dependence between the technical and physical preparedness of the athletes in the aforementioned case. The higher their mastery, the faster the rise in such indicators of physical preparedness as absolute-strength (Fmax) and static-strength-endurance (Tmax). The specific features of sports requiring precise, strictly dosed efforts, makes the creation of an original "power reserve" necessary; the range of which can guarantee that one receives the necessary amount of force despite alterations of external forces.

There is yet another characteristic peculiarity. In the preceding examples there was a rise in the correlation between technical mastery (or sport results) and physical preparedness; in the given case, the reverse is true, the correlation between muscular strength and strength-endurance accompanying sport results, decreases with the growth of mastery. This indicates that physical preparedness is not fully utilized, by far, and that the limits of the "power reserve" do not have a definitive significance.

Types of Sports Characterized by Changing Competition Conditions and Requiring Specific Endurance. Single-combat, sport games and all-around sports belong to this group. A distinguishing feature of technical mastery in these types of sport is the presence of an extensive complex of intricate motor actions, requiring a highly developed ability to display explosive-force and the possession of a definite accommodative variability to changing competition conditions. They are characterized also by a highly developed ability to resist fatigue without a decrase in technique effectiveness, tactical actions and methods.

These peculiarities can be illustrated by using wrestling as an example. Thus, observations of athletes at the world wrestling championships (Freestyle) showed that technical actions clearly decreased by the end of the third period. The time periods with the most technical actions were at 1, 4 and 7 minutes, i.e., athletes are more active immediately after resting. Although they were prompted to do this by the rules of competition, nevertheless, their specific endurance played an important role.

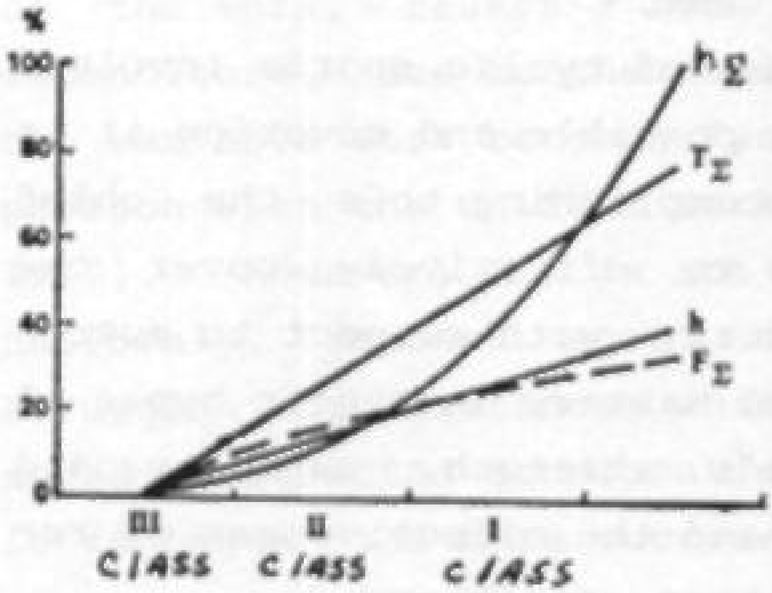
In a laboratory experiment modeling competition matches (135 throws, 45 in each period), it was established that time of execution of technique modes increased reliably; there was a redistribution of the time parameters of the phasic structure and a decrease in the quality of its execution, especially in the third period. It was established also that an athlete's ability to display maximum force without time restriction decreases, although insignificantly. Strength-endurance decreased the most; explosive and especially starting-strength decrease also. So, the quality of technical mastery is, to a significant extent, determined by strength-endurance. Strength-endurance increases constantly along with the rise in the qualification of wrestlers, which makes it possible for them to preserve technical activeness in the presence of fatigue for a longer period of time (A. P. Khrenov, 1973). The perfectioning of the aerobic mechanisms of energy-acquisition is the basis for the development of a wrestler's strength-endurance (A. A. Shepilov, V. P. Klinmin, 1977).

A similar picture is observed in boxing. A boxer perfects technical mastery by mastering an arsenal of striking actions and by individualizing the manner in which the blows are delivered. The force and rate of the blows increase with the growth of mastery. Novices are able to deliver about 400 blows in 100 seconds but highly-qualified boxers are able to do about 1,500 (V. V.

Kim, 1976). The functional basis of the technical-tactical mastery of boxers is expressed in the increased absolute-strength and the development of the ability to execute explosive-force of high power (V. V. Filimonov, 1979), as well as in the perfectioning of aerobic and anaerobic productivity (P. N. Repnikov, 1977; A. Mabruk Khedr, 1979). Thus, a comparison of the functional preparedness of victors and vanquished in boxing matches indicates that the victors exceeded their rivals in all parameters of maximum aerobic productivity (P. N. Repnikov, 1977). It was also established that energy-acquisition for boxing is realized through the participation of glycolysis and the boxers' special endurance is to a significant extent determined by their body's stabiliby to the products of anaerobic exchange {I. P. Degtyarev, et al., 1979).

The athlete's functional preparedness also plays a determining role in the growth of technical mastery in sport games. With the rise in qualification, the increase in special-strength-preparedness (figure 28), which is quite specific, secures a rise in the sum of the indicators (TS.) of technical mastery of volleyball players (ability to lower both arms, throw the ball upward with two hands, spiking, blocking and setting). Thus, if the muscles' explosive abilities, as displayed in the vertical jump (h), increase linearly, but the sum of the strength of 10 muscle groups (F 2) - even slow down, jumping endurance (h£) clearly accelerates. The correlation between this indicator (jumping endurance) and the technical mastery of masters of sport, rises significantly (V. P. Filin, etal., 1977). The perfectioning of a basketball player's technical-tactical arsenal is also associated with the growth of their functional preparedness and the rise in the stability of the specific motor habits towards the developing fatigue, during the intense conditions of competition.

Qualified athletes are playing 57% of the general length of a game (about 70 minutes). They execute an average of about 4 jumps per minute during playing time. The length of highly active playing periods (substitutions, arguments, brief interruptions, entering the game without a time-out, etc.) in high-class



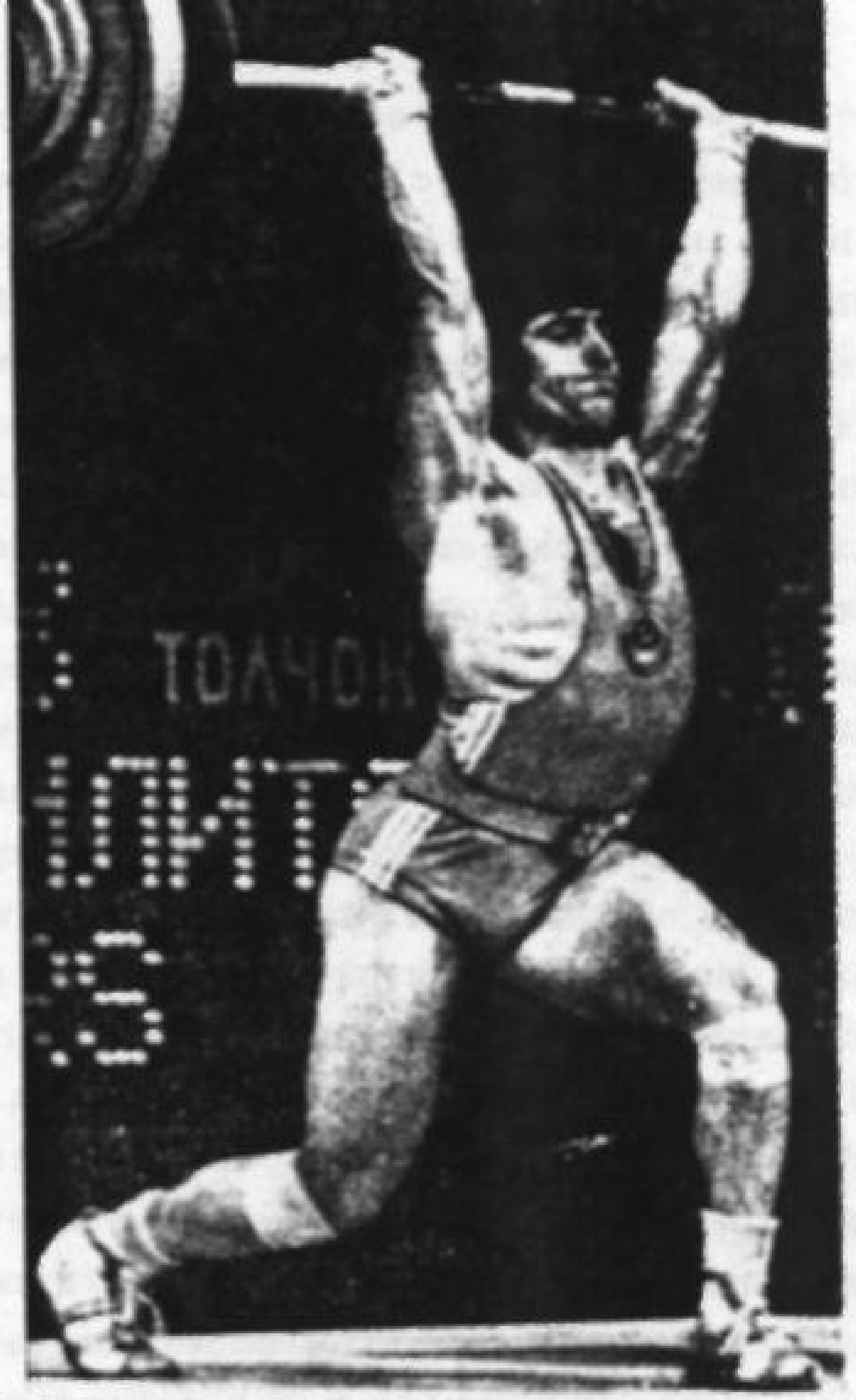


Figure 28. Alterations in technical and physical preparedness of volleyball players, with the rise in mastery.

teams is about 30 seconds. These periods are repeated on the average, about every 20 seconds (I. N. Preobrazhensky, 1976). In order to preserve the effectiveness of technical mastery under such conditions, a high development of maximum anaerobic power is necessary; which is the foundation of a basketball players' speed-strength preparedness and the anaerobic-glycolytic abilities which provide a basketball player's specific speed-endurance. At the same time, along with the growth of mastery the contribution of the aerobic processes in energy acquisition rises; this permits multiple repetitions of periods of high activeness during the course of a game (V. M. Koryagin, 1973; B. N. Kalyunov, 1976; V. A. Danilov, 1977).

Cyclic Types of Sports. As already emphasized, the motor components of cyclic exercises are viewed as somewhat simpler than in acyclic locomotion. Cyclic locomotion consists of multiple repetition of stereotypical cyclic movements not requiring powerful muscular effort. However, the externally simple kinematic scheme of cyclic locomotion conceals an extraordinarily precise bio-dynamic structure and its organization is of exclusive significance. In order to understand this significance and to see the role physical preparedness plays in securing technical mastery, one should look at the objective of the component motor task and chief emphasis of the athlete's movements, which determine the successful execution of the task.

A general motor task for all types of cyclic sports involves moving a certain distance as fast as possible and covering it in the shortest possible time. In accomplishing this the chief emphasis of the movement systems is to effectively cover the distance with the maximum economicalness, with respect to muscular effort and energy. So, technical mastery in cyclic types of sport is determined by the athlete's strength, capacity and economicalness of energy expenditure and the effectiveness of restoring expended energy under competition conditions.

Economization in the expenditure of the organism's energy resources is a specific feature of technical mastery in cyclic sports. For example, qualified skaters require less oxygen in executing a standard training load. And, since MOC increases along with the rise in mastery, consequently the athlete's percent utilization of aerobic potential decreases during this loading (G. M. Panov, 1970).

It has also been established that along with the rise in trainability (with respect to movement at a standard speed), the ratio of the rate and length of the distance overcome in one motor cycle changes. More qualified athletes execute the task with longer strides or strokes, but at a lesser movement rate which is further evidence of the economization of energy-expenditure phenomenon (V. V. Mikhailov, 1971; N. A. Levenko, 1977).

Of great significance for rational and economical expenditure of energy is the so-called conservation of strength or the tactic of "passing" distance. It has been established that uniform running is more economical than variable (F. Henry, 1954; V. V. Mikhailov, 1971). Variation of the running speed of qualified athletes, within a relatively small range — from 6 to 6.5 M/sec, causes sharp changes in the energy-acquisition mechanism. A sharply increasing maximum oxygen debt and its alactate fractions result in significant displacement to the blood's acid-base balance and the accumulation of sub-oxydized exchange products (A. A. Korobova, et al., 1975). It has also been shown that a variable work tempo, associated with increasing the power of the work, causes a rise in the anaerobic portion of energy-expenditure, due to the activation of glycolysis. As a result, the variable work becomes "energetically" less effective, in comparison with the uniform work (Y. K. Dravniek, I. V. Akulik, 1977). However, it is not always practical to cover distances uniformly. Modern sport is characterized by intense tactical struggles at distances which are distinguished by changes in speed, protracted acceleration and a "stormy" finish; the earlier it is begun the more successful it is likely to be. In this instance one is already not speaking of economization of energy-expenditure but about the skill to fully and effectively utilize the energy potential that should be attained through special preparation during the course of training.

So, in summation one can single-out a number of principal tendencies and conditions of the formation of sport-technical mastery, which are of great importance for programming and organization of training.

1. As has already been emphasized the perfectioning of sport-technical mastery is one of the composite parts of man's long-term adaptation process to sport training. Sport-technical mastery is not a state one can achieve in one day, but the current result of the continuous and unending process of movement from a state of lesser perfection to a state of greater perfection. Therefore, the essence of perfecting technical-mastery over many-years training is in effect a constant search for and

mastering of rational motor modes, enabling one to best utilize one's current motor potential in specific sport activities. Consequently, the steady rise in motor potential and the perfectioning of the ability to purposefully and effectively utilize it by means of a concrete movement system represents a key invariant of training; and the degree of full utilization of motor potential is one of the criteria of its effectiveness.

2. Depending on the specific competition conditions and requirements, the athlete's skill to effectively utilize his motor potential in the execution of motor tasks is perfected in three different directions.

In types of sports requiring concentrated explosive effort, characteristically, there is complete utilization of the athlete's motor potential. In this case the movement system does not have superfluous details, it should be economical, with respect to energy expenditure, in the preparatory phases and secure a comprehensive mobilization of motor potential in those phases in which one realizes the fundamental objective of the motor task. In endurance sports the economicalness of motor potential utilization is the basic criterion of the effectiveness of technical mastery for both the organization of each movement cycle and throughout the entire competition. However, in the latter case the tactical aim should provide, ultimately, the full realization of the athlete's potential. Finally, in sports requiring spatially precise movement, the characteristic feature of technical mastery is the rational utilization of motor potential. In this instance, complete exhaustion of the athlete's potential is not required, however in the interests of competition reliability, it (the athlete's physical potential, Ed.) should exceed significantly, what is required for this level.

3. The perfectioning of technical mastery and special-physical-preparedness are very interdependent and interconditional components of the athlete's multi-year system of preparation. The nature of the athlete's external interactions and the organism's corresponding work regime determine the substance, direction and

magnitude of its functional specialization. At the same time the enhanced motor potential makes possible the further perfectioning of technical mastery. However it is important to emphasize that the key role in the interdependence of the aforementioned components appertains to the functional perfectioning of the organism. The specialized development of speed-strength and the system of energy-acquisition for intense muscular work is a determining (and limiting) factor for perfectioning technical mastery.

It is also necessary to single two more conditions contributing to the effective perfectioniing of sport-technical mastery, which one should bear in mind for programming training.

The first is associated with the expedient forestalling of in-depth work utilizing the means of special physical preparation; the second is associated with the selection of favorable times for in-depth perfectioning of technical mastery, including maximum efforts. In other words, an enhancement of special-physical-preparedness should precede in-depth technique work, which should be done in the midst of a decreased volume of loading and with the organism in an optimal functional state. To realize this, it is necessary from the very beginning, to organize technique training correctly, in harmony with physical training and primarily to perfect technique uniformly in accordance with the current level of special-physical-preparedness.

All of the examined pecularities of the PASM as a whole and some tendencies in the alteration of some aspects of sport mastery were revealed by considerable statistical study, independent of athletes' training specifics and other factors. The material presented is indicative of the necessity and the order of those changes in the functional state of the organism; which bring the athlete to a high work-capacity, as well as the causual conditions, determining that the internal, essential correlation between these changes which determine the sequence of the sportsman's shift to the peak of mastery.

So, one has sufficient basis to speak about the PASM as a system phenomenon, regularly developing over time, having specific contents, concrete forms and distinguishing features.

The general regularities of the organism adaptation to sport activities, which are externally expressed by a specific sequence of morpho-functional specialization of the organism and the perfectioning of the athlete's skill to effectively utilize his potential under competition and training conditions are at the heart of the PASM. Regulation and systematic perfectioning of these PASM components in their unity and interdependence, is in-and-of-itself the main task of programming training.

Chapter 3
The Principal Connection Between the Athlete's State and the Training Load

The connection between athlete's state and a given loading is the central question in the theory and technology of programming training. This is also the weakest link in the management of training; requiring the special attention of specialists and immediate scientific search. Before examining the practical aspects of the connection between loading and the sportsman's state; we will define the concepts -- the training load and its effect.

Strictly speaking, the training load does not exist in-and-of-itself. It is a function of the muscular work inherent to training and competition activities. To wit, muscular work is that training potential which provokes an appropriate functional (accommodative) reaction (training-effect) from the organism. Well then, the training potential of muscular work, and consequently its training-effect is to a significant extent determined by the athlete's current state.

So, the connection between the sportsman's state and the training load is an extraordinarily complex interplay, dependent upon a multitude of factors and determined by numerous variables. Unfortunately, one has to acknowledge that objective data, characterizing this connection, is as yet very small. Some research in this area is not a complete representation; the studies are often incompatible and contradictory. Therefore, the contents of this chapter represent, in essence, the first attempt to systematize and multi-facetedly examine the connection between the sportsman's state and the training load. Basically, the actual material used were the results of special multi-year research of the author and his collaborators.

Naturally, considering the novelty and the complexity of the problem, it is still early to talk about its value. However, even that information which has been successfully accumulated in this area already makes a substantial contribution to the tasks associated with programming training.

3.1 Characteristics of the Training Load and its Effect

The training load is understood to mean the quantitative measure of the training work executed. It is customary to differentiate the concepts of "external", "internal" and "psychological" loading, i.e., the quantity of work done, its affect on the ogramisn and the psychologically percieved affect on the athlete (L. P. Matveyev, 1964; N. I. Volkov, 1969; N. G. Ozolin, 1970; G. S. Tumanyan, 1974, and others). The volume and intensity are utilized as the most general characteristics of the training load (N. G. Ozolin, 1949; L. P. Matveyev, 1956; L. S. Khomenkov, 1970; M. Y. Nabatnikova, 1972 and others).

There are other classifications of the training load based on the motor specifics of the types of sports; the power of muscular work; the pedagogical tasks of the training; the affect on restoration and the effect of the subsequent work; the interaction of work of different emphasis (for example, the interaction of primarily strength work and speed-strength work, Ed.) and other criteria (V. S. Farfel, 1958; N. I. Volkov, 1969, 1974; N. V. Zimkin, 1963; V. D. Monogarov, V. N. Platonov, 1975; F. P. Suslov, 1978; I. Scherrer, 1962, 1969).

However, each of these classifications, taken separately are not quite suitable for resolving the task of programming training. A somewhat different approach is required here, providing special requirements for the preliminary assessment of the loading and taking into account the aforementioned classification criteria for a somewhat different basis for systematizing them.

The concept of "loading" suggests first of all a physiological measure of the affect on the organism that occurs as a result of specialized muscular work and reflected by the organism in the form of concrete functional reactions of a certain degree and duration. Consequently the necessity arose, in the subsequent development of the concepts of "external" and "internal" loading, to introduce the concepts of the "training potential" of the loading and its "training effects", which enables one to more concretely characterize the relationship "influence — effect" (the principal way, in the sense of foreseeing the latter).

The loading's influence is expressed by its training effect (TE); assessed, first of all, by the magnitude of the alteration of the sportsman's state. Discussion in the literature concerning the forms in which the TE is displayed is very contradictory. On the whole it amounts to the following linear representation concerning the displaying and summing of the training influences (V. M. Zatsiorsky, 1964; N. I. Volkov, 1966; L. P. Matveyev, 1977):

urgent TE lagging TE cumulative TE.

The first two forms are associated with one training session: the urgent TE is the organism's current reaction to the physical loading; the lagging TE is the alteration in the sportsman's state, observed after the workout. The cumulative TE is the result of the subsequent accumulation of all the TE's within the organism; which were created in the course of training.

However the scheme presented is one-sided and does not take into account the qualitative aspects, indispensibly inherent to the TE, when it comes about as a result of training loads of different primary emphasis. The fact is that the accumulation, as a phenomenon of the generalization of the traces of the training influences on the organism, is not simply summed and is far from its limitations.

The mechanism of generalization, as a universal quality of a biological system providing a conformity between its state and the influences of the external surroundings, is determined first and foremost by the criteria of expediency in the selection of the organism's adaptive strategy. This is manifested in its selective relationship to the training influences of different primary emphasis, as well as in the expression of its crucial reactions and stabile accommodative acquisitions. As has already been mentioned, the cumulative TE itself can have a different quantitative and qualitative expression, depending on the current state of the organism, the order in which training influences of different emphasis follow each other, the traces of the preceding loading, duration of using certain means and other actors (Y. V. Verkhoshansky, 1970).

For example, it has been known for a long time in sport practice that one can alter the end result of a workout somewhat, depending on the exercise sequence emphasizing the development of speed, strength and endurance; or working-on technique, strength and speed. Considerable research has shown convincingly the affect of a particular sequence of training loads of different emphasis in long-term training stages has on the state of the organism; for example, aerobic and anaerobic glycolytic loading for the development of special endurance (M. Y. Nabatnikova, 1972; N. I. Volkov, 1975; V. N. Platonov, 1980) or strength and jumping exercises for explosive-strength (V. V. Tatyan, 1975; A. V. Khodykin, 1976; G. V. Chernousov, 1978; A. V. Levchenko, 1980).

Based on similar research it has been suggested to differentiate the concepts "partial TE" (the result of the affect of loading of one primary emphasis or means) and "cumulative TE" (the result of the generalized affect on the organism of loading of different primary emphasis, used simultaneously or sequentially). In the latter case there is a quantitative and qualitative side of the TE. The essence of these concepts can be explained with examples.

In one experiment (figure 29) group I began by using barbell exercises, then depth-jumps (the "shock" method of developing explosive-strength). Group 2 utilized the reverse sequence of means. Each group of means were used for three months each.

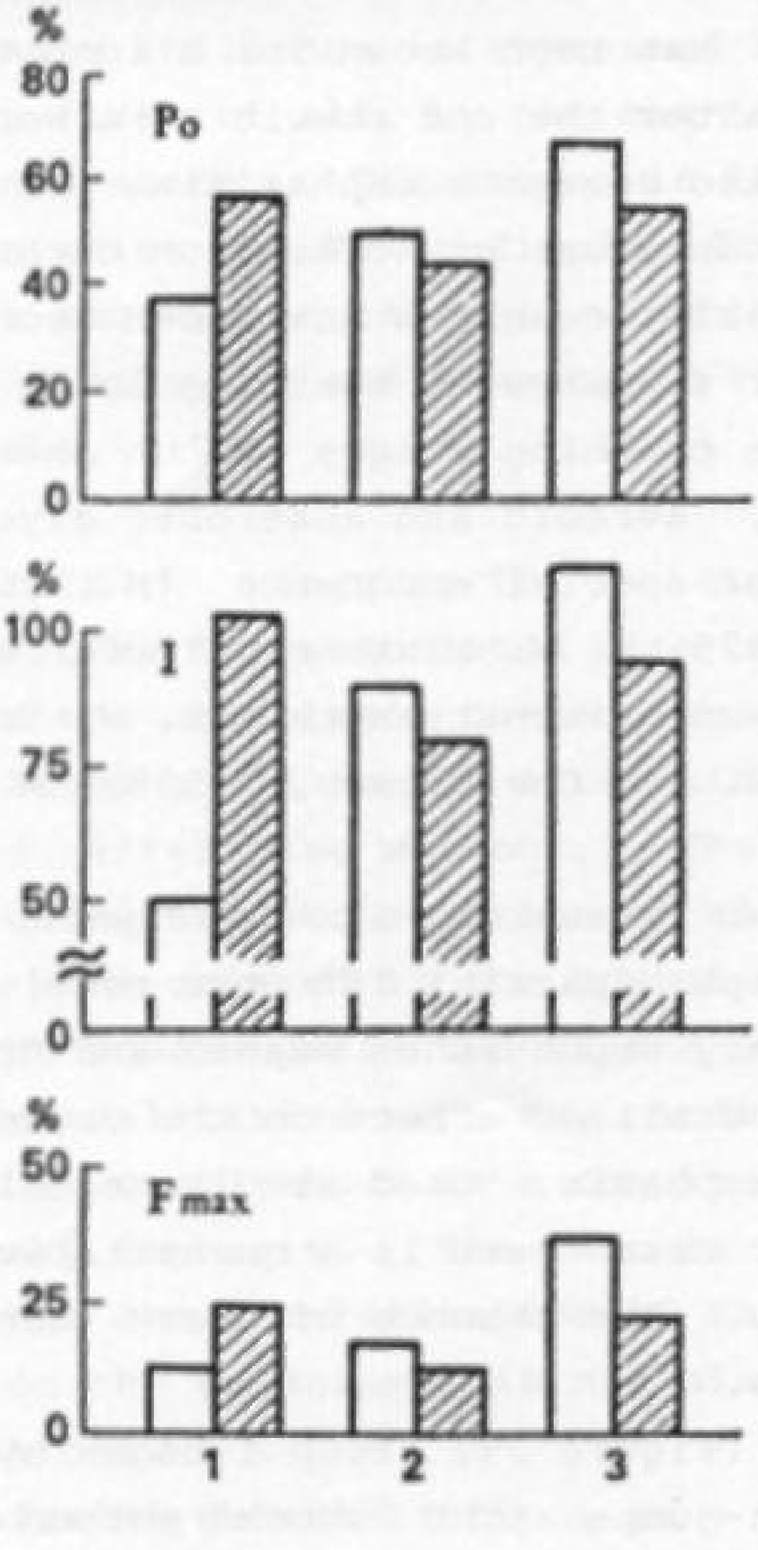


Figure 29. The training effect for different sequence of applying speed-strength means in high jumpers of middle qualification (A. V. Khodykin) Po - absolute strength of plantar flexors, I- explosive-strength indicator (the take-off after a depth-jump, Fmax - maximum explosive effort (a vertical jump). 1, 2, 3 - experimental groups.

Group 3 utilized the barbell exercises and the depth-jumps simultaneously (complexly) throughout both 3-month stages. The general volume of the loading was equivalent in all groups. The alterations in the speed-strength preparedness of the athletes after the first and second (shaded) stages of training are presented in the figures.

The results of the studies enable us first of all to see and compare the partial TE of utilizing only barbell exercises and depth-jumps (the first stage for groups 1 and 2); as well as the cumulative TE obtained as a result of two different forms of organizing the loading -- simultaneous (group 3) and sequential (the second stage of groups 1 and 2). One can draw the following conclusions based on this experiment.

1. The partial TE of the depth-jumping is higher than the barbell exercises.

2. The final effect of the training is altered essentially by the rearrangement of the loading of different primary emphasis. The sequence of using barbell exercises then depth-jumping (group 1) produced a higher level of speed-strength preparedness (a positive cumulative TE), than the reverse sequence (group 2). In group 2 the TE was essentially lower at the end of the second stage than after the first (negative cumulative TE).

3. The simultaneous use of the aforementioned means in the first stage (group 3) yielded a larger cumulative effect than in groups 1 and 2. However, the TE noticeably decreased for group 3 in the second stage because the lengthy use of one means decreases the training potential of the loading.

In another experiment (figure 30), over a 7-week period, group 1 utilized exercises with 30-50% weights; group 2 used 70-90% and group 3 used weights of 30-90% simultaneously. The general loading in all groups was equivalent according to the physiological criteria of the cost of the work. Once again one can clearly see the partial TE of using different weights (groups 1 and 2) and the cumulative TE from the simultaneous use of those and other resistances (group 3).

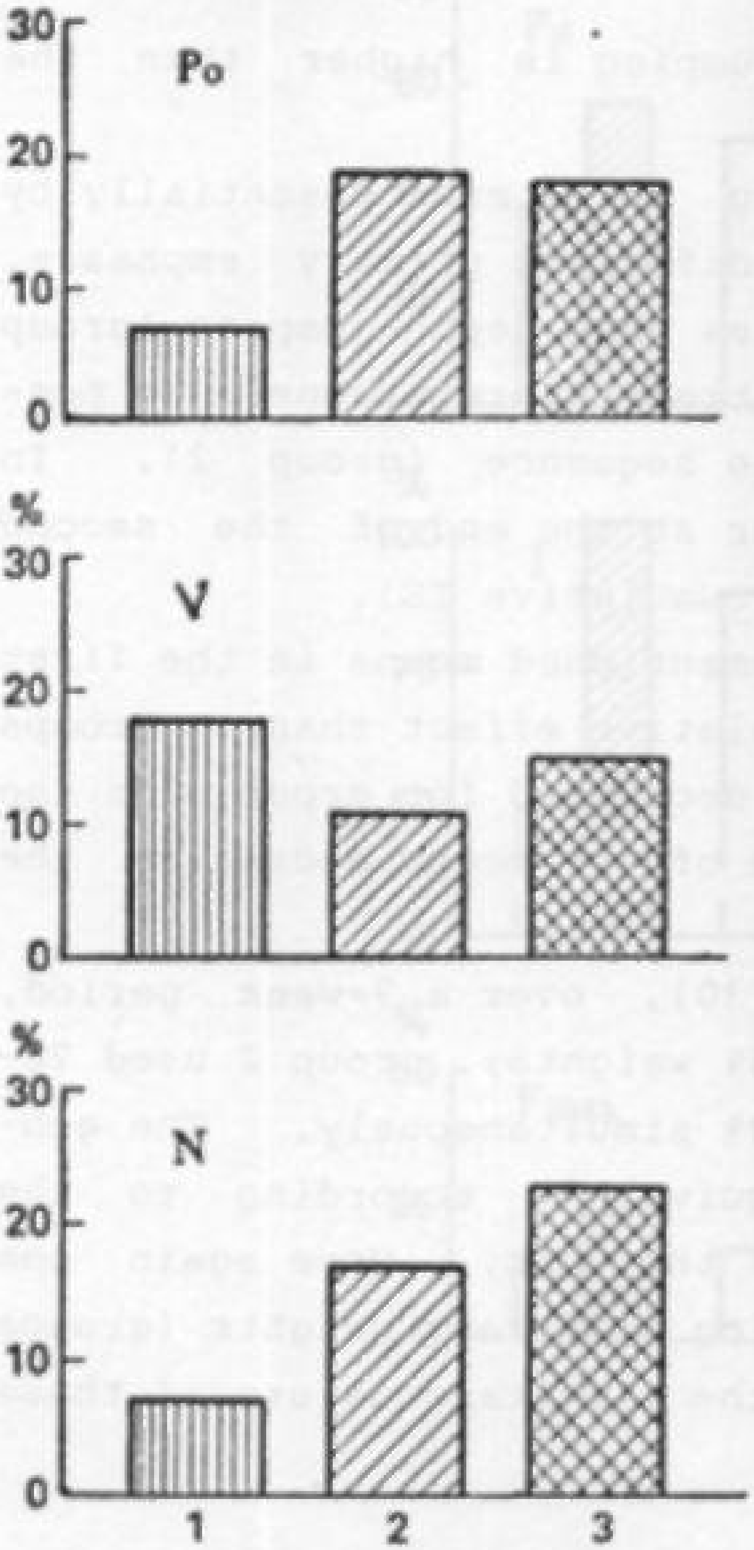


Figure 30. The training-effect from different loadings on highly-qualified high jumpers (A. P. Nedobyvailo): Po - absolute-strength, V-speed and N - power of the extensor force of both legs. 1, 2, 3 - experimental groups.

One should turn special attention to how the "cumulative" phenomenon appears, as a result of combination-work with weights of 30-90%, at the level of power (N) achieved in group 3, and how much higher it is relative to the partial TE obtained with means of single emphasis (groups 1 and 2).

The data presented serves as a vivid example of how much the effect of an athlete's preparation depends on the organization of training loads, and what one needs to clearly represent when organizing training; what sort of TE is required in each concrete case and what one needs to do in order to achieve it.

From a practical standpoint, it is expedient to differentiate and assess the TE with respect to two criteria — temporal (urgent and lagging) and qualitative (partial and cumulative). The urgent TE is the effect observed immediately during or right after a training session; the lagging TE appears a relatively short time after the loading; for example, in a number of mixed sessions or in a short stage (the nearest TE), or is preserved for a longer time after the loading assigned in prolonged training stages (long-term TE). We will dwell on the latter of these in more detail.

A number of qualitative forms of the cumulative TE (urgent or lagging), depending on the organization of the training loads, are distinguished. Thus, the cumulation can be momentary (the organism's urgent reaction to a complex of training influences of different emphasis, assigned in one or mixed workouts; as well as the prolonged, parallel use of loading of different emphasis), accumulation (the stratification of functional traces of the training influences of different emphasis, following in a certain order in prolonged training stages), and finally, positive or negative (if the functional traces of some loads create or just the reverse, do not create favorable conditions for the organism's accommodative reaction to other loading).

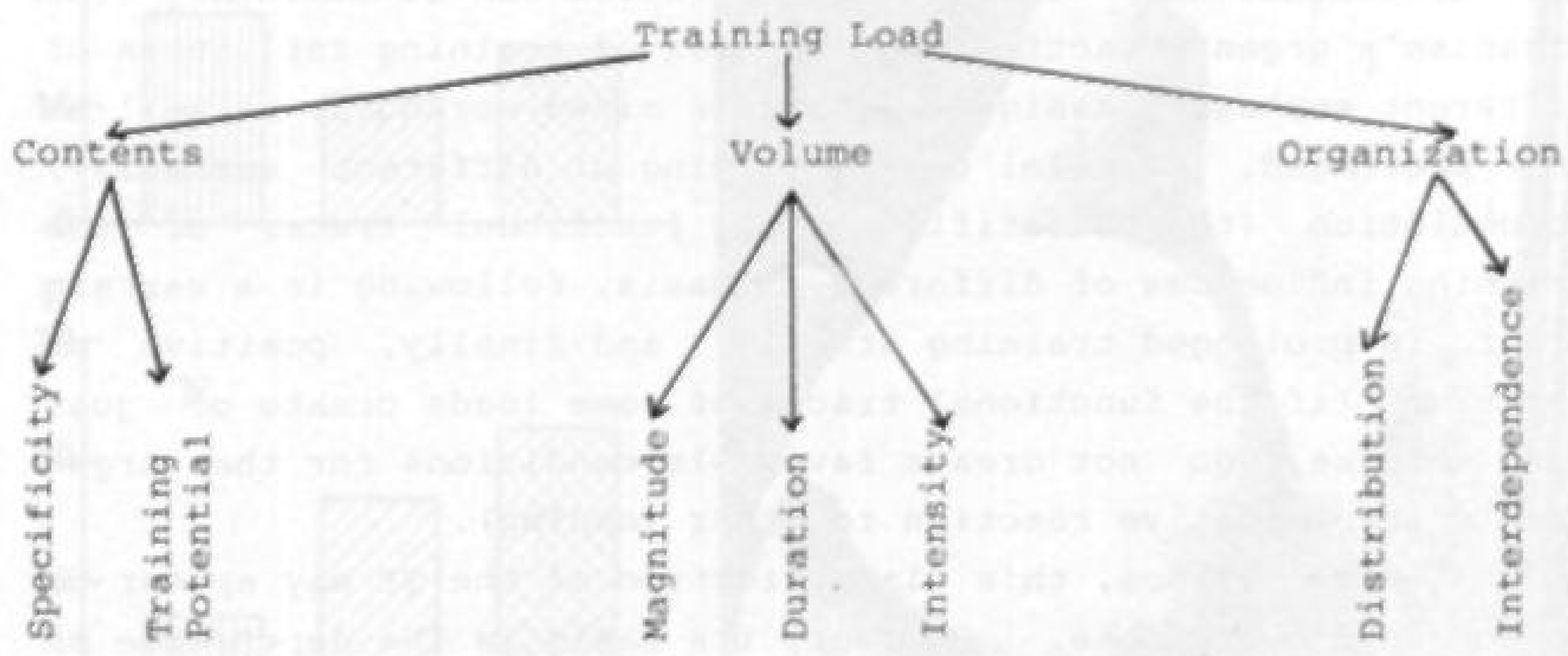
At first glance, this classification of the TE may appear to be somewhat cumbersome. However, its basis is the dependence of the athlete's state on the training loads in actual sport conditions and it is impossible not to take this into account when programming training.

The physiological nature of the TE is so complex and the forms in which it is manifested so diverse, that exhaustion of its characteristics is only possible on the basis of aforementioned criteria. This has great practical significance, since the programming of training loads should be based first of all, on the objective of achieving a concrete TE. Therefore, a clear-cut representation of the required TE and the conditions, objectively necessary for its achievement, is an obligatory prerequisite for determining the contents and organization of training.

3.2 Factors and Conditions Determining the Training-Effect

In order to select the optimal (out of the many possible variants) training loads, it is necessary to do a preliminary assessment of their effectiveness. To do this, it is expedient to determine, through qualitative and quantitative measures, the affect of the loading on the organism, such as its contents, volume and organization (figure 31). The degree of reliability providing the effect generated by each of these characteristics, has great significance for the success of training.

Figure 31.



We will examine in more detail the basis for a particular selection, associated with each characteristic. In doing so we will restrict our examination to the loading that is designed to develop explosive-strength and specific-endurance.

3.2.1 The Contents of the Loading

The programming of training begins with the determination of its contents, i.e., the composition of the means, selected on the basis of preliminary assessments according to two criteria -- the specificity of the training influence and the training potential.

The specificity of the means' training influence is understood to mean their conformity to competition activities, with respect to the motor structure, the regime of work and the mechanism of energy-acquisition. The basis of this criterion is used to distinguish between means of special and general physical preparedness (SPP and GPP). The SPP means primarily produce a rise in the organism's special-work-capacity. The means of GPP are utilized for general (multi-sided) physical development, activation of the restoration processes within the organism after voluminous or intense loading; as well as for creating the effect of switching from one type of work to another (N. G. Ozolin, 1949; L. S. Khomenkov, 1957; L. P. Matveyev, 1964).

The means of SPP should be as close as possible to the conditions of the sport activity, with respect to its dynamics and the regime of work. This requirement is the so-called principle of dynamic correspondence which stipulates as criteria, the similarity between the training means and the fundamental sport exercises of such indicators as the amplitude and direction of movement, the accentuated part of the working amplitude, the maximum force and the time it is displayed, the regime of muscular work (Y. V. Verkhoshansky, 1963, 1970).

One should however, take into account that in practice the external similarity of the training means to the fundamental sport exercise is often over-stressed and the importance of the conformity of the means to the regime of muscular work and to the mechanism of its energy-acquisition is under-stressed. The fact is that literal conformity of the training means to the fundamental sport exercise in motor structure is appropriate only if it provides "conjugate" (V. M. Dyachkov, 1968, 1975) influence at the athlete's level of physical and technical preparedess. However, if special-physical-preparation is worthwhile it is not as important that the training means mimic precisely the fundamental exercise, with respect to its external spatial characteristics. The main criterion of conformity in this case is the organism's regime of muscular work as a whole. For example, strength exercises such as barbell squats (resistance), bear little resemblance to the athlete's movement in running, throwing or playing basketball. However, the use of squats is justified because they actively contribute to raising the athlete's special-work-capacity in these types of sports.

Each type of sport has a sufficient quantity of SPP means available, conforming to the fundamental sport exercise, with respect to certain criteria. However, it is important to point out that the necessity of preserving the loading's training potential (especially for highly-qualified athletes) requires means that not only conform to but exceed competition conditions, with respect to maximum force, time of maximum force development and the power of the metabolic processes securing the organism's work-capacity. It is easy to conclude from this, that satisfaction of this requirement is associated with improving the strength component of the movement. The very emphasis of strength or, more precisely, the use of specialized-strength-exercises in the system of SPP means, makes it necessary to examine this question in more detail.

First of all, one needs to point out that the role of strength exercises in an athlete's preparation is, by far, not limited to "pumping" strength; as is sometimes thought. It is important to increase strength but this is not the fundamental and the sole task of strength exercises. By itself the latter dwindles and is still not utilized in practice as much as possible for raising the effect and the specificity of the loading under sport conditions. However, this possibility in speed-strength types of sports is obvious and realized successfully;

but in many types of sports (in particular, requiring endurance). They are still, in essence, not understood.

The development of endurance, as we have already said, is primarily associated with improving the aerobic productivity of the organism; as a result of employing the distance method of training. However, such an important condition as the muscles' adaptation to intense and prolonged work, is clearly underestimated. At the same time, the functional specialization of the muscles, as the immediate executor of the work, is of greater significance than the development of the vegetative component of endurance. A more intense influence is necessary for the muscles to adapt to endurance work, than for the cardio-vascular and respiratory systems. Therefore, when one uses only the distance method for developing endurance, a definite non-conformity can arise between the functional level of the vegetative systems and the working potential of the muscles. In this case, the high sport results one is counting on do not occur.

This situation is very charactertistic of the preparation of our middle-distance runners. Elementary logic says: in order to run 800 M in one minute forty-five seconds (1:45.0) it is necessary to have a result of 10.6-10.7 sec in the 100 M. One needs to possess great strength potential to do this -- three standing long jumps of 9 M and more and ten standing long jumps of 33-34 M, which middle-distance runners do not have the strength for. Elimination of this insufficiency is only possible through specialized strength and jumping work which renders a stronger (compared to distance training) influence on the muscles, intensifies their adaptation to endurance work and activates the functional reserves of the organism's systems which satisfies their requirements. As a result, the power and the capacity of the metabolic processes are enhanced, including anaerobic energy-production, which provides a high level of local muscular endurance and is in conformty with the organism's aerobic productivity. At the same time, it is possible to reduce the volume of exhausting distance work in the anaerobic glycolytic zone (L. N. Zhdanovich, 1980; Y. V. Verkhoshansky, V. A. Sirenko, 1982).

Selection and methods of executing specialized strength and jumping exercises in endurance types of sports should provide first, an increase in strength up to a definite optimum, and second, an organization of specific training influences on the mechanisms crucial for the energy-acquisition of repeated reproduction of motor-effort. The specifics of the type of sport, methodical experience and experimental search can and should prompt the optimal variants of specialized strength training for each concrete case. The main thing here is to be able to overcome the traditional stagnate viewpoints regarding strength-training, only as a means of increasing absolute-strength.

The means of GPP play no less of an important role in the organization of training. Besides traditional multi-sided motor preparedness and the creation of a functional groundwork for specialized perfectioning of motor abilities, the means of GPP are associated with activation of the restoration processes within the organism. This has special significance in those types of sports in which there are few assistance means and training is inherently monotonous, i.e., where the competition exercises are the basic training means (gymnastics, weightlifting, cyclic types of sports).

For example, the sole and systematic use of swimming restoration procedures during the execution of voluminous loading secured an increase of 24.2% in absolute-strength and 18.9% in strength-endurance; whereas the athletes who did not use the restoration procedures increased these indicators by 7.7 and 4.9% respectively. At the same time, the volume of the training load was increased an average of 15% (O. N. Kuchnyev, 1977; V. N. Platonov, 1980). The complex use of low-frequency vibro-massage and psycho-regulatory training in the pre-competition preparation of highly-qualified middle-distance runners contributed to an increase of 12-20% in the volume of the training load, executed at competition speed and increased the speed of covering training distances by 2-4% (I. P. Potapchenko, 1979).

So, the rational combination of training loads and restoration procedures is an important condition and a large reserve for the intensification and the raising of the effectiveness of training. However, it is necessary to emphasize that restoration of the organism after work is a natural process, unfolding in a definite sequence and requires a definite time period. This process occurs through the reconstruction mechanism of the inter-system regulation, under the influence of systematic loading (N. N. Yakovlev, 1971). Artificially accelerating (or providing) the restoration process can disturb the natural course of the organism's long-term adaptation to intense muscular activities and therefore can be justified only in extreme cases of serious over-strain.

Frequent and regular utilization of non-specific means of restoration are found to be in some physiological non-conformity (with respect to the aims of the influence on the organism) with the use of large training loads. Raising the volume and intensity of the loading disburbs homeostasis, as a basic condition for the organism's adaptation to loading, and the training of the restoration processes. At the same time, intervention during the course of restoration hinders the organism's ability to perfect this process by natural means (L. Y. Yevgenyev, et al., 1975). The process "loading-restoration" within the general system of the athlete's preparation should be strictly regulated; and its methodical resolution scientifically substantiated.

The training-potential of the loading characterizes the strength of its influence on the sportsman's state. The higher the training-potential (relative to the current state) the greater the probability of raising the athlete's special-work-capacity. The training-potential of the means employed decreases as the special-work-capacity increases; therefore, it is important to preserve it by introducing more effective means in training. This important principle of organizing training is presented in figure 32. The graph depicts the practical possibliity of altering the sportsman's state (F) under the influence of means with different training potential (A, B, C). However, it is inappropriate to use highly-effective means right off because the organism is functionally unprepared for them;

this leads to an excessive intensification of training and disturbs the natural course of the adaptation process.

The means of SPP are introduced into training with a definite sequentialness; the absolute strength of the training influences on the organism are gradually increased and a logical continuity is observed, in accordance with which, the preceding means provide favorable conditions for utilization of the subsequent. Presented in figure 33 are examples of a practical work-up of such a system of special-strength-training means, in different types of sport. We will examine in more detail the methodical questions associated with it.

Correct assessment of the training potential of the loading selected and the training-effect it provides, which is an objective necessity at a concrete stage of preparation -- is one of the chief requirements for programming training.

3.2.2 The Volume of the Training Load

The volume of the training load characterizes primarily the quantitative aspect of the training influences on the organism and plays an important role in its long-term adaptation to intense muscular work.

The function of the volume of the load consists chiefly of the systematic and prolonged disturbance of the constancy of the organism's internal relationships (homeostasis), stimulation of the mobilization of its energy resources and plastic reserves. This is the fundamental condition for switching from the urgent (specific) reaction, provoked by individual segments of the training influences, to the general (non-specific) accommodative reaction; and then to the development of long-term adaptation; at the basis of which lies the stabile morpho-functional reconstruction of the organism. Therefore, in each year's cycle athletes should execute larger volumes of loading, providing a rise in special-work-capacity and its prolonged preservation.

In types of sports requiring brief, highly-concentrated efforts, the volume of loading has yet another important significance. As already indicated, in the modern stage of sport the mechanical integrity of the ligamentous-joint apparatus can

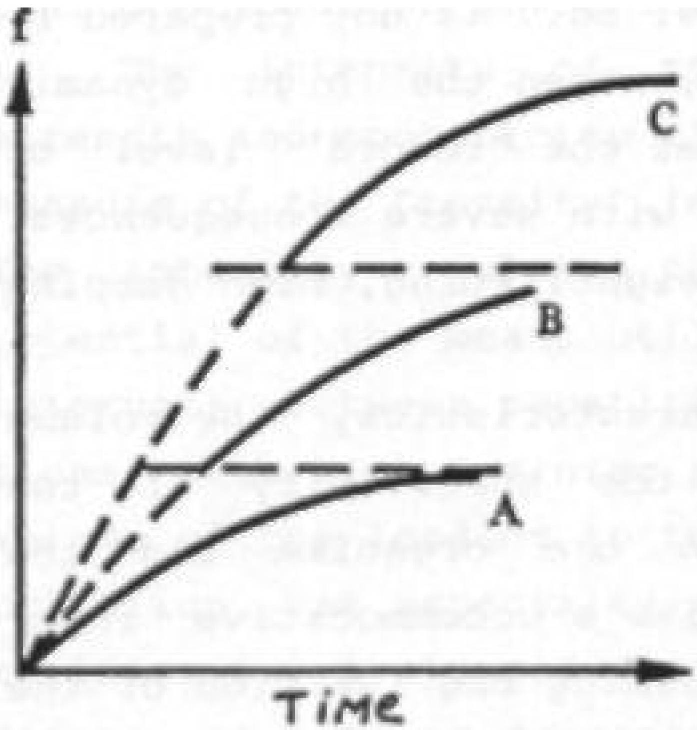


Figure 32. The Affect of means with different training effect on the athlete's state

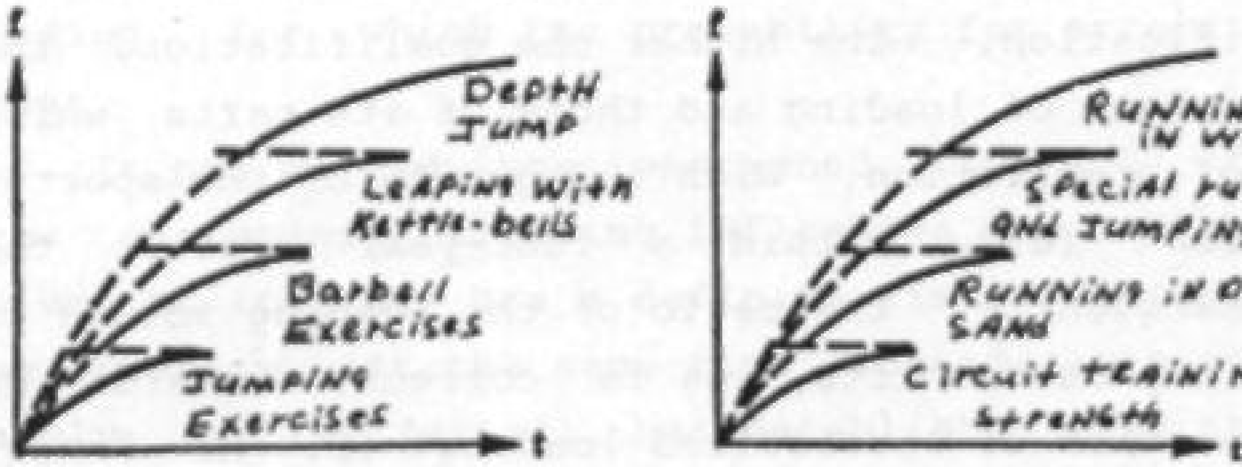


Figure 33. The system of the means for the development of Track and Field jumpers' explosive-strength (Y. V. Verkhoshansky, 1970) and the strength-endurance of middle-distance runners (A.A. Nurmekiv, 1974)

become the limiting factor to the progress of sport achievements. And, if it (ligamentous-joint apparatus, Ed.) is not prepared by voluminous work of moderate intensity, then the high dynamic overloading the sportsman encounters at the "record" level of achievements can lead to joint injury, with severe consequences. This occurs frequently in gymnastics, weightlifting, high jumping and triple jumping.

Representing only quantitative characteristics, the volume in-and-of itself does not determine the specificity of the training influence of the loading on the organism and the qualitative peculiarities of the organism's accommodative reactions. Therefore, when programming training the function of the volume can be determined correctly in that instance if one takes into consideration the magnitude of the loading, its duration and intensity.

The magnitude of the volume is the quantitative measure of the executed (or planned) training load of a certain primary emphasis; relative to the specific micro-cycle, stage (period) or the year cycle as a whole.

The magnitude of the volume is determined, first of all, by the athlete's qualification. The higher the qualification, the larger the year's volume of loading and those of its parts which are in each stage of preparation. With the growth of the sportsman's qualification (also within a four-year cycle) the magnitude, and consequently, the ratio of the loading volume of different primary emphasis shifts, as is correct, towards an increase in the portion of specialized loading (G. M. Panov, 1975; S. V. Zhikharevich, 1976; A. A. Vankov, 1977; L. P. Matveyev, 1977; V. B. Gilyazova, 1978, and others).

The practical magnitude of the year's loading volume is established individually, based on the peculiarities of the sportsman's preparation in the preceding stages of training. A more serious task of programming training is the determination of the optimal volume of loading in concrete time segments (month, stage, period). This magnitude should be determined based on the general stage-conceptions of training construction in the yearly cycle and the principles of rational organization of training loads of different primary emphasis.

The intensity of the loading is the criterion of the strength and specificity of its influence on the organism or the measure of the "tensity" (difficulty, Ed.) of the training work. The intensity regulates the magnitude (strength) of the training potential of the means utilized, the frequency of their use, the intervals between repetitive use of the means or training sessions with high training potential; as well as the ratio of the volume of the loading to the time of its realization. The latter criterion has especially important significance for programming training for prolonged periods; since it takes into account the degree of loading concentration relative to time. Intensification of loading is permitted at specific stages in the yearly cycle and only after preliminary preparation of voluminous low-intensity loading.

The duration of the training load is an extraordinary criterion of the volume, on which we should dwell in more detail. The duration of the loading renders a significant affect on the dynamics of the sportsman's state and are those parameters of the loading, for which the probability for errors are particularly great.

It has already been mentioned (see 2.1) that the length of time systematic training influences are employed (the general volume of loading) has a definite limit, depending on the CAP of the organism. At the same time, considerable research (unfortunately, still limited) has established that there also exists a time limit where specialized portions of loading of a primary emphasis are employed, the exceeding of which adversely affects the perfectioning of mechanisms crucial for maximum and explosive-strength; aerobic and anaerobic productivity. Going beyond this limit loading, already does not yield a developmental effect and leads to a useless expenditure of the athlete's time and energy. It is important to have a representation of the optimal time-span for loading of any primary emphasis, as well as the rate of improvement of the appropriate indicators, when programming training.

Unfortunately there is no special research directed at determining the appropriate length of time for loading of a specific primary emphasis. However indirect data has been gathered, enabling us to shed some light on this problem. Thus, there is a linear increase in absolute-strength in connection with an assigned loading, the slowing down of this increase begins at the limits of this optimal time-span of training; which defines the exhaustion of the organism's CAR. Observational data of highly-qualified athletes indicates that absolute-strength increases with little fluctuation; rising continuously during the year's training.

When explosive-strength is the subject of special training, there is a clearly expressed tendency for the rise in explosive-strength to slow down; the sharper the expressed growth, the earlier it plateaus. When one is emphasizing the development of explosive-strength exclusively, by utilizing these means, the plateau appears in 3-4 months. In those instances where explosive-strength is not the key ability (for example, in a single-cycle of periodization in the year's training of decathletes, see 2.1, figure 6) the increase in explosive-strength (with some fluctuation) can continue up to 10-months.

Loading that is primarily aerobic in nature will result in significant increases in aerobic productivity, already in one month's time (E. P. Borisov, 1979; V. A. Sirenko, 1980). The dynamics of the aerobic productivity and loading indicators executed within the aerobic zone (at a HR of 120-170 beats/minute), are unidirectional. Their rate of increase is approximately equivalent and they are linear in nature over a 2-3 months period. Despite increased loading volume, the aerobic productivity indicators do not increase significantly later on; they fluctuate within the range of the level achieved (V. M. Zatsiorsky, et al., 1974; A. P. Skorodymova, 1974; F. P. Suslov, 1977; Y. A. Ustkachkintsev, 1979; V. A. Sirenko, 1980).

The rate of increase in work-capacity cedes to rate of increase in the loading (of corresponding emphasis) within the anaerobic zone of energy-acquisition. About 4-months are necessary to achieve the highest results in anaerobic productivity (V. M. Zatsiorsky, et al., 1974; B. S. Serafimova, 1974; N. I. Doroshchenko, 1976; Y. A. Ustkachkintsev, 1979). Increasing the volume of anaerobic work renders a positive effect only if it precedes a significant volume of aerobic work, stimulating the aerobic reaction (B. S. Serafimova, 1974; V. I. Naumenko, 1978).

Note that the aforementioned data applies to the natural conditions of an athlete's preparation, where the development of a certain motor ability is realized simultaneously along with the resolution of other tasks and where loading of other primary emphasis is employed. They conform to those actual loading volumes that modern highly-qualified athletes assimulate and realize with the help of the principles of organizing training which are acceptable today. And, since these principles are being constantly perfected, the duration of loading indicated is not definitive. However, it can serve as a preliminary orientation when programming training.

3.2.3 Organization of Training Loads

Organization of training means its regulation within a concrete time span (stage, period), which ensures the planned dynamics of state and the achievement of the planned level of SPP. The basis of such regulation should be the achievement of the positive cumulative training-effect of the loading of different primary emphasis. Here, it is necessary to observe the chief requirement -- preservation of the training-potential of the loading.

The organization of loading is defined by two criteria: the nature of its distribution over time and the principal interdependence of the loading of different primary emphasis.

Distribution of the training load over time is understood to mean the way in which it is distributed in separate stages, cycles and periods of the year-cycle. The distribution of the general volume of loading and its dynamics in the year-cycle are determined by the traditional periodization of training and the regularities of the organism's long-term adaptation to training influences. If one speaks of loading of one primary emphasis, then one should distinguish two variants of organizing it time-wise: distribution and concentration. The first assumes a relatively uniform distribution of means within a year-cycle; the second -- the concentration of means at definite training stages.

The effectiveness of the distribution and concentration variants of organizing training loads should be based on the sportsman's qualification. Research indicates that both variants bring success in the training of middle-qualified athletes. The second variant is appropriate for the training of highly-qualified athletes. Thus, it has been shown that the distribution of glycolytic work in the year-cycle of highly-qualified sprinters manifests itself in increased loading volume, but does not lead to an increase in the effectiveness of the loading. However, by concentration of the volume of glycolytic work at certain stages, the work was executed at a smaller volume of loading but achieved a more significant displacement in the athletes' speed-endurance (0. A. Kornelyuk). Similar results were obtained by concentration of the volume of sprinters' special-strength work (A. V. Leuchenko), middle-distance runners (V. A. Sirenko, L. N. Zhdaovich), boxers (V. I. Filimonov} and jumpers {I. N. Mironenko, T. M. Antonova).

Special observations have shown that concentration of the volume of uni-directional loading results in more extensive functional changes within the organism and more essential displacement to the sportsman's physical preparedness. Distribution of the volume of training influences by dispersion over time provokes only a brief functional reaction which does not provide conditions for the development of long-term adaptational reconstruction. Distribution of the loading initially can yield some rise in the functional level, but then, in connection with the rapid adaptation of the organism, loses its training potential and becomes non-productive work.

The interdependence of loading of different primary emphasis, assuming they are combined rationally over time, provides the required cumulative training-effect.

The cumulative loading of different primary emphasis can have positive and negative effects. Thus, when developing explosive-strength, the positive interaction of the organism's functional reactions is achieved practically, through the following brief combinations of training means:

"short" and "long" jumping exercises;

barbell exercises and jumping exercises;

barbell exercises with 30 and 90% of maximum;

barbell exercises and the "shock" method of developing explosive-strength (for example, depth-jumps);

leaping with kettle-bells and jumping exercises;

barbell exercises and leaping with kettle-bells.

In a single training session the order of the means, combined in a systematic complex, has no significance, in principle; since the length of time the organism maintains the traces of the training influences in this instance, exceeds the time-span of the workout. Within the time-span of this session and the nearest restoration period, a generalization of the traces of the entire complex of training influences of different primary emphasis occurs; which results in the same cumulative effect, regardless of the sequence with which these influences follow in time.

So, in the given case, concerning the development of explosive-strength, of fundamental significance is not so much the order of the means, as volume of the loading as well as the "contrastness" of the training influences of different means phenomenon. Nevertheless one should still preserve the aforementioned order of combining means, since it provides the favorable affect of a brief rise in functional state, which the first exercise creates with the execution of the second. The best methodical variant of utilizing the aforementioned combination of special-strength exercises -- is to employ them serially with active rest between series. When repeating such a series it is desirable to vary the exercises, in order to avoid monotony of training work and to maintain the optimal rest pause for eliminating the alactate debt.

One cannot speak with as much certainty about the effect of the interaction of loading of different primary emphasis on the development of endurance. The facts available lack conformity and are often so contradictory, that it is very difficult to ascertain definitive tendencies. It is believed that the main reason for this situation is the failed attempt at methodical interpretation of "never popular conceptions" concerning the mechanism of energy-acquisition for intense muscular work (R. Margaria, et al., 1964). An outcome of this conception is the division of training loads into aerobic, alactic anaerobic, anaerobic glycolytic, mixed and so forth; nominally, so conditional that they permit very broad interpretation, they exclude the possibility of strict classification with respect to primary emphasis and consequently, objective assessment of their training effect (the more cumulative).

One hopes that in the near future the negative consequences of such interpretations will be eliminated, but until then, note that available experimental material indicates that there is a positive interaction of endurance loading in those instances where:

aerobic exercises are done after loading of alactate-anaerobic influence;

aerobic exercises are done after loading of glycolytic-anaerobic influence (in a small volume);

glycolytic-anaerobic exercises are done after loading of alactic-anaerobic influence.

Under these conditions the previous loading creates favorable conditions for executing the subsequent loading and raises the effect of the training session, as a whole.

There is a negative interaction when:

alactic-anaerobic exercises are done after a large amount of glycolytic work;

glycolytic exercises follow large volumes of aerobic work (N. I. Volkov, 1975).

It has been established that restoration of energy resources and disturbance of neuro-endocrine equilibrium within the organism is prolonged by 2-3 days after a large volume of aerobic work. During this period it is appropriate to employ a small volume of anaerobic loading, which will not have a negative influence on the restoration of the aerobic capacity and will stimulate the development of anaerobic capacity.

Restoration after anaerobic loading, executed at a moderate volume, usually takes 3-8 hours. However, extraordinarily large volumes of anaerobic loading slow restoration. The effect of alactic-anaerobic workouts worsens if the sessions are done without full restoration from the preceding loading (M. Y. Nabatnikova, 1972; N. I. Volkov, 1975; V. N. Platonov, 1980).

Sequential-cumulation of the training-effect of loading of different primary emphasis has a place in the long-term stages of preparation and is expressed by the "superimposed*' training-effect of the subsequent work on the training-effect, achieved by the preceding work. In this case, if the preceding work creates favorable prerequsites for the subsequent work, there is a positive sequential cumulation of their training-effects.

For the development of explosive-strength the positive cumulation is achieved through a sequence where voluminous loading with submaximum resistance is employed first; then means which stimulate the display of explosive-effort. In this instance the positive cumulation is achieved by the first loading securing a rise in the general energy potential of the neuro-muscular apparatus. This creates favorable conditions for the further development of adaptation, conditioned by the subsequent loading and the emphasis on perfectioning the athlete's ability to display explosive-effort of great power. The reverse sequence of the aforementioned loading leads to a negative cumulative-effect.

The mechanism of sequential-cumulation is appropriate only if the training-effect of the previous work has become relatively stabile (requiring no less than 4-6 weeks). When the strength means of different emphasis are changed over shorter time intervals, for example after 2-weeks, already the organism is unable to differentiate the specifics of their influence and the organism's accommodative reaction is realized by means of the brief cumulation mechanism. This corroborates the circumstance, that a change in the order of loading of different emphasis, after two-week stages of use, has practically no affect on the resulting training-effect.

With the development of special-endurance (the main method in cyclic sports) the appearance of the sequential cumulation of the training-effect of loading of different primary emphasis has a more complex character than with the development of explosive-strength; which gives rise to the following circumstances.

First, it is permissible and customary to develop explosive-abilities with assistance means that are sometimes nominally (externally) far from the motor structure of the fundamental sport exercise; however, the fundamental sport exercise is traditionally the chief means of developing special-endurance in cyclic types of sports. Here the effect of the special-endurance depends on the successful selection of the volume ratios of work of different intensity and duration.

Second, endurance training causes more profound changes within the organism, which require more time for restoration of expended energy. Here, selection of the work to follow is of great importance. And, since in this case, it is appropriate to do work of a different character, which contributes in particular, to intensification of the restoration processes or is designed to improve other abilities (V. N. Platonov, 1980); this significantly complicates the maintenance of the chief emphasis of the training influences and leads to composite training, which is not always appropriate for highly-qualified athletes.

The methodics of developing endurance have been established long ago and there are still two opposing points of view amongst their adherents. One of these is based on the expediency of the so-called parallel or simultaneous development of general and special-endurance (L. P. Matveyev, 1970; I. G. Ogoltsov, 1971; M. Y. Nabatnikova, 1972). This variant introduces special-endurance loading already at the beginning of the preparation period, while one is developing general-endurance. It is assumed that this training will be more specialized, creating more favorable conditions for specific adaptation to competition activities. At the same time, one provides multi-sided preparedness simultaneously and the athlete achieves a more stabile work-capacity in the competition period. This point of view has been corroborated experimentally; a significant portion of the research was done with athletes who have not yet reached the apex of sport mastery, in particular, with junior middle-distance runners (V. N. Baranov, 1969), swimmers (V. V. Kuzovenkov, 1969) and skiers (V. M. Malikov, 1974).

The other point of view emphasizes sequential development of endurance, where one begins by perfectioning respiratory (aerobic) possibilities, then lactate endurance (glycolysis), and finally alactate endurance (the creatinphosphate mechanism). This sequential introduction of aerobic work creates favorable conditions for the training-effect of anaerobic work (N. G. Ozolin, 1959, 1970; N. I. Volkov, 1963; N. N. Yakovlev, 1957; E. P. Borisov, 1979; S. A. Loktev, 1978). A gradual increase in the duration of aerobic-loading leads to an an accumulation of the supply of energy substances and an increase in the organism's energy potential (N. N. Yakovlev, et al, 1960). Here, the volume is not of principal significance, but the intensity of the work is (P.-O. Astrand, K. Rodahl, 1970). When one's aerobic abilities are insufficient, an excessive increase in the volume of anaerobic means leads to a decrease in sport achievements (V. I. Naumenko, 1978; Y. N. Vavilov, 1977; B. S. Serafimova, 1974; N. V. Morzhevikov, 1980).

A third point of view on practical methodics of endurance development has been formulated and has found experimental corroboration. Basically, this point of view involves the complex rise of aerobic and anaerobic means, but with a sequential switch in the accentuation of their emphasis, from general to special-endurance. The effectiveness of this type of training construction in a yearly cycle has been demonstrated, in particular, for highly-qualified middle-distance runners (N. I. Doroshchenko, 1976; S. A. Loktev, 1978; E. P. Borisov, 1979); as well as for multi-year training (M. M. Linyets, 1979). One can assume that this system represents a compromise, unifying in-and-of itself the merits of the complex and sequential variants of special-endurance training. This is even more important because it is done in practice.

The organization of loading is closely associated with the selection of the optimal rest interval between repetition of a single training session and between contiguous sessions. We would remind you that the essence of training consists not only of muscular work, but the effect of the organism's compensatory reaction, provoked by it. Therefore, the rest pause is an important training means, equally important as muscular work; and this means should be employed skillfully. It has been emphasized repeatedly, that the art of training management consists of the rational combination of specific and non-specific loading along with skillful regulation of work and rest (B. S. Hippenreitor, 1955; V. V. Petrovsky, 1969; N. G. Ozolin, 1949, 1966). The rest interval is the most important pedagogical component of training methodics. Sustaining the optimal pause between repetition of work requires definite methodical competency and the coach's pedagogical mastery to skillfully "fill" this pause. In the opposite case, the specificity of the influence is diminished and the cumulative effect of the loading is altered; as a result of which, it turns into "gross" work, developing everything, but not resolving the training's concrete task.

So, the aforementioned data is indicative of the extraordinarily complex connection between the sportsman's state and the assigned training load; and coupled with this, of the difficulty of selecting the optimal variant of training organization to achieve the given special-work-capacity. Nevertheless, in spite of the limited objective data one can already speak, not about concrete recommendations for each type of sport, but about some principal approaches to the organization of training loads in the system of yearly preparation.

3.3 The Long-Term Lag in the Training-Effect of the Loading

We will isolate and examine in detail, the particular connection between the dynamics of the sportsman's state and the assigned loading, in the long-term training stages.

Considerable research (S. V. Nikitin, 1977; I. N. Mironenko, 1979; T. M. Antonova, 1982; A. V. Leuchenko, 1982) has revealed a steady decrease in speed-strength preparedness in individual training stages of different length (from 5-12 weeks). This decrease is the result of voluminous strength loading (figure 34, shaded rectangle), after which speed-strength returns to its initial level and significantly surpasses it. Since this phenomenon is not in accordance with established ideas concerning the "steadfast" rise in an athlete's special-physical preparedness as an indispensable condition for rationally organized training; and is not accompanied by clear-cut signs of over-training, it has become a subject of special study. The following has been established as a result of this study.

The volume of the training load has a definite (individual for each athlete) level, above or below which quantitatively and qualitatively alters the organism's reaction to the loading. There is a characteristically simple connection between the quantity of work executed and the dynamics of the athlete's state. An increase in the volume of loading raises the athlete's special work-capacity, and vice versa. If the volume of loading is essentially lower then the aforementioned level, special work-capacity, after some rise, begins to decrease. If the volume of loading exceeds this level significantly, a steady decrease in special work-capacity occurs, which however, rises intensely during the timely reduction in the volume of loading. This intense rise in the athlete's special work-capacity is in-and-of itself a phenomenon of the long-term lagging of the training effect (LLTE) accompanying one of the forms of the organism's compensatory adaptation to the volume of loading.

This phenomenon, in its general appearance, has been known for some time in practice, where it has been observed in the form of a natural increase in sport results after a decrease in the volume of the training load in the pre-competition stage (N. G. Ozolin, 1949, 1967; V. M. Diachkov, 1953; L. P. Matveyev, 1970;

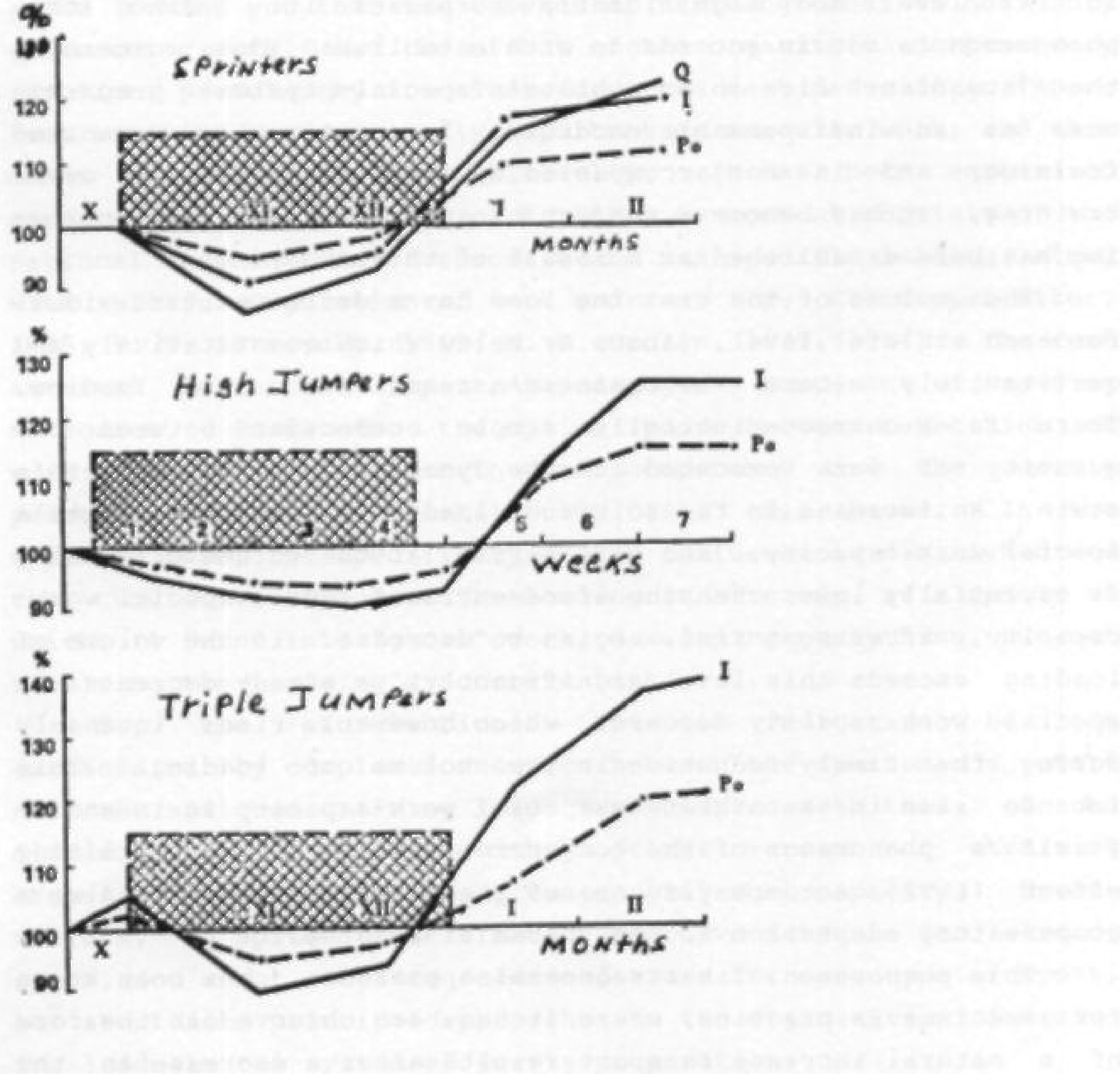


Figure 34. Dynamics of absolute (Po), explosive (I) and starting (Q) strengths under conditions of concentrated strength loading.

R. M. Charyev, 1975). However, this is only the external aspect of adaptation; the causual conditions, mechanisms and peculiarities of its manifestation which, and the chief possibility of utilizing it as a special way of constructing training up-until-now, was not a subject of intense scrutiny. Essentially, no one had any idea that the appearance of the LLTE has great promise for rationalization of training, especially for highly-qualified athletes.

Several graphic, practical examples of the LLTE phenomena are shown. Presented in figure 35 are the dynamics of the speed-strength indicators (leg extension) of highly-qualified volleyball teams (group A), who for two months prior to an official tournament used a concentrated (4-weeks) volume of special-strength work (chiefly depth jumping). This loading caused a brief rise in speed-strength in the first week, then lead to a steady decrease of the same. An intense rise in speed-strength occurred after the specialized strength loading ceased; speed-strength then reached a level that far exceeded the initial. The speed-strength dynamics of other teams who used traditional methods of strength and pre-competition preparation (group B) are presented for comparison. It is easy to see that the first group performed in official competitions (9-12 weeks) at a higher level of functional preparedness due to the unidirectional use of the LLTE of concentrated strength-loading.

Similar results were obtained in an experiment which verified the effectiveness of a six-week program of special-strength-training for increasing the speed of movement of tennis players on a tennis court (figure 36). In this case, there was a similar tendency in the dynamics of explosive-effort (leg extension) and the tennis players' speed of movement in special motor tasks.

The LLTE phenomenon of concentrated strength-loading was observed in specially organized experiments in cyclic types of sports — middle distance runners (L. N. Zhdanovich, 1980), swimmers (N. M. Rudokene, 1981), skaters (P. I. Kabachkova, et al, 1982). Thus, a steady increase in the strength-endurance of middle-distance runners was verified — increased stride length

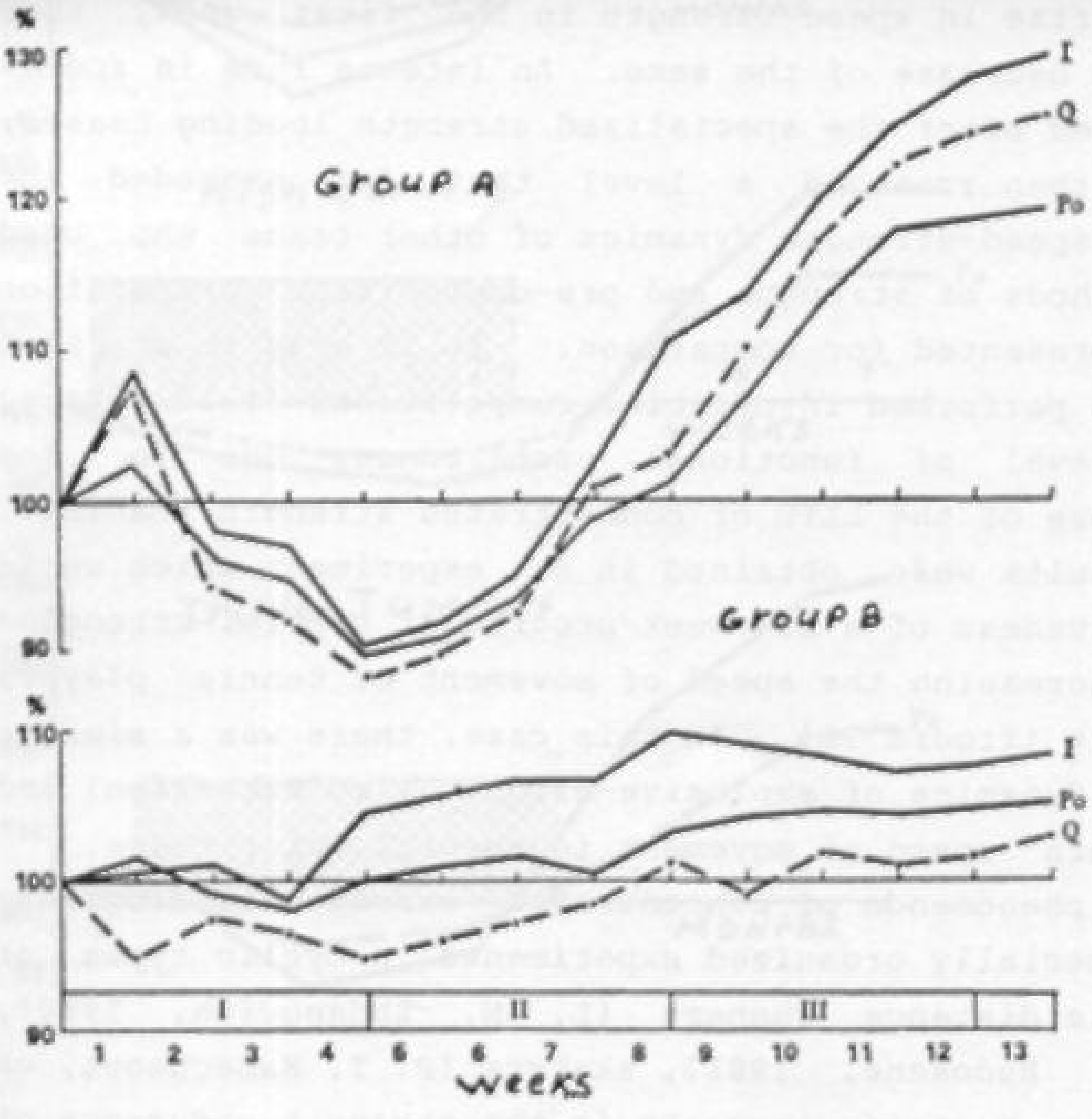


Figure 35. Speed-strength dynamics in two groups of volleyball players (D. Naraliev):
I - Strength loading,
II - Pre-competition training
III - Competition

Is and the results in 10-standing long jumps (figure 37), after concentrated strength-loading. It is interesting that one can see an increase in the ability to display a single explosive-effort (vertical jumping) in the concentrated strength-loading stage, but one finds that there is a tendency for this ability to decrease in the competition stage. One can assume that the reason for this phenomenon is due to the raising of the volume of intense distance work, which has a negative affect on the ability to display a concentrated explosive-effort, since the latter is non-specific for cyclic types of sports.

Based on generalized results and schematics of experimental materials the LLTE phenomenon can be characterized in the following way (see schematic in figure 38).

1. Concentration, i.e., within a limited time period, concentration of the volume of strength loading (A), creates the possibility of an extensive, unidirectional training influence on the organism. Concentration of strength loading is the basic condition for the beginning of the LLTE.

2. The lower (within an optimal range) the speed-strength levels fall in the concentration of strength loading stage, the higher they subsequently rise in the realization of LLTE phase (graph of Fi and F2)- Excessive concentration of strength-loading results in a more significant drop in speed-strength and to a disruption of adaptation (graph F3).

3. When utilizing concentrated strength loading oriented to obtaining a LLTE, the means used should not be intensive. Concentration of unidirectional loading is already an intensification of the training influences, and one should not strengthen it with high-intensity means.

4. A moderate volume of general-developmental work, combined with special work of gradually increasing intensity contributes to realization of the LLTE through concentrated strength-loading (B) .

5. The length of time LLTE is displayed is determined by the volume and the duration of the concentrated strength-loading. In principle, the steady display of the LLTE (t2) is equivalent to

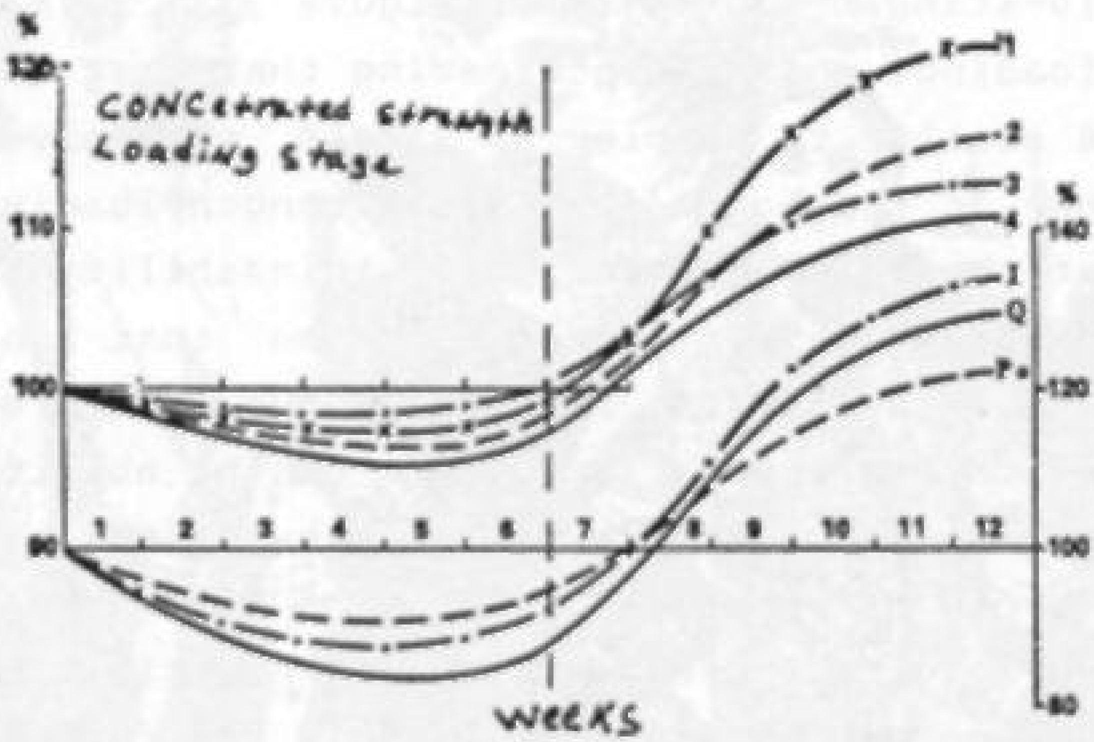


Figure 36. Dynamics of explosive (I), starting (Q) and maximum (Po) muscular strength of Tennis players, during special motor tasks (Y. V. Verkoshansky, 1982): 1- long volley, 2- serve, 3- short volley, 4- run up to the net

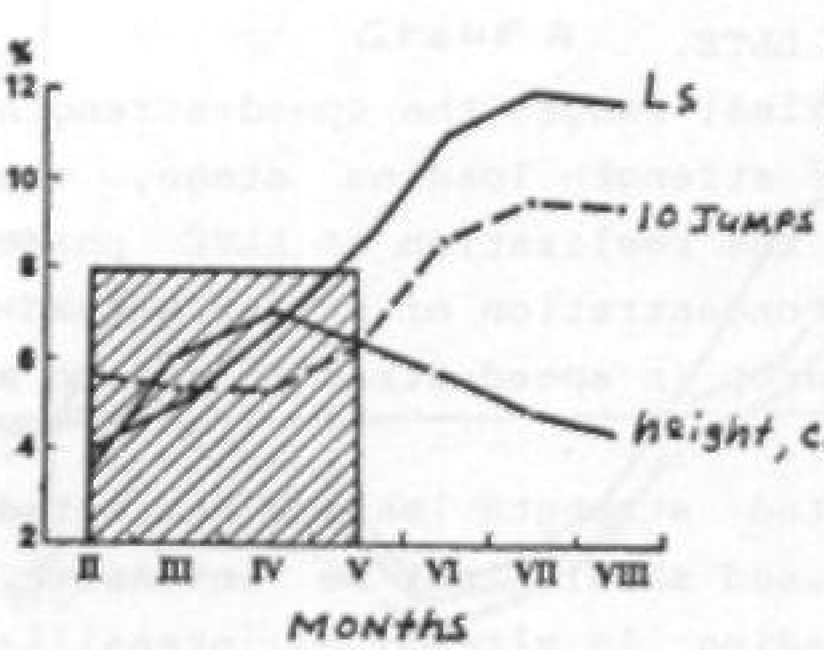


Figure 37. An example of the long-term lagging of the training-effect of concentrated strength-loading for middle distance runners (L. Zhdanovich)

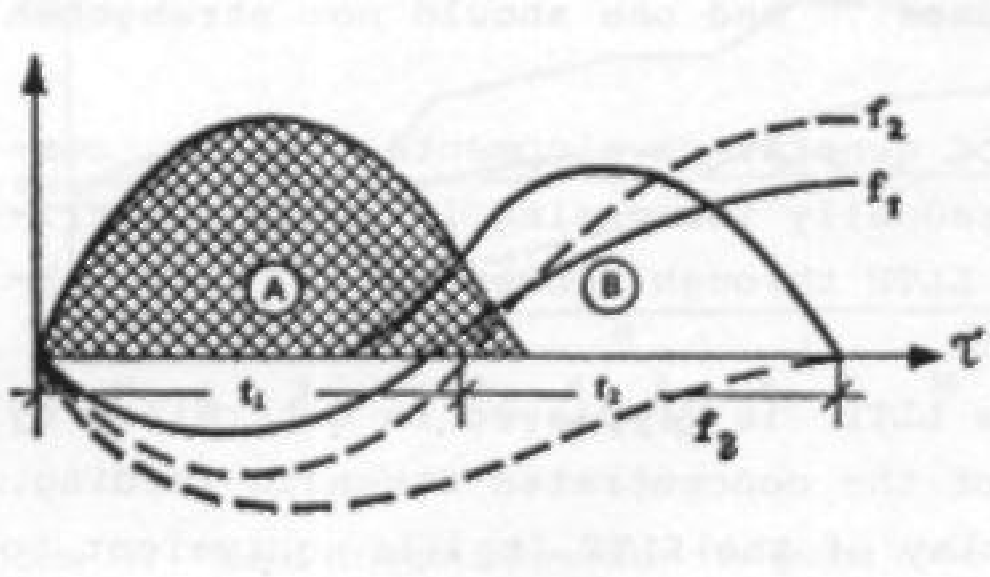


Figure 38. A scheme of the LLTE of concentrated strength loading

the duration of the strength work stage (t^). Under the actual training conditions of highly-qualified athletes, the stated tendency was observed from 4-12 weeks during the long-term stages of strength preparation. However, one should bear in mind, that manifestation of the LLTE is individualized and to a significant degree depends on the sportsman's volume of loading and his recuperative ability. An equivalent volume of loading for two athletes of the same qualification can yield different effects.

There are a number of important circumstances associated with the manifestation and utilization of the LLTE of strength-loading in the year cycle. Athletes do not have sufficient time for recuperation after voluminous strength-loading. Consequently, they exclude the possiblity of realization of the LLTE of the strength-loading and these conditions are extremely unfavorable to the organism. Besides this, the organism is forced into a unjustifable expenditure in order to restore its energy potential. The effectivensss of the athlete's preparation is rather low under such conditions and their special-work-capacity is not very high in the competition stage.

During the period of the LLTE realization of voluminous strength-loading it is relatively easy and painless for the organism to switch to intensive loading, but it will react negatively to voluminous work. This is manifested in the slowed growth and even decrease in speed-strength. So, one must not permit an increase in the volume of training work during the period of the realization of the LLTE. One should be especially cautious with strength-loading in the competition period. At this time, intensive and short-term strength work can be utilized in a small volume as a means of toning the neuro-muscular system during competition preparation; as well as for preserving the achieved level of speed-strength preparedness, in the event the length of the competition period exceeds the time period of the realization of the LLTE of strength-loading.

With respect to aerobic and anaerobic productivity, there is no experimental data that clearly documents the LLTE phenomenon of cyclic (distance) work. The exceptions are cases of intense training in the low-oxygen conditions of altitude. Here, characteristics of the LLTE phenomenon dynamics were observed in swimmers (figure 39) -- maximum aerobic capacity, the total volume of work which the athletes are able to execute at the critical level of power, MOC and the oxygen debt. All of the athletes improved their results immediately after training at altitude.

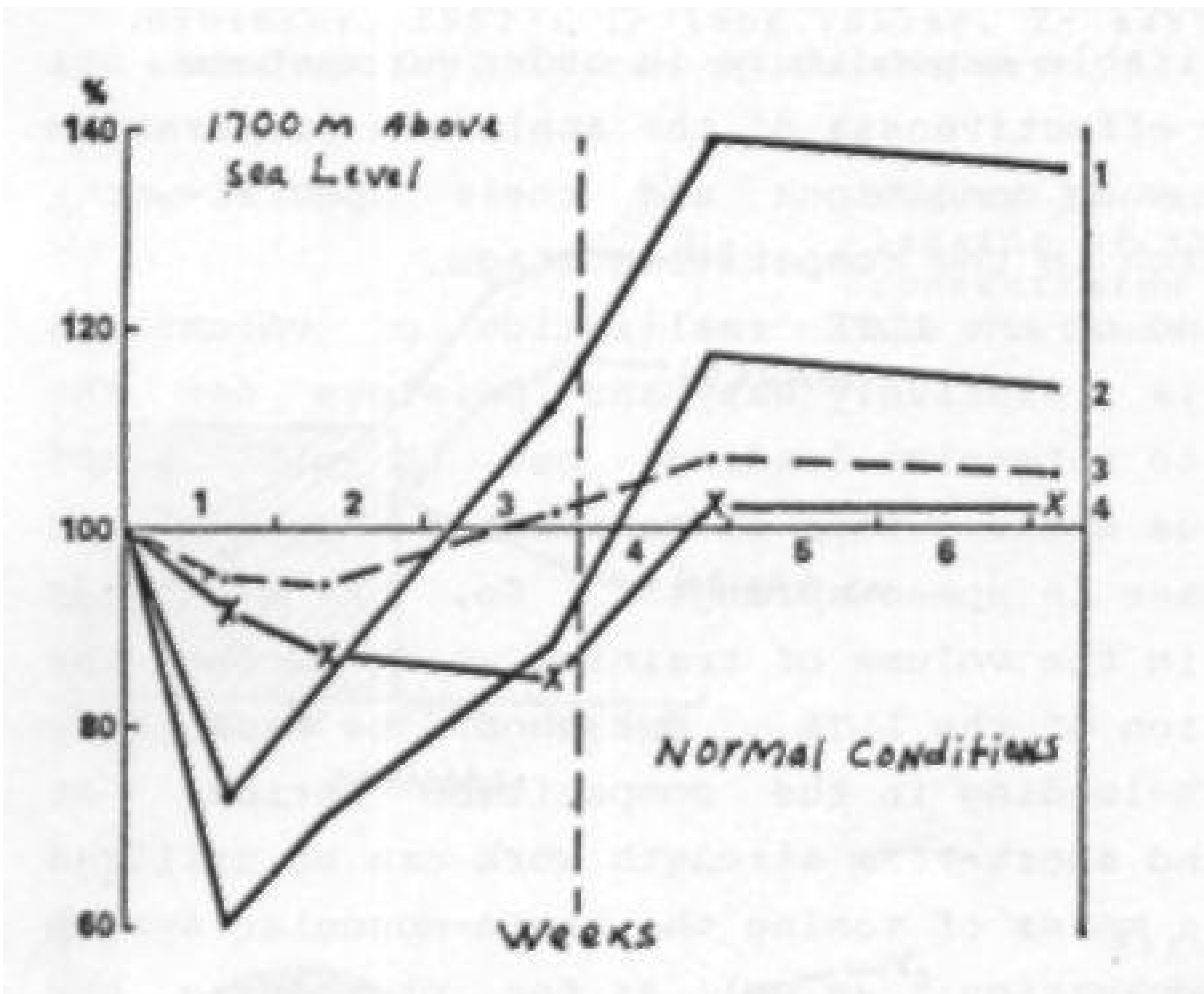
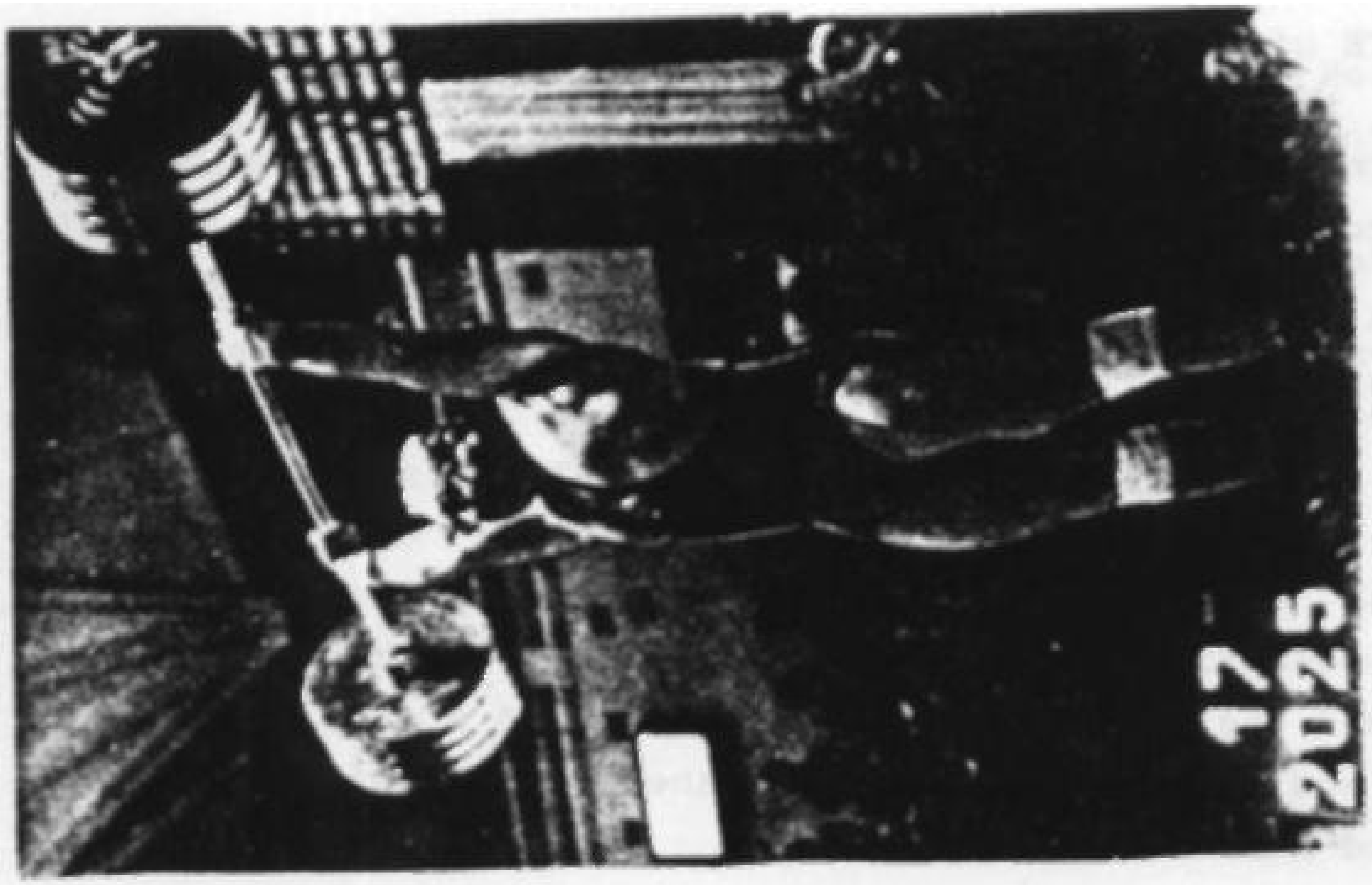


Figure 39. Dynamics of swimmers' functional indicators (S. M. Vaitsekhovsky, et al, 1974):
1 - Summed volume of work at level of critical power,
2 - Maximum aerobic capacity,
3 - Alactate portion of the oxygen debt,
4 - MOC

The LLTE of training at altitude was slightly different with respect to the organism's reaction to a standard dosage of loading. Thus, a disturbance in the motor-visceral regulation and the economicalness of circulatory-respiratory activities (figure 40) were discovered in skaters, at altitude conditions; during four-minutes of bicycle-ergometer loading. The result was an increase in the intensity of the work, a decrease in TANE, activiation of the lactate mechanism of ATP resynthesis, increased energy expenditure and a decrease in the mechanical effectiveness of the work. After returning from altitude functional economization and mechanical effectiveness of standard work exceeded the initial level as a result of a more economical metabolism and a significantly diminished portion of anaerobically produced ATP.

The stay at low-oxygen conditions was common to both experimental examples, which was an extreme training influence, provoking persistant disturbance of the organism's homeostasis and the subsequent activation of the plastic resources.

As already emphasized, this phenomenon is not observed by means of standard, traditional ways of assessing the state of the vegetative systems under normal barometric conditions. However, if it originates from the general biological regularities of the organism's adaptation to external influences, the prolonged disturbance of homeostasis (indispensable conditions for the beginning of the LLTE) occurs at the system level; the functional dynamics of which are not perceptible to methods utilized for assessing the aerobic and anaerobic possibilities of the organism. In this instance the adaptational processes apparently, develop at deeper -- subskeletal and molecular levels (in the mitochondria, the endocrine system); concerning which, the results of considerable research is indicative (N. I. Yakovlev, 1957, 1974; A. A. Viru, 1969, 1981; V. S. Finogenov, 1979). However, disturbance of homeostasis can be manifested in the dynamics of a number of psycho-physiological indicators; reflecting the functional state of the CNS and the neuro-muscular apparatus.



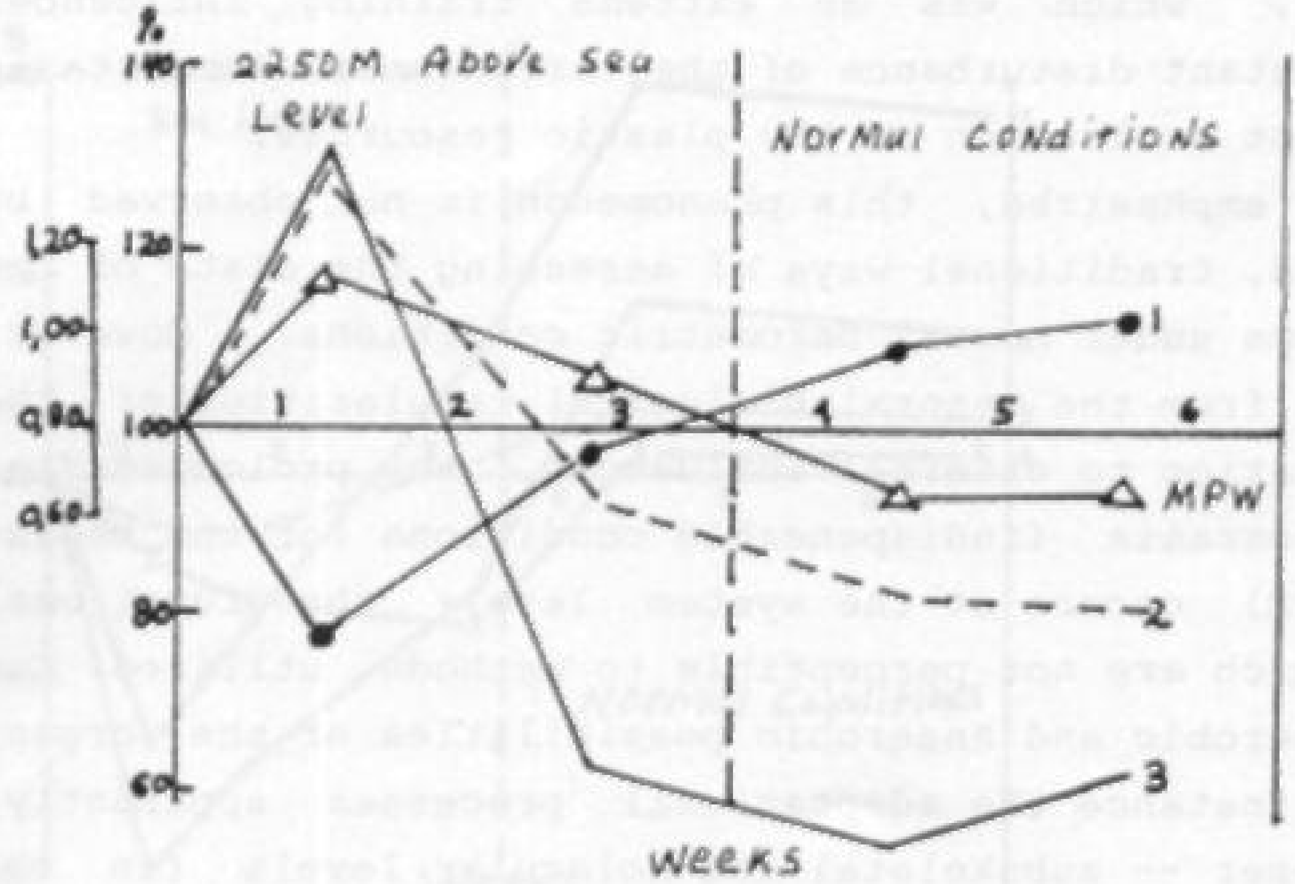


Figure 40. Energy dynamics of standard 4-minute bicycle-ergometer loading (A. S. Ivanov, 1977):
1 - Mechanical effectiveness of the work,
2 - Oxygen requirement
3 - Oxygen debt, MPW - metabolic power of work

Thus, the use of large complex training loads, caused a decrease in the functions of swimmers: an increased latent period of a complex motor reaction and its motor component, diminished preciseness of muscular force, a worsening of the preciseness of reaction to a moving object. At the same time there was a noticeable decrease in sport work-capacity, a worsening of the functional state of the cardio-vascular system (according to cardiac rhythm data), a decrease in muscle tonus and a decrease in mineral-cortical hormones in the adrenal cortex. After the training loads were reduced and the intensity of the swimmers' workouts was altered, there was a rise in psycho-physiological functions with the subsequent switch to the super-restoration phase. Simultaneously, the swimmers' work-capacity increased, the functional state of the cardio-vascular system improved and muscle tonus increased **(N. V.** Susman, **1978).**

One can hope that research in this area in the near future will enable us to characterize more completely the LLTE phenomenon of voluminous specific loading in cyclic types of sports and make a significant contribution to the theory and technology of programming training.

So, the just described characteristics of the LLTE phenomenon should be considered an important foundation and an objective prerequisite for rational systems of preparing highly-qualified athletes in the yearly cycle. Intentional creation of conditions for origination and unidirectional utilization of the LLTE significantly increases, the possiblity for raising the effectiveness of training in all types of sports, without exception.

It is necessary to emphasize that one should differentiate between the preservation of the training effect and the LLTE of loading. In the first case, bear in mind the general duration of the organism's retention of functional reconstructions, as a result of the training influences (after they have ceased). In the second case, there is an essential and relatively prolonged rise in the functional indicators, as a result of using specially organized, concentrated volumes of loading.

3.4 General Tendencies in the Dynamics of the Sportsman's State in the Year Cycle; Depending on the Organization of Training Loads

As we have already emphasized repeatedly, knowledge of the regularities of the interdependence between the dynamics of the sportsman's state and the training loads, is of exclusive importance for programming training. However, in practice, there is very little experimental research associated with the systematic observation of the dynamics of the sportsman's state in the year cycle. Research, inclusive of stage (3-4 times a year) assessment of the sportsman's state, is not very informative, since the most interesting alterations in state occur between these stages.

There is considerable foreign research on the changes in functional indicators of untrained people, done in laboratory conditions, over a period of 2-3 months (M. L. Pollock's review, 1973). These studies are undoubtedly of interest for studying the mechanism of the organism's short-term adaptation to muscular work; but of little use in programming the training of highly-qualified athletes. Therefore, any observations of the dynamics of a sportsman's state, with a periodicity of only once a month, is of significant practical interest.

Our laboratories were the first to conduct extensive research on the dependence between the dynamics of the sportsman's state in the year cycle on assigned training loads; this created interest crucial for programming training results. The research included observation of dynamics and experiments under the natural conditions of training athletes of various qualification. Functional indicators were recorded 1-2 times per month and the training loads completed were carefully calculated.

Research has established that in sports requiring explosive-force, a chaotic dynamics in speed-strength is observed in athletes of middle qualification, along with insignificant alterations in speed-strength level during the year cycle; furthermore, the fluctuations often do not conform to the logical periodizations of training or the competition calendar. The reason for this is because complex training is applied, i.e., the parallel use of loading of different primary emphasis; and chiefly, the monotonous monthly distribution of the general volume of loading in the year-cycle.

Accompanying the growth of mastery, the dynamics of an athlete's state shows a tendency towards regulation, which first of all reflects the type of training periodization in the year-cycle. During uni-cyclic periodization (for example, in the decathlon, see figure 6) the dynamics of special-strength preparedness are ascending in nature, without any significant fluctuations throughout the year. In two-cyclic periodization (see figure 5), two large waves are clearly manifest, conforming to two large periods of preparation; concluding in the winter and summer competitions.

However, the dynamics of highly-qualified sportsman's speed-strength in the year cycle, can not be regulated in such a manner. Our people have accumulated material that shows a rather large diversity in the dynamics of an athlete's state. Large fluctuations in speed-strength preparedness can be of different duration and magnitude; can take place at different stages of the year-cycle and often have neither a logical connection with traditional (for the type of sport) periodization of training, nor the competition calendar.

A phenomenon which has great significance for regulating the influence of loading was first discovered as a result of observation of the dynamics of sportsmen's state in the year-cycle. It has been established that the unidirectional (in principle) dynamics of the speed-strength of leg extension and plantar flexion can supercede to different-directional dynamics, at certain training stages. The dynamics of triple jumpers' explosive-strength is presented in figure 41, and can serve as an example. This phenomenon is associated with the relatively unequal emphasis of the training influences on the functioning of the muscle system, securing the extension effort in the legs, The complex use of jumping and barbell exercises can lead to a more intensive local influence on the plantar flexors, and as a consequence, to depression of their functional state. However, this type of loading is not as intense on the thigh extensors, consequently their functional indicators will be high. In this instance the athlete notices that movement coordination is difficult while, on the whole, feeling good.

So, when one is determining the composition and the means of special strength-training and one does not take into account (and does not equalize) their primary emphasis on the muscle groups securing the working-effect of a sport movement, the result can be a non-conformity in the functional state of the muscles involved. This, in turn, has a negative affect on the quality of the sportsman's technical preparation and on his preparedness for competition. Consequently, it is necessary, first, to regulate the emphasis of the loading on the plantar flexors, and second, periodically decrease the loading influence on them especially during the technical and immediate pre-competition training stages.

The dynamics of the sportsman's state, as characterized by his aerobic and anaerobic posibilities, depend on the contents at\u Giqat\\7A\A0Tv ol Xhfe tX&it&Oq loads. Data from observations of the dynamics of state of two groups of middle-distance runners during a year-cycle are presented in figure 42. Of particular interest is the fact that with equivalent volume and distribution of running means, the groups of runners were differentiated by the organization of strength-training. In one of these groups (A), a traditional single-peak variant in the distribution of strength-means was used; whereas the other (group B) used a double-peak distribution of means, with the emphasis concentrated in December and March-April.

The results of the experiment show that the difference in the organization of strength-preparation caused essential differences in the dynamics of the sportsmen's state. Group B's aerobic and anaerobic productivity reached higher levels of development. The differences in the organization of special-strength-training appeared in the results of control runs of 400 and 1200 M, as well as in the sport achievements of these groups of runners. During the summer competition stage group B improved

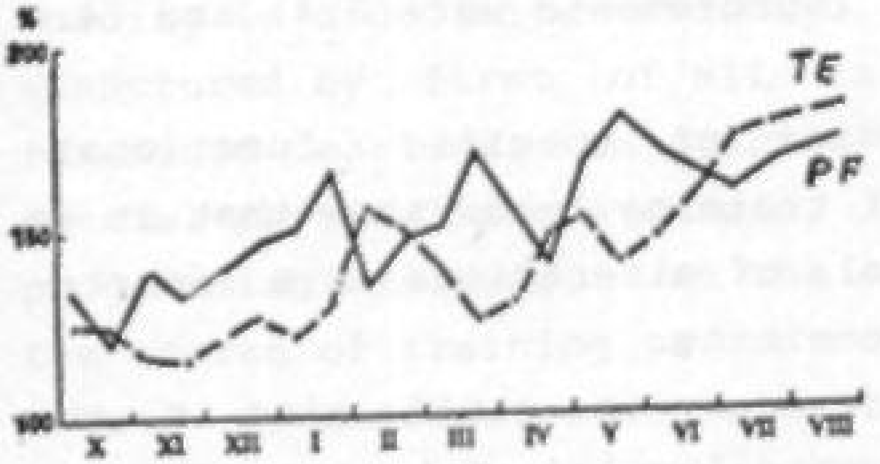
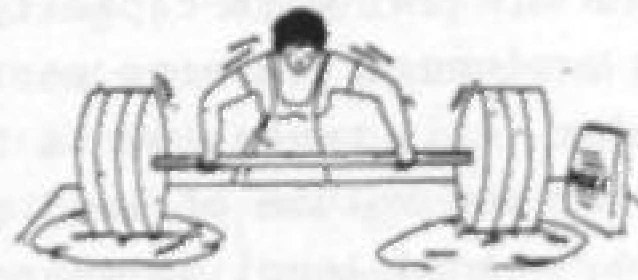


Figure 41. Dynamics of Triple-Jumpers' explosive-strength during a year-cycle: TE- thigh extension, PF- plantar flexion



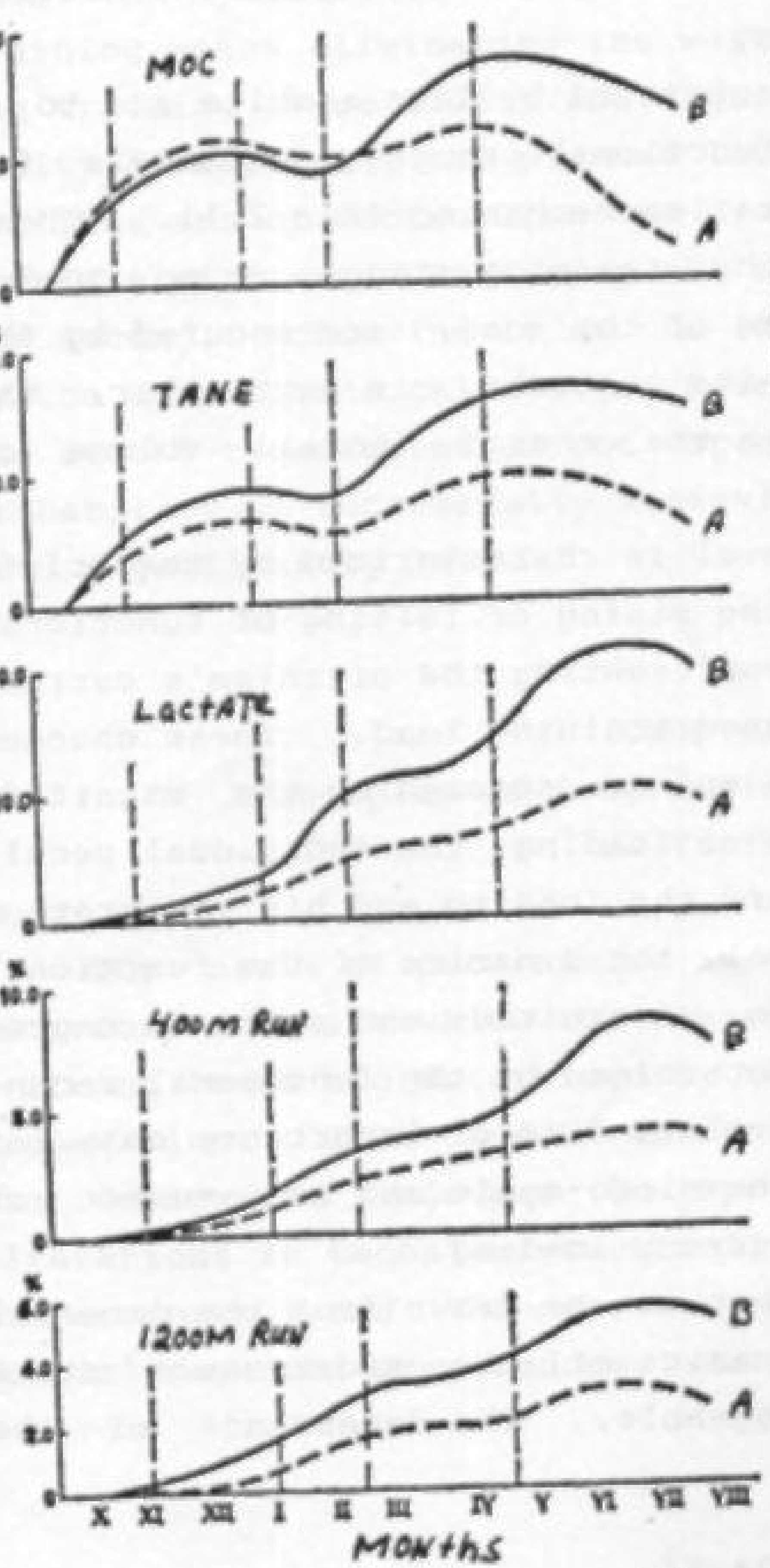


Figure 42. Trainability dynamics of two groups of middle-distance runners. Dotted lines indicate the stages of concentrated strength loading in group B (V. A. Sirenko, 1980)

the 800 M time by an average of 4.8 seconds and the 1500 M run by 6.3 seconds. In group A, the improvements were 3.4 and 4.6 seconds respectively.

So, studies of the dynamics of specific functional-indicators under the influence of training loads show that it is possible to single-out three levels of alterations in a sportsman's state during the course of training.

The first level is characterized by the steady rise in the athlete's special work-capacity; this level is inherent chiefly to the prolonged training periods -- year and multi-year. The basis for this mechanism is the long-term adaptation, formed chiefly by the volume of loading.

The second level is characterized by less stabile and to a definite extent, reversible functional changes; the basis for which is the compensatory adaptation mechanism (see 2.1). These changes are inherent to lengthy training stages -- up to 5-6 months and along with the volume of the load, are secured by the qualitative characteristics of its contents, in particular, the portion of intensive means in the general (total) volume of loading.

And finally, the third level is characterized by the brief, but not definite tendencies; the rising or falling of functional indicators, i.e., changes, representing the organism's current (urgent) reaction to the assigned training load. These changes are inherent to the micro-cycle and are secured by the magnitude and the intensity of the volume of loading, the individual peculiarities of the athlete to endure the loading and his restoration capabilities. On the third level, the dynamics of the functional indicators are to a known degree, fortuitous and at times unpredictable. This level is not determined by the functional reconstructions of the first two levels and is of importance only for the rational organization of the micro-cycle and achievement of the expeditious effect of the current loading.

One practical conclusion that can be drawn from the material just discussed is that the dynamics of the sportsman's state during the year-cycle are manageable. The dependence of the dynamics of state on the contents, volume and organization of the loading is a definite tendency. Consequently, training should be structured by first of all taking into account the concrete (examined earlier) tendencies in the dynamics of the athlete's special-physical-preparedness, -- in this context, the task of programming training. At the same time, it is necessary during the course of training to control the degree of conformity of the actual dynamics of state with the given tendency (stage), — in essence, the task of managing training. Mastering the skill to rationally program the contents of training and opportunely regulate the dynamics of the sportsman's state during the course of training means eliminating the weak link in the system of managing training (see 1.2); and significantly increasing the probability of achieving the planned level of sport mastery.

The art of controlling the dynamics of the sportsman's state consists of first, achieving the necessary level of conditioning and second, achieving it at the instant required (as determined by the competition calendar). Research shows that realization of the second requirement is not especially complex. However, the probability of successfully achieving the first requirement is as yet, significantly less.

Chapter 4
Principles of Programming and Organization of Training

The basis of programming is the program-objective approach; in accordance with which the contents, volume and organization of training loads are determined by the objectives of the athlete's preparation. The objectives consist of three main components: the designated increase in sport results, the appropriate alterations in technical-tactical, psychological and competition preparedness, and the necessary displacement in the sportsman's special-physical-preparedness.

The selection of a strategy in programming is realized, in a practical sense, through logical premises "if, then", which are understood in the following way. If one sets some (concretely and quantitatively determined) task, then the (concrete) work which is necessary to accomplish for the realization of the task and how it is to be done, is the quantitative expression of the strategy selected.

Let's look at those objective fundamentals for selecting a strategy when programming traiing, which at the present time, already can be formulated as well as those fundamentals of programming technique, which have received practical approval.

4.1 Forms of Constructing Training

Forms of constructing training are the ways of regulating its contents, providing the expeditious utilization of loading of different primary emphasis, i.e., the combination and arrangement of the contents over time, such that the required training-effect occurs within an optimal energy expenditure.

Consequently, time and organization are two closely interdependent and interinfluencing variants of the forms of training construction. The contents and organization of training are dictated by the training objectives and the regularities of the organisn's adaptation to intense muscular work; determined as necessary for this period of time. Time, limited by the competition calendar and the optimal duration of CAR of the organism, affects the selection of the contents and organization of training. Actual conditions do not always satisfy the optimal parameters of these variants. Therefore, programming of training requires creative flexibility; based on the skill to foresee the effect of any form of training construction and to select its optimal variant.

Let's turn now to a number of forms of training construction and examine their peculiarities, as revealed by the results of research on the regularities of the organism's adaptation to intense muscular work and the principal tendencies in the dynamics of the sportsman's state; as dependent upon the assigned loading. Two categories of the form of training construction are designated, based on organization and time. Under organization, bear in mind the ways of combining loading of different primary emphasis, as a basic condition for achievement of a high training-effect; under time -- the ways of regulating the loading within concrete cycles and stages as determined by the periodization of training and the competition calendar.

4.1.1 Forms of Constructing Training with Respect to Organization

The complex form, which encompasses simultaneous (within one workout or micro-cycle) and parallel (prolonged stages of training, up to one year) selection of a number of training tasks and loading of different primary emphasis, is always regarded as the most effective form of training construction. In the past, considerable data was favorable to the complex organization of training. This data showed that the athlete achieves harmonious and multi-sided physical development; the development of one motor ability contributes to the development of others and that multi-sided loading improves strength, speed of movement and endurance to a greater extent than unidirectional exercise (A. N. Krestovnikov, 1951; S. P. Letunov, et al., 1954; N. V. Zimkin, 1956; A. V. Korobkov et al., 1960, and others).

As an outcome of this there were arguments for the methodical principles unifying GPP and SPP; unification of the habits and qualities, determining the training methods, independent of the athlete's qualification. Complex-training construction is prefered over unidirectional, with its (unidirectional) inherent to it, monotonous workouts, diminishing effectiveness of the training means relative to the organism's adaptation and the one-sided physical preparation of the athlete. It is believed that prolonged unidirectional work (one-sided training for strength or speed, etc., Ed.) causes the organism to form an accommodative process with the dominence of only some of the physiological mechanisms and does not create conditions for specific adaptation to competition activities. Parallel loading of different emphasis simultaneously improves physiological functions and in the typical ratio for the selected sport (L. P.

Matveyev, **1970)**.

All of these concepts in principle, are indisputable and are of importance as the most general guidelines, determining the methodical fundamentals of physical education and sport training. However, the research touting these ideas was done many years ago and utilized low-class athletes. If qualified athletes had taken part in these studies, then, with respect to modern criteria, their achievements would be only average. Besides this, one should emphasize in particular, that the loading in those days was different. Therefore, under modern conditions this loading would only be applicable to beginners or athletes of average qualification.

There appears to be little advantage for high-class athletes to utilize the complex system of training. Arguments in favor of this conclusion are based on progressive sport practices (see 1.1); where there is an active search to overcome the glaring insufficiencies of the complex system of training.

First, extra-class athletes have a very high level of special-physical preparedness. In order to raise this significantly, which is a necessary condition for the progress of sport mastery, one must utilize strong and relatively prolonged training influences of appropriate emphasis. Complex-training does not achieve this. In complex-training the distribution of the volume of special loading (see 3.2) is not able to provoke extensive adaptational reconstruction of the necessary emphasis within the organism.

Second, there is a clearly expressed specificity in the structure of the physical-preparedness of high-class athletes. Complex-training, with respect to its multi-sided influence on the organism, cannot create the conditions necessary for the formation of this physical-preparedness. Besides this, complex-training (at high volumes) creates prerequisites for the beginning of concrete relationships between the processes perfectioning separate functional systems of the organism; as well between the training-effects of loading of different primary emphasis.

Third, highly-qualified athletes execute the competition exercise skillfully and with precise regulation of effort. Voluminous complex loading, stipulating simultaneous perfectioning of sport technique and special-physical preparedness, inevitably leads to general functional fatigue and has a negative affect on the quality of this regulation (see 2.4; 3.2).

The aforementioned insufficiencies of complex-training are not as noticeable in sportsmen of average qualification and are significantly more apparent at the high-mastery level; where there is a high general volume and intensity of loading. And, if one does not prescribe measures to eliminate these insufficiencies, they can significantly affect the success of training.

One should seek just such measures to rationally utilize loading of some single training emphasis in separate workouts, and at stages of different duration. Research has shown that utilization of unidirectional loading, in separate workouts for example, makes it possible to achieve training objectives more effectively. It is because of this that the accommodative processes within the organism are more intense than when one is trying to achieve several training objectives by using means of different primary influence (A. B. Handelsman, K. M. Stetsenko, 1980).

For example, it has been shown that individual workouts devoted solely to perfectioning sport technique are appropriate. Even when a wide variety of means and rational regimens of work and rest are utilized, these types of training sessions are very effective in raising an athlete's technical mastery (Z. S. Struchkov, 1980; I. N. Mironenko, 1981; V. V. Petrovsky, 1977). Available data shows that training sessions with the primary emphasis on the development of a single motor ability (but under conditions of a wide diversity of means and methods used) renders a more extensive influence on the organism in comparison with training sessions where several objectives are undertaken (I. V. Urzhensnevsky, 1969; M. Y. Gorkin, et al., 1973; V. D. Monogradov, V. N. Platonov, 1975; L. E. Fedorova, et al., 1975; V. I. Chepelyev, 1980 and others).

In addition to separate workouts, unidirectional loading is appropriate in the micro-cycles (A. B. Kudelin, 1980; T. M. Mikhailova, I. P. Sokolova, 1980; T. M. Budokho, et al., 1978; I. N. Mironenko, 1981). It has been established, for example, that micro-cycles of a single primary emphasis (in particular, to increase speed or various types of special endurance) are powerful stimulants to the growth of trainability in swimmers (A. B. Kudelin, 1980); and micro-cycles of a primarily strength emphasis, have the same effect for raising the special-physical preparedness of track and field jumpers (I. N. Mironenko, 1981). Methodical recommendations emphasize that unidirectional loading is only effective if one uses a diverse complex of means of a single primary emphasis, along with a variety of methods (L. E. Fedorova, et al., 1975; V. N. Platonov, V. D. Monograov, 1977; Y. V. Verkhoshansky, 1977).

Considerable research has revealed that the primary utilization of unidirectional training influences for prolonged (from 4-12 weeks) stages of training is very effective. Use of a variety of means and chiefly, a gradual increase in the strength of their influence, has been shown to be appropriate; especially for perfectioning sport technique, speed-strength preparedness and for increasing the power and capacity of the processes of alactic and glycolytic anaerobic energy-acquisition (I. N. Mironenko, 1981; T. M. Antonova, 1980; V. N. Deniskin, 1976; A. V. Leuchenko, 1981; A. 0. Kornelyuk, 1980).

A special concentrated volume of specialized training loads was devised and approved (based on research) for the practical preparation of highly-qualified athletes -- this loading being concentrated at specific stages of preparation (Y. V. Verkhoshansky, 1977). The principal novelty of this method consists of creating a massed training influence on the organism with a high volume of unidirectional loading, within a limited time period (up to 2 months). This massed influence results in a brief stabilization of the state of incomplete restoration, which is associated with the persistant and relatively prolonged disruption of homeostasis. This triggers extensive functional changes, which are prerequisites for the subsequent supercompensation of energy potential and the transference of the organism to a higher level of special-preparedness. An important condition for the utilization of concentrated loading -- is the relatively low intensity of the means, since the frequent use of these means already leads to intensification of training. The loading can be considered concentrated if its volume in the month in which it is concentrated is 23-25% of the general year-volume.

It is appropriate to use concentrated loading, first and foremost, for raising the effectiveness of SPP; and for this purpose one can use loading of any primary emphasis. However, the concentration of specialized strength-loading is of particular significance (and not only for raising the sportsman's physical preparedness, but for regulating the entire complex of loading in the year cycle in all types of sports).

Concentrated strength-loading, as a part of the athlete's preparation, is a relatively independent part or "block", which creates a functional foundation for the subsequent perfectioning of technical mastery or those motor abilities which chiefly determine success in a certain type of sport. Hence, one, the composition of means and their organization in strength "blocks'", as well as their logical connection with other loading, should be determined by taking into account the training specifics in that type of sport. Two, the strength "block" should have a specific place in the year cycle, and consequently, have an affect on the succession of loading and the organization of loading of other primary emphasis over time. Here the idea of a "block" has a definite meaning, emanating from the programming of technique, including individual programming of training. To realize the principal idea of organization of loading (especially for certain sports) in the year-cycle, the coach can (depending on the conditions) select a certain strength "block" or substitute one "block" for another. Naturally, in order to do this he needs to arrange in detail, a supply of worked-out and approved strength "blocks".

The effectiveness of concentrated strength-loading has been confirmed by many coaches, as well as by special research in a number of speed-strength, cyclic and game sports; in single and multi-events (A. P. Varakin, 1979; L. N. Zhdanovich, 1980; N. M. Rudokene, 1981; A. M. Naraliev, 1981; G. M. Ptushkin, 1981; N. Y. Verkhoshanskaya, 1982; P. I. Kabachkova, et al., 1982). It has been established that this is most appropriate for highly-qualified athletes, and the use of concentrated strength-loading enables one to painlessly reduce the general year-volume (within 13-15%) of strength-loading, in comparison with those assimilated in the modern stage (I. N. Mironenko, 1981; T. M. Antonova, 1982).

Concentrated strength-loading has its deficiencies along with its obvious advantages. It leads to a brief but consistant decrease in speed-strength, which has a negative reflection on the athlete's special-work-capacity; and complicates the task of perfectioning technical mastery and speed of movement.

Thus, the connection between the organization and the volume of training loads, the changes in the dynamics (Fy) and time (Te) characteristics of the take-off in jumping, sport results (S) and the explosive-strength of women athletes (long jumpers) is clearly depicted in figure 43. It is obvious that in the months with the largest volumes (XI-XII and III-IV) there is a noticeable decrease in the special-strength preparedness of the women and the quality of their sport mastery. And vice versa, these same qualities rise during the months with reduced loading (II and V-VII).

Shown in figure 44 are the interdependence between the dynamics of the volume of special strength-training means, the elasticity of the muscles and the control results of the standing triple-jump of highly-qualified sprinters, during their spring-summer stage of training.

Here, it is also obvious that an increase in the volume of special-strength-training means (4-6th and 8-9th weeks) resulted in increased muscular stiffness and a decreased working-effect of explosive-effort. Unfavorable conditions were created at this time, for perfectioning of technique and running speed; the probability of injury increases significantly.

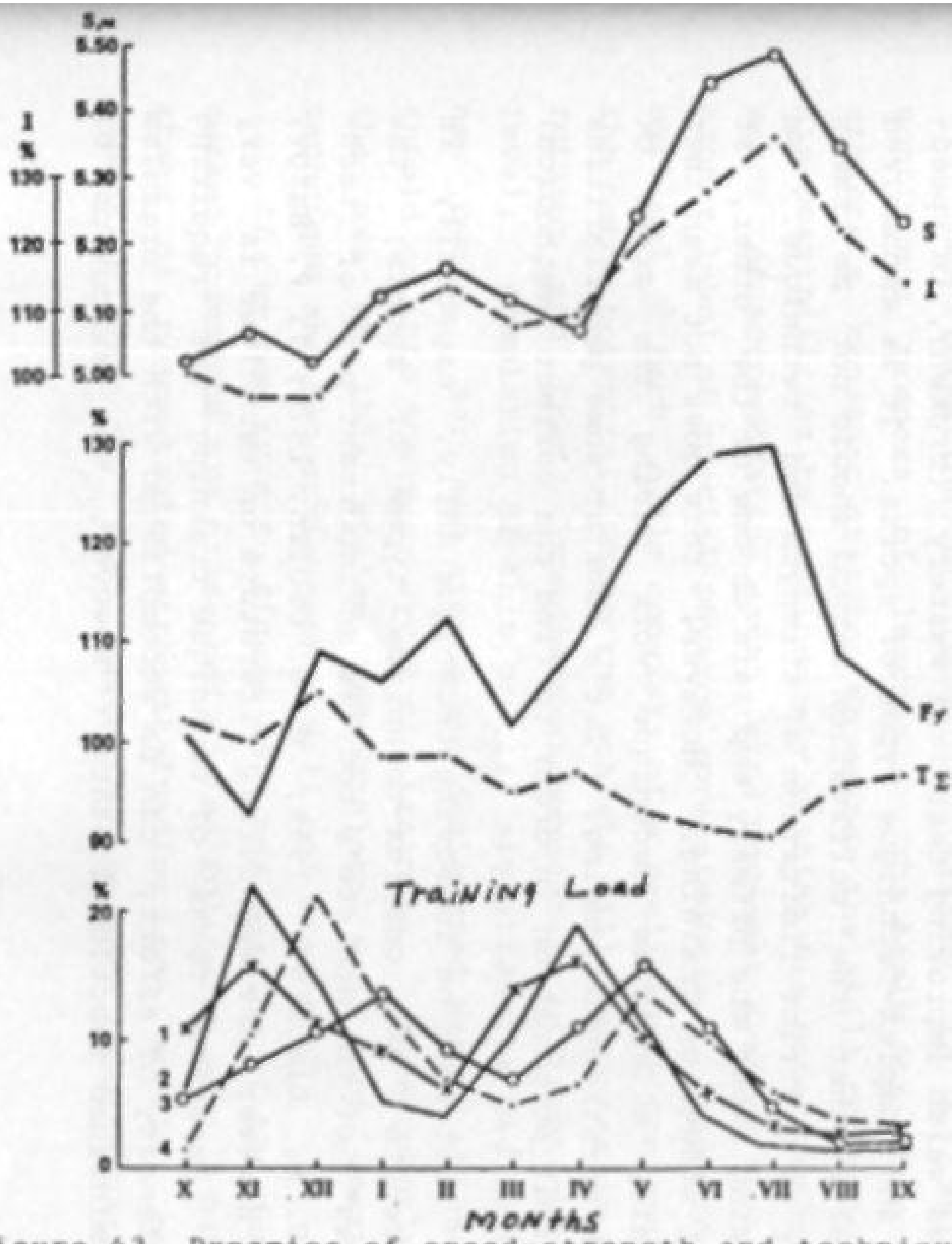


Figure 43. Dynamics of speed-strength and technique indicators and the distribution of the fundamental training means of women long-jumpers, in the year-cycle (T. M. Antonovov): S- sport result, I- explosive-strength, F_y- vertical force, T - general time of the take-off; 1- jumping exercises, 2- barbell exercises, 3- long-jumping, 4- running

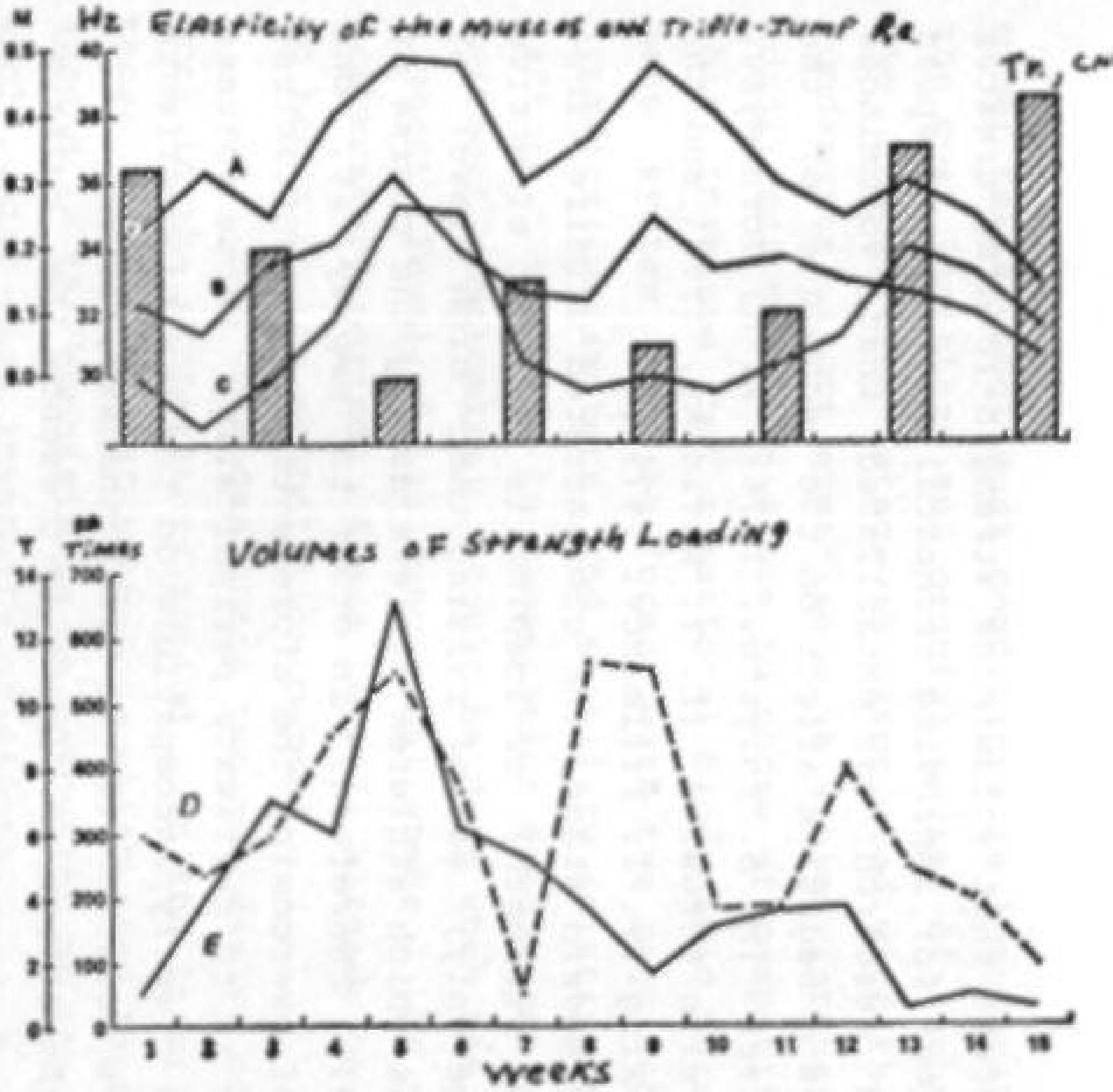


Figure 44. The dependence between the volume of spec-strength training means and the state of sprinters' support motor apparatus (A. V. Levchenko): A- calf muscle, B- quadriceps muscle, C- hamstring muscles, D- jumping exercises, E- resistance exercises

So, it is apparent that voluminous strength-loading creates unfavorable conditions for improving technical mastery and speed work. Considerable research has established that voluminous strength-loading has a negative affect on the technique of the weightlifting exercises (M. S. Khlystov, 1976; A. N. Vorobeyev, et al., 1978), javelin throwing (L. I. Ruvinsky, 1980) and the punching speed in boxing (V. I. Filimonov, 1979).

However, in the modern stage, the concentrated unidirectional method (including strength) of loading is the most effective (if not to say the only) way of raising that high level of physical-preparedness which athletes achieve during the course of multi-year training. Therefore, in order to employ it, one should seek ways of overcoming the aforementioned insufficiencies. One such way is to cultivate periodically, those volumes of loading which are clearly incompatible on the training-effects which have a negative relation (Y. V. Verkhoshansky, 1977).

For example, the scheme in figure 45 presents the cultivation of concentrated-strength-loading (shaded area) and work associated weith improving technical mastery (broken), in speed-strength and complex-technique types of sports. It is emphasized immediately, that the cultivation method should not be taken literally as a strict limitation of strength and technique. We are talking about the primary emphasis on one or the other, at different stages of training. However, this does not mean that one totally eliminates technique work during the stage of concentrated-strength-loading. Let's look at some peculiarities of technical preparation in order to find the correct methodical solution.

One must work on improving technique daily, especially in speed-strength and complex-technique types of sports; the "freshness" of the athlete's body is an important part of technique (V. M. Diachkov, 1966; N. G. Ozolin, 1970; I. P. Ratov, 1979). However the methodical literature on technique is very diverse. Separate tasks of technique training not requiring limit intensity of effort, can be accomplished with the organism in a diminished functional state. However, the execution of other tasks under such conditions is intolerable. For instance, the most important and crucial course of technique preparation in the competition stage is associated with the execution of the fundamental sport exercise with a high intensity of effort; under conditions that are close to those of competition. It is only in this instance that a rational biodynamic structure of the movement system can be formed with the required ration of time, dynamics parameters and stability relative to the inconsistant factors, inherent to competition conditions. This type of work (without compromise) should be done when the organism is at the highest level of its functional state. It should begin in the preparatory period, since it will already be too late if it were to begin in the competition period.

So, one can designate two successive stages of technique work in the preparatory period. In the first stage one, perfects those components of technique which need improvement and in the second — the emphasis is on execution of the sport exercise as a whole, with high intensity of effort.

The formation of technical mastery is a multi-year, continuous process of learning. The basis for this is the athlete's constant striving to master the skill to fully realize his possibilities by continuously raising his motor potential; by means of accommodating established movement systems to a newer, higher level of special-physical-preparedness. This process is cyclical. Each cycle consists of a preliminary preparation of the motor potential, which the athlete will encounter in the near future; and then, immediate accommodation of technique to that level. Completion of this process signifies the beginning of a new cycle. So, two stages are designated here, which ideally should go into the year-cycle of training. Consequently, with the use of this system, the athlete will not worry about technique and his achievements will not stagnate.

If we now turn to figure 45, the meaning of the just discussed concepts are presented in the following way. During the stage of concentrated-strength-loading one should primarily emphasize learning, i.e., mastering the more precise variants of technique, oriented to that specific level of speed-strength preparedness, which will be provided by the concentrated-strength-loading. Taking into account that functional state is diminished, this task is carried-out at a low intensity of effort, and chiefly by means of special-supplementary exercises, imitation of the rhythmic pattern (but not the tempo) and the related individual elements, reproduction of the whole sport exercise, not at full strength, but under lightened conditions

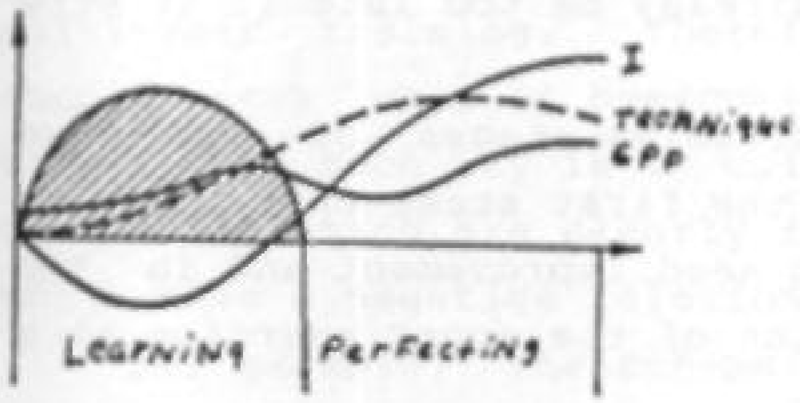


Figure 45. Organization of loading for speed-strength and complex-technical types of sports

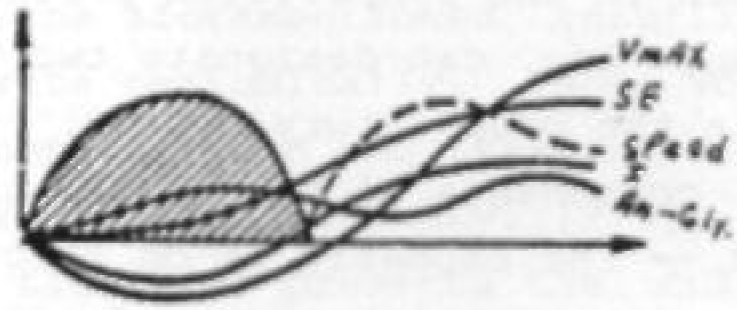


Figure 46. Organization of loading in types of sport with a cyclical movement structure

(including accentuation of individual elements). The intensification of effort is gradually increased during execution of the whole sport exercise.

One begins perfectioning technique during the realization of the LLTE stage of strength-loading, i.e., adapting it (technique, Ed.) to the athlete's increasing speed-strength preparedness. Here is where one employs modeling of competition conditions in training; which provides the achievement of stabile and reliable technique of the competition exercise, executed at a high intensity of effort.

Since perfectioning of technique is timed for the LLTE stage of the strength-loading, it is appropriate to look at this phenomenon and add to the recommendations made earlier (3.3).

A relatively prolonged stage of a reduction in the general volume of training is required to obtain the LLTE. However, in practice, coaches nominally aim for assimilation of large volumes of loading and as yet, do not always assess the role of restoration.

Although they provide rehabilitational pauses within the micro-cycle and the so-called over-load micro-cycles as necessary rest, they still do not effecitvely utilize prolonged reduction of loading after large volumes. However, such methods are objectively necessary, not only and not so much for rest and restoration of the organism's "freshness", but for the development and "flowing" of those physiological processes which are the basis for adaptive reconstructions. These processes "flow" relatively slowly; and a definite amount of time is necessary for their completion, which is far removed from the one-two weeks usually allocated for the reduction of loading.

By overestimating the quantitative criteria of the loading, athletes frequently not only "take on" the volume they do not need, but also execute this volume when it is simply contraindicated, i.e., at the moment when restoration of the organism is an objective necessity. Therefore new, additional volumes of loading not only do not ensure a training influence on the organism, but become a significant hindrance to the unleashing of the restoration processes, for which the organism is in extreme need.

A scheme of training construction which emphasizes the development of speed (sprinting, middle-distances, single-combat, sport games), is presented in figure 46. It is distinguished from speed-strength types of sports (see figure 45) in that it provides a sharper differentiation of concentrated-strength-loading (shaded) and work on improving speed (broken line). Speed work is excluded totally in the concentrated-strength-loading stage. However, it is possible in this stage to perfect the athlete's motor mastery, which directly secures (and limits) high speed of movement.

This motor mastery is a rational inter-muscular coordination, where there is no tension in the muscle groups which do not directly take part in the execution of the motor tasks; it is a clear-cut sequence of tension and relaxation of the working muscle groups, perfectioning the general coordination structure of the sport exercise. This type of work is quite compatible with the athlete's decreased functional state, only if it is in the optimal range of intensity of effort and frequency of movement.

Speed work begins only with the beginning of realization of the LLTE of strength-loading and along with the obligatory, gradual rise in the intensity of effort — the frequency of the movement and the athlete's speed of movement also rise.

High speed of movement or the movements of the athlete under competition conditions are to a great extent determined by the specific speed-endurance. The latter is expressed at a definite level of power and capacity of the anaerobic glycolytic processes of energy-acquisition; the acquisition of which (special-endurance) is necessary not only to provide energy for training, but in order to correctly select the place for the appropriate loading.

This type of loading has two waves (see figure 46). The first is timed for the end of the stage where there has been a concentrated volume of strength-loading; specialized-strength-means (see 2.3) are employed and the objective is to develop special (primarily local) strength-endurance. The second wave follows the fundamental volume of speed work; distance methods (in cyclic types of sports) or specialized means and methods (one on one events, sport games) are employed and the objective is to develop specific speed-endurance. This type of work should be done in "segments" of small volume and combined with speed work in such a way that it does not have a negative affect.

It should be taken into account, that along with the rise in strength-endurance (SE), explosive-effort (I) has a tendency to decrease when the second wave of loading of anaerobic glycolytic emphasis occurs. Therefore, in those types of sports where explosive-effort is of great importance, it is necessary to provide an appropriate intensive, small volume of maintenance loading.

So, the just examined forms of loading organization of different primary emphasis, is indicative of the departure from the traditional understanding of the complex preparation principle consisting of the parallel execution of several tasks. However, these forms by no means, negate the idea of complex preparation. They only show that the acknowledgement of the latter as a unified principle of training construction is unorthodox; and also the necessity to search for more rational ways of training construction, in accordance with the requirements of preparing today's highly-qualified athletes.

In recent years research shows that it is appropriate to utilize the so-called "conjugate-sequence system of organization of loading" for highly-qualified athletes. This is based on those same ideas for the systematic combination of special strength-training means; which take into account their training potential (see 3.2, figure 32); as well as the appropriate concentration and cultivation, at times, of loading of different primary emphasis. In this instance, sequence means a strict order and succession of introducing loading of different emphasis into training; while taking into account the systematic intensification of the strength of the specific training influence on the organism. Conjugate assumes an appropriate succession in the sequence of utilizing loading; the purpose of which is the creation of such conditions, through which the preceding loading provides a favorable functional background for raising the training influence of the subsequent loading. Sequence should be understood not as an abrupt, at times, differentiation of loading, but chiefly as a switch from one type of loading to the primary utilization of another (Y. V. Verkhoshansky, 1977).

A scheme of loading organization, based on the conjugate-sequence system, over a prolonged training period is presented in figure 47. The scheme depicts an appropriate sequence (but not the quantitative and time ratios of the volumes) of loading of different primary emphasis, taking into account the positive interaction and an increase in the specific training potential of the loading (TP). Thus, in order to develop speed-endurance, the numerical order signifies the following, in-stages, sequence of using distance loading: 1-aerobic, 2-mixed, 3-alactic-anaerobic,

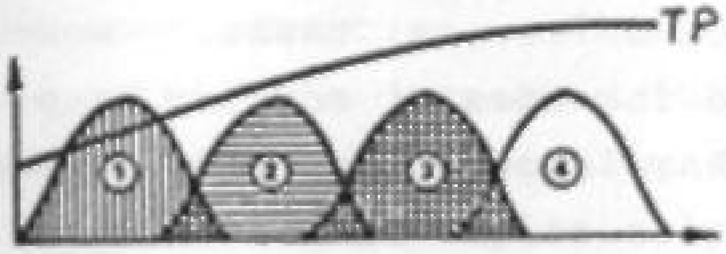


Figure 47. Conjugate-sequential organization of loading of different primary emphasis

4-anaerobic-glycolytic. The "block" of specialized-strength-loading is concentrated in stage 2. Speed work is concentrated primarily in stage 3 and is executed against a background of the realization of the LLTE of the strength "block". Stage 4 is devoted to improving speed-endurance when there is a significant decrease in the general volume of loading.

For speed-strength and complex-technique types of sports. The sequence of loading of different primary emphasis can be the following for speed-strength and complex-technique types of sports: 1- general-developmental work, in preparation for specialized-loading; 2- a "block" of concentrated-strength-loading; 3- in-depth perfectioning of technical mastery, against a background of the realization of the LLTE of the strength-loading; 4- further perfectioning of technical mastery under conditions of competition loading.

Well then, the general characteristics of the conjugate-sequence system of loading organization can be expressed in the following way.

The conjugate-sequence system does not reject complexness as the most general principle of training, but only develops it in conformity with the conditions and requirements of the preparation of the modern, highly-qualified sportsman. In the given case, complexness should be understood in the succession of its unfolding over time; not in one moment or parallel. The chief mechanism of the training-effect of such a method consists of the succession of positive, accumulated traces, from superceding loading of different primary emphasis. Thus, the conjugate-sequence form not only preserves the advantage of the complex organization of training, but provides a more expressive, specific training-effect of the loading of a certain primary emphasis. On the whole, the positive succession of cumulations of achieved training-effects of this form, results in a more unidirectional elevation of the organism to a higher and more stable special-work-capacity.

The advantage of the conjugate-sequence system consists not only in providing a high and stable cumulative effect of loading of different primary emphasis, but in achieving a high degree of rationality in their usage. In this case, the entire volume of the loading executed, completely and unidirectionally contributes to increasing motor potential and perfectioning the sportsman's technical mastery. At the same time, "superfluous" work is excluded; since it does not contribute to the development of trainability, but often has a negative affect on the planned cumulative training-effect of the loading.

The conjugate-sequence system should be used in the year-cycle of training for organizing loading of different primary emphasis; and in separate stages for organizing loading of a single primary emphasis; furthermore, it should be distinguished by the strength and specificity of the training influence of the means and methods used.

Forms of Constructing Training by Provisional Indications

Provisional indications stipulate first of all, rational ways of organizing training within the framework of a concrete time period, limited by external conditions, the competition calendar, traditional periodization of training, work or studies. Timewise, one ought to distinguish three fundamental forms of training construction: the year cycle, the large stage and the micro-cycle. Training can be effective if it has been constructed optimally, with respect to organization and provisional indications.

The scientific search for time variants of training organization has traditionally concentrated on two of its forms: the year cycle (rational periodization and coordinated with the competition calendar) and the micro-cycle (working-out its "model" organization for different periods and stages of the year cycle). And, although within the framework of a year-cycle, everything has been divided into separate stages, the principles governing their construction are accorded little attention. These stages are often formed arbitrarily and by chance, dictated by the competition calendar and the current training objectives. The length and sometimes the quantity of the stages changes from year to year. These circumstances, apparently, lead to this -- the practical necessity to work-out some special, systematically formed principles, unifying the contents of training in separate stages into whole and functionally complete forms does not arise. The exception to this being pre-competition training stages, lasting 1-1.5 months; to which considerable research has been devoted (N. G. Ozolin, 1953, 1966, 1970; D. A. Arosyev, 1969; L. P. Matveyev, 1977, and others). Practice has fully answered the requirements of the preparatory period through empirically established ways of constructing separate stages from a combination of micro-cycles of different emphasis. In the methodical literature the most prevalent are three and four-week stages, in which one week (the last) is the restoration week. There are combinations of two-weeks with large and two-weeks with moderate loading or an alternation of weeks with high and moderate loading. One can find many variants of such combinations in practice, and all of them, depending on the conditions, can bring success. It is very difficult to establish that any of these are highly effective, since the criteria are extraordinarily diverse.

Therefore, without casting doubt on the achievements of practice, we examined potential approaches to organize the so-called large stage as a functionally definitive and a relatively independent part of the year-training-cycle. The differentiation of such a stage is based on the regularities (examined in the preceding chapters) of the organism's adaptation to intense muscular activity and chiefly, the optimal periods of the organism's realization of the CAR; comprising about 20 weeks (see 2.1).

Based on the aforementioned forms of the organism's compensatory adaptation (see 2.1, figure 4), feasible, workable and suitable forms of training organization in the large stage are presented (figure 48). We would remind you that one of the forms of compensatory adaptation (A) is characterized by a smooth increase in the functional indicators, right up to where they pass through the plateau; the other (B), begins with a steady decline then a sharp increase in functional indicators, up to a level that significantly exceeds the first variant. The schemes represent suitable forms of training organization. Variant A expresses a traditional form of training organization, the idea of which is obvious, and does not require explanation. Therefore let's look at the specific peculiarities of the construction of loading in Variant B.

1. Two micro-stages are distinguished, taking into account the adaptational regularities within a large-stage. There is a concentration of loading in the first micro-stage, containing primarily means of special-physical-preparation. Requiring increased expenditure of energy resources, these means provoke extensive accommodative reconstruction within the organism, which is expressed, externally, by a steady decrease in its functional indicators. Specialized loading (at a lesser volume) is done in the second stage, including competition loading. This loading is designed primarily to improve technique or the speed of execution of a sport exercise; it contributes to activation of the compensatory reactions, the surplus restoration of energy resources and raises the athlete's special-work-capacity. The entering of and the stabilization of the organism at a new functional level, signifies the manifestation of its new adaptational reserves and, consequently, its readiness to respond with positive accommodative reactions to further training influences.

2. The traditional scheme of the volume and intensity ratio is preserved in the large training stage (Variant B), but it is realized in a somewhat different form (see figure 48). The volume increases and decreases more steeply than in the traditional scheme, while there is a slight rise in the intensity of the loading. The necessity of such a form of interdependence between the dynamics of the magnitude and intensity of the loading is explained by the fact that the concentrated volume of intense loading causes an extraordinary overstrain on the organism and results in a disruption of adaptation. In other words, one can realize the necessary volume of work only with a relatively low intensity of loading.

3. The aforementioned principles of construction of the large stage of training eliminate the nominal contradictions, that

arise when the utterly unjustified (which often happens) objectives of the loading are associated with "fatiguing" the motor potential, and the competition objectives with "realizing" it. If this were so in actuality, then the sportman's results would decrease with each competition. However this does not occur with correct organization of training. On the contrary, there is an increase in the sportsman's special-work-capacity and achievements in the competition stage.

Training and competition loading are different in the strength and the specificity of the influence on the organism; the forms of the preparation, within a large-stage, are associated with an utterly concrete sequence and continuity. The first provides the necessary prerequisites for the further increase in the athlete's work-capacity. The second contributes (if it is not excessive) to intensifying those physiological processes which are the basis for raising this level. Therefore, the success of the training as a whole depends on a proper understanding of the objectives, roles and ratios of the loading in the large-training-stage.

Variant B provides extensive and unidirectional utilization of the means of GPP and a definitive combination of them with the special-work. The basic purpose of the GPP means is to provide the effect of switching to contrast activities, different from the special-work and thereby contributing to the restoration of the athlete's work-capacity and his motor apparatus. The means of GPP solve the problem of restoring work-capacity during concentrated-loading (primarily after voluminous loading); and during the realization of the LLTE -- the GPP means are used for restoration after high-intensity technique and speed work. On the whole, the means of GPP are executed at a low intensity. But, in order to prepare the organism to switch to the development of speed and to the perfectioning of technical mastery during the reduction of concentrated-loading, the intensity of the GPP means is increased slightly.

5. Variant A is appropriate for athletes of middle qualification; as well as for qualified athletes needing to devote

considerable time for perfectioning technical mastery. Variant B can be utilized to the fullest extent by qualified athletes who possess a high special-physical work-capacity, can endure voluminous loading and have perfect sport technique.

6. The tasks and forms of the large-stage organization should have a concrete and special-emphasis, oriented towards a definitive contribution to the systematic achievement of the special objectives of the year's training; and especially to propelling the organism to a new level of special-work-capacity and towards the creation of the most necessary conditions for effective technical and competition preparation. The necessary contents, volume and organization of training and competition loading are determined on the basis of such a concrete, special-emphasis. The most important, distinguishing trait of the large-stage is the completeness of the execution of all the intermediate tasks associated with the athlete's special-physical, technical and competition preparation.

So, the large stage is the relatively independent part of the year-cycle, acting as an amalgamation of the fundamental forms of training construction; it executes a regulating function, with respect to the micro-cycles and their consolidation based on the unity of the tasks completed. The duration of the large-stage can vary (from 3 to 5 months), since its apportionment, to a significant extent, depends on the competition calendar and, chiefly on the dates of those competitions which are designated as fundamental.

Special research shows that it is possible and appropriate to utilize two large stages of preparation, in the year-cycle; providing for the organism's realization of the CAR (figure 49). In this case, the dynamics of the sportsman's state (I) form two large waves, with the second having the higher special-work-capacity indicators. The most suitable two-cycle organization of a year's preparation empirically was worked-out long ago and approved in practice, in a number of types of sports; receives yet more convincing corroboration.

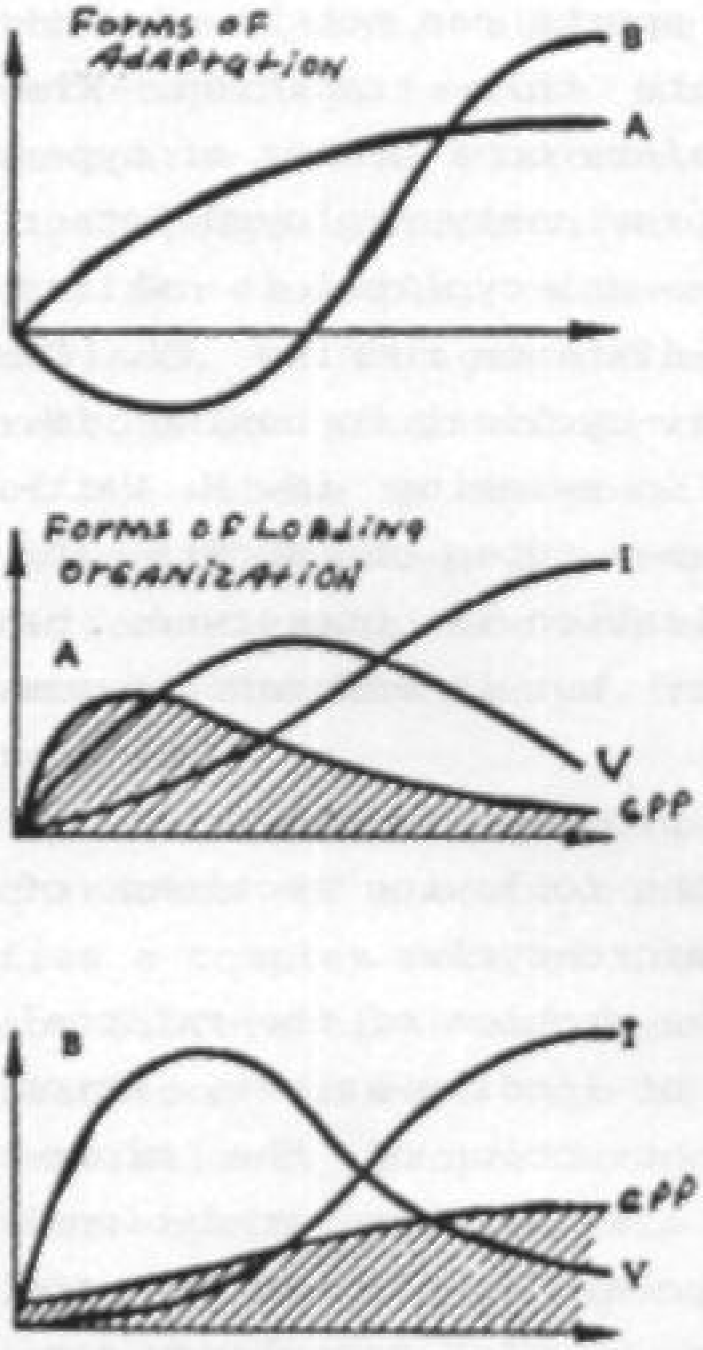
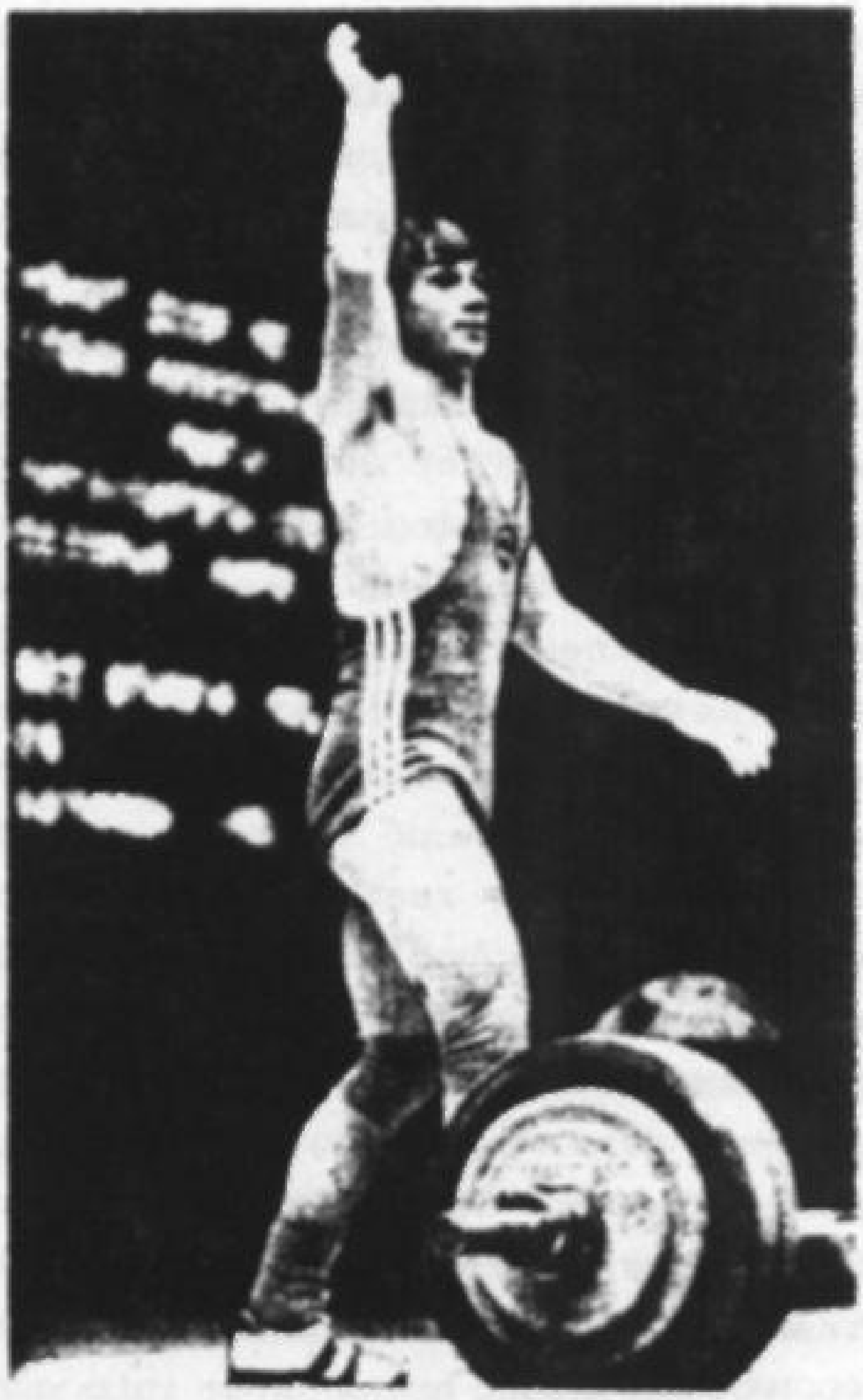
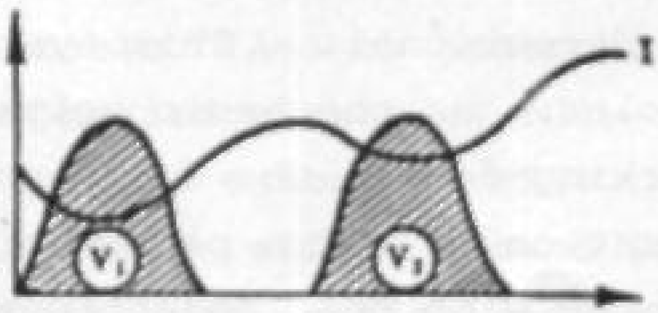


Figure 48. Two forms of loading organization at the large stage of training





Fifure 49. Organization of a year's training with two large stages

Consequently, traditional adherence to uni-cyclical periodization in a number of types of sports can not be justified, and the sooner coaches repudiate this tradition, the better. Two-cycle periodization transfers to a number of types of sports, which traditionally, had previously employed other forms of periodization; in particular — uni-cyclical in skiing (I. G. Ogoltsov, 1979) and in middle-distance running {Y. D. Turin, 1980; V. A. Sirenko, 1980) and tri-cyclical in boxing (Y. B. Nikiforov, I. B. Viktorov, 1978) and in swimming (S. M. Vaitsekhovsky, 1981) . In a number of games types of sports and single-combats the tri-cyclical periodization is preserved, as conditioned by the competition calendar; -but in endurance types of sports — uni-cyclical.

We will examine the principles of programming and organization of training in the year-cycle in the following sections of the chapter, but let's now turn to the micro-cycles.

When programming the large-stage the problem of the rational "accommodation" of the necessary volume of loading arises, which brings out new requirements for the construction of the micro-cycle. One should acknowledge that all of the traditional schemes of construction of the micro-cycle, in stipulating the complex completion of training objectives, {under compulsory conditions) not only restoration, but increasing the specific-work-capacity at the beginning of a new micro-cycle, do not satisfy these requirements. It is necessary to seek new forms of construction of micro-cycles, which permit the realization of high volumes of loading, including uni-directional. This yet again confirms the thesis that micro-cycles, as the basic units of training construction, become its working-forms; the function of which consists of the rational utilization of those parts of the volume which bring them into conformity with the objectives and general strategy of the construction of the large stage.

Let's look at the scant, for the present, experimental data which suggest ways of solving these problems. It has been established that large unidirectional loading causes a sharp reduction in the capability to display those qualities and abilities which secure the execution of training programs. At the same time, athletes who are capable of displaying a high work-capacity, secure it primarily by other systems (V. D. Monogarov, V. N. Platonov, 1975; L. E. Fedorova, et al., 1975; V. I. Chepelyev, 1980; V. N. Platonov, 1980).

For example, a weeks* cycle of loading (figure 50) was devised, of fatigue and the length of highly-qualified swimmers' restoration after voluminous unidirectional workouts. The idea of the scheme is the possibility to realize a high, on the whole, volume of loading; based on a rational combination of workouts of different magnitude and emphasis of loading, while taking into account the duration of the restoration processes that correspond to them.

It should, however, be noted that despite the unidirectional character of the workouts individually, on the whole this typifies a complex form of training organization. The organism cannot differentiate and "accumulate", at the same time, specific reactions to each type of loading and will respond to them with generalized, proportional reactions. Therefore, this form of micro-cycle construction, undoubtedly, enables one to realize a large volume of loading (which it is based on, and intended), but it hardly secures a clear-cut increase in speed, aerobic and anaerobic productivity.

Presented in figure 51 are examples of the unidirectional organization of week-cycles for highly-qualified athletes; inclusive of three workouts, with large loading of primarily aerobic (Ae) or anaerobic (An) emphasis, combined with workouts emphasizing complex (C), speed-strength (SS) and the development of speed-endurance (SE). Observations of the immediate lagging training effect showed (figure 52), that in the first instance there was a significant depression of aerobic potential (MOC); the restoration of which up to the level exceeding the initial was observed over a 72 hour period. At the same time, anaerobic potential (assessed by the swimming test — **4** x 50) restored quickly and held at a level exceeding the initial. In the second instance, restoration of anaerobic productivity took

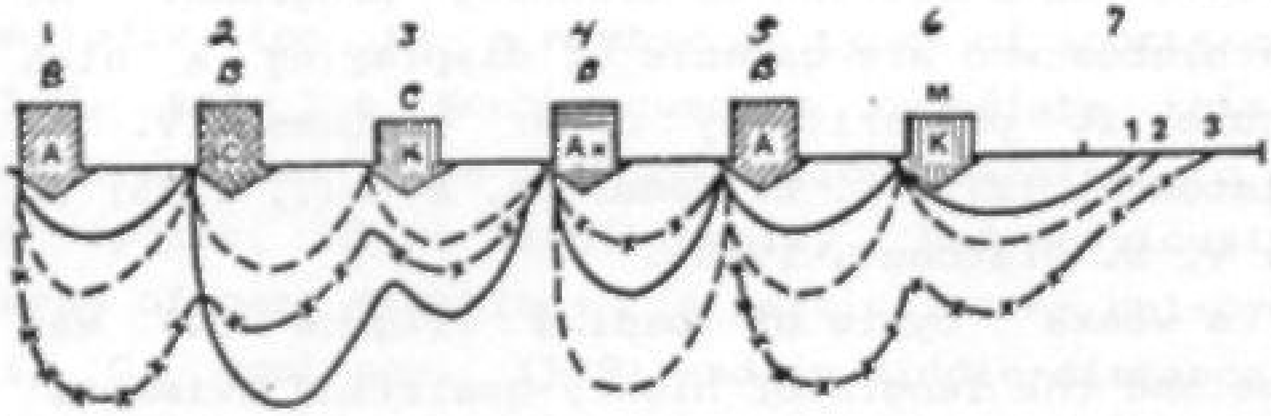


Figure 50. Construction of a week's training for highly-qualified swimmers taking into account the dynamics of the restoration processes after speed (1), anaerobic (2) and aerobic (3) emphasis work (V.N. Platonov, 1980)

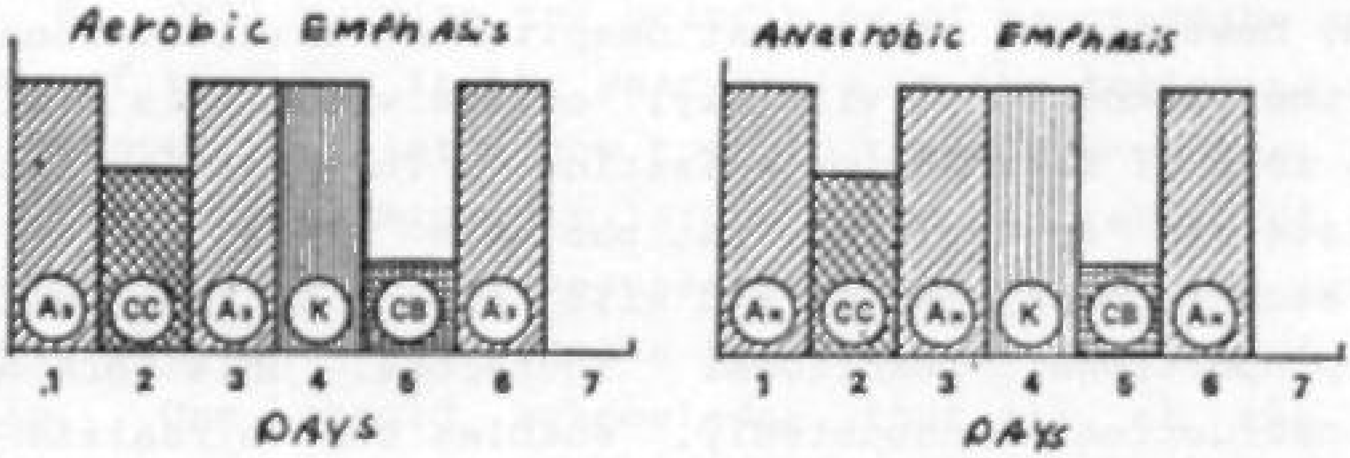


Figure 51. Unidirectional organization of week-cycles in the training of swimmers (A. B. kubelin, 1980)

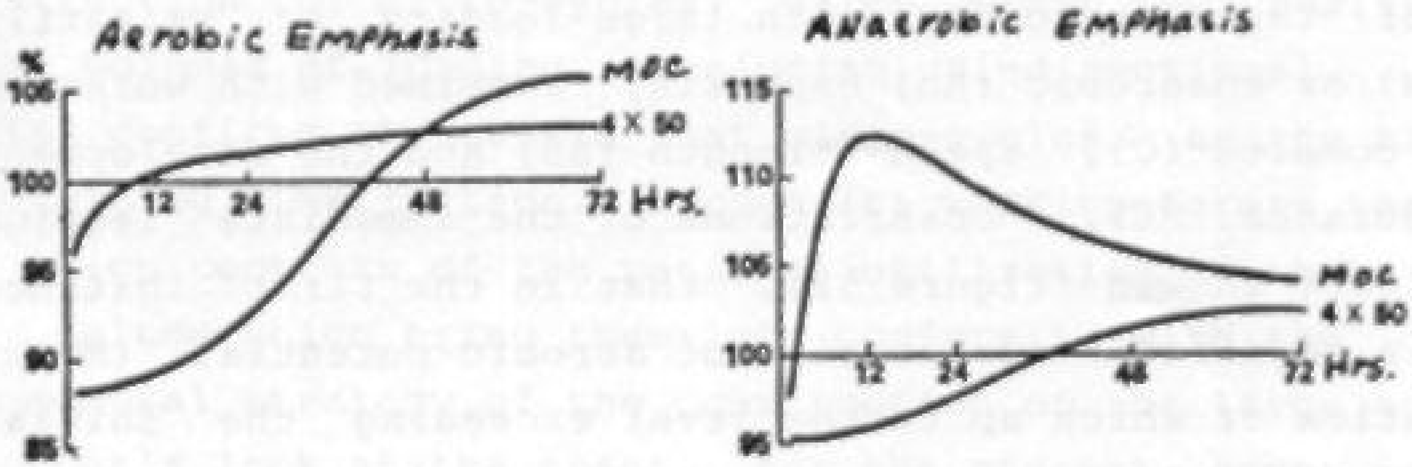


Figure 52. Dynamics of recuperation processes after unidirectional week-cycles of training (A. B. Kubelin, 1980)

longer and exceeded its initial level after 72 hours. It is interesting that during this time, aerobic potential rose within a 12 hour span and then receded.

The following variant of organization of a week micro-cycle, chiefly emphasizing special-strength-training (figure 53), is possible in speed-strength and complex-technical types of sports. In addition to workouts with large and moderate volumes of strength-loading (SS), these micro-cycles include workouts with technique (T) and complex (C) emphasis.

So, one has to say that due to the new demands in the preparation of highly-qualified athletes, the micro-cycles from the old days — the most cultivated form of training construction, became the weakest link in the technique of programming training. Naturally, the examples cited still do not eliminate those insufficiencies; however, to a known degree, they stipulate the ways in which one should direct the scientific search.

4.2 Primary Aims in Programming Training

A methodical review of all of the just discussed material can be expressed by a number of primary aims, which contain the most general basis for the selection of the optimal variant of programming training. The primary aims are a separate category of methodical concepts and rules; especially with respect to the general principles of physical education and sport training. First, they develop the leading ideas that make-up these principles, applicable to the modern conditions and requirements of the training of highly-qualified athletes; and, second, they become the concrete rules of programming training.

1. The aim of realizing the organism's CAR is associated with the organization of loading based on the regularities of the organisn's adaptation to specialized muscular work. One stipulates (within the year cycle), the apportionment of large-stages, their concrete objectives and the contents, volume and organization of loading objectively necessary to achieve these objectives. The large-stage should be inserted into the year's training system in such a way that the athlete attains the new level of special-work-capacity at the instant of his performance

in the most important competition. It is appropriate to designate two large-stages in the year-cycle; even in those types of sports, which traditionally adopt a unicyclical periodization of training, with one competition season.

2. The aim of preserving the training potential of the loading is associated with systematically raising the strength and specificity of the training influence on the organism, according to the increase in its work-capacity. Practical realization of this takes the form of the conjugate-sequence system of organizing loading of different primary emphasis.

3. The aim of a concentrated use of voluminous, specialized-unidirectional-loading is associated with creating a concentrated training influence on the organism, for the purpose of significantly increasing its special-physical-preparedness. In order to provide steady, functional recostruction within the organism, the training influence should be of optimal strength, frequency and of sufficient duration. The mode of concentration can be applied to loading of any primary emphasis. It is especially effective for strength-loading which represents a relatively independent "block" in the year training system. Its purpose involves the creation of a functional base for the subsequent in-depth, special preparation, associated with the perfectioning of technical mastery, the development of speed or of special endurance.

4. The aim to utilize the LLTE of concentrated-strength-loading is associated with first of all, rational ways of regulating the general volume of loading in the year-cycle and the effective utilization of specialized-strength-work for the purpose of creating favorable conditions for the athlete's technique, speed and competition preparation.

5. The aim of cultivation, during the voluminous loading of differet primary emphasis, is associated with rational ways of utilizing incompatible loading (for example, emphasizing strength and perfectioning technique or speed of movement); elimination or reducing to a minimum the negative affects between the training-effects of loading of different primary emphasis; as well as

towards those combinations, which provide a partial sequential cumulation of their partial training-effects.

6. The aim of out-stripping the emphasis of SPP emphasizes the key role of this training in the growth of highly-qualified athletes' achievements. The aim is associated with such an organization of training where SPP precedes in-depth technique or speed of movement work.

7. The aim of modeling competition activities is associated with reproducing (in training) work that is inherent to competition conditions; especially towards the execution of the sport exercise with a high intensity effort, within the rules of competition. This is a very effective form of special-training, improving the athlete's physical, psychological, technical-tactical and competitive readiness.

The aims formulated are the basis for working-up general strategic conceptions of training organization, as well as the direction in which one ought to seek a concrete method for programming training, at the quantitative level. However, adherence to these aims will lead to success only if all the preceding preparation has been systematic, without the forcing of these aims or other aspects of sport mastery and when the athlete has a well balanced technical and special-physical-preparedness. In order to realize these aims one should institute measures that take into account actual conditions, the individual peculiarities of the athlete and the specifics of the sport.

4.3 Fundamental Model Systems of Constructing Training in the Year-Cycle

The development of principles regarding the contents and organization of training and the accumulation of the corresponding statistics, permits one to first, formulate the idea of "modeling sport activities" and to devise methodological and concrete, practical ways to realize it. With respect to the theory of sport training, modeling -- a new method of research, constructively expressing the essence of the form of training construction, its developmental tendencies over time and defines the methodical conceptions of these tendencies.

Modeling makes it possible to overcome the pithy, organizational complexity inherent to sport activities; as well as the implementation of operational analysis and prognostical research on some supplementary object. This object represents a simplified analogue of the actual training process, omitting some details, but preserving the most essential information concerning its composition and structure. This object is a model of the dynamics of the athlete's state and a model of the systems of training construction in the year-cycle.

A model of the dynamics of the athlete's state is a graphic expression of the optimal tendencies of the changes in the most essential indicators of his special work-capacity, over time. It stipulates the concrete moment in time, towards which one should plan for the achievement of the maximum level of the functional indicators, and is the initial prerequisite for programming training.

A model of the systems of training construction is expressed graphically or by any other signs or symbolic form of the pithy interpretation of principles and logical prerequisites, determining its organization. This model is quite adequate for the actual training process; making it possible to substitute this process with a view of logically researching the expediency of different variants of training construction and providing (by means of this) a sufficient representation about their effectiveness. At the same time it is a convenient way of graphically and laconically expressing the methodical conceptions, prescribed on the basis of training organization.

Two forms of models are distinguished -- principal and quantitative. The principal model is a descriptive (qualitative) expression of the dynamics of the athlete's state and the most essential parameters of the contents and the connections between the components of the training process; which are in conformity with training construction, under the actual sport conditions. The quantitative model is the result of programming and contains the quantitative significance of the composition and organization of training. Principal models are the basis for its elaboration for a specific athlete or group of athletes and is a working document for the organization of training.

Before we analyze models, let's look at some of the general questions concerning their description.

1. Since the models pertain to the so-called summer and winter types of sports, the specific months of the year are not designated. Each model consists of 11 months, since, on the average, one month is allotted for the final period.

2. Models of the systems of training construction include two components for each sport group: the optimal tendency in the alteration of the most essential functional indicators (a model of the dynamics of the athlete's state) and the corresponding organization of loading, necessary for the realization of this tendency (a model of the program of loading). The logical scheme of training construction in each sport group is based on the traditional periodization of training in the year-cycle, inherent to them.

3. The model of the dynamics of the athlete's state includes the essential functional indicators, which objectively reflects his special-work-capacity. One can use any method that is of easy access to the coach to quantitatively assess these indicators.

4. All of the models utilize the principle of concentrated-special-strength-loading; which provides for the realization of the LLTE. The strength-loading is represented by "blocks" (designated by squares), timed for concrete stages of the year cycle.

5. By expressing the qualitative characteristics of training organization, the models present an optimal tendency in the distribution of the volume of loading of different emphasis in the year-cycle and the principal ratio of this loading over time. However, for the purpose of clarity there are no volume ratios of loading of different emphasis, by months.

6. The boundaries of the stages and the dates of the major competitions in the models provided, are based on the most frequent occurances in sport practice. However, taking into

account the actual calendar, they can vary somewhat, in order to adhere to the general principles of the organization of loading.

Now let's look at principal models of the systems of constructing training in the year-cycle for a number of sport groups; which were drawn-up on the basis of the just formulated primary methodical aims.

4.3.1 A Model for Groups of Sports, Requiring the Display of Explosive-Force

The model originated from the two-cycle periodization of training and includes two large-stages; oriented to the realization of the organism's CAR and achievement of the planned level of special-strength-preparedness at the most important competitions (figure 54).

The model of the dynamics of the athlete's state shows the optimal tendency in the alterations of the absolute (Po), explosive (I) and starting (Q) strength indicators; the highest values of which are achieved at the end of each large-stage.

The organization of loading provides for the utilization of the LLTE of the "block" of strength work in each large-stage; against a background of the fundamental volume of speed (S) and technique work. The most sustaining principle is the cultivation of loading of different primary emphasis, which creates favorable conditions for in-depth improvement of technique and unidirectional preparation for competition.

As has already been said, technique work is not excluded during the strength loading "block". However, such work is included at a reduced intensity; executed in the form of the separate elements and their links, as well as the rhythmic structures of individual phases and the general scheme of movement.

The second strength "block" is of a lesser volume of loading; however, the general intensity of the loading is higher than in the first "block". Considering that the second "block" is executed against a background of the adaptational reconstruction of the first large stage; the LLTE will be preserved during the second competition stage. It is not necessary to further increase the volume of strength work at this time. Tha latter can be used exclusively for toning the neuro-muscular apparatus preceding the training emphasizing technique or competitions.

The contents and the organization of the strength work "blocks" are based on the principle of preserving the training potential of the loading; based on the conjugate-sequential system, regulating the means of special-strength-training.

The means of GPP are specialized — within the "blocks", they create the effect of contrastness and aid restoration after voluminous strength-loading; at the LLTE stage -- GPP assists restoration after intense specialized-loading. The largest, relative volume of GPP means occurs in the competition period.

4.3.2 A Model for Groups of Sports, Requiring Endurance (Middle Distances)

The model is based on a two-cycle periodization of training and consists of two large-stages, designed for realization of the athlete's CAR (figure 55). There are two competition stages in the year-cycle and one need not compete at the fundamental distance in the first stage. Here, it is important to maintain the tendency towards intensification of training, in order to realize the CAR. One can achieve this by competing at other distances in competition; which will simultaneously serve as control estimates of the athlete's developmental level of aerobic and anaerobic productivity.

The model of the dynamics of the athlete's state provides a two-peaked tendency for the changes in aerobic (Ae) and anaerobic (An) productivity. The dynamics of the special-strength-preparedness is expressed by the accelerated increase of general-strength-endruance (SE) and the special-endurance for repetitive execution of explosive-force (EF), in the second competition stage; as well as by the planned rise in absolute-strength (Po). Explosive-strength (I) reaches maximum at the beginning of the second competition stage; then it decreases, in connection with the rise in the volume of intense cyclic work. The fundamental, functional indicators -- anaerobic productivity and strength-endurance reach their highest levels during the most important competitions (X - XI months).

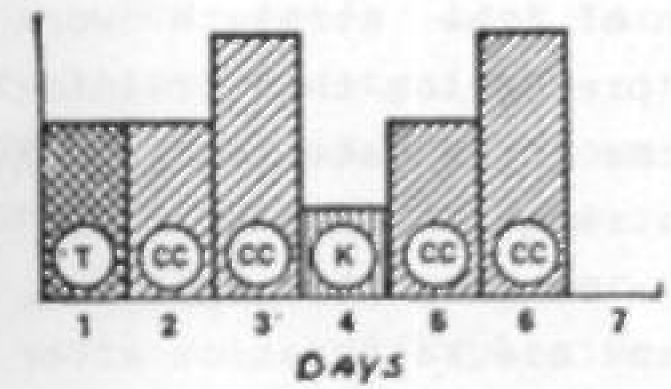


Figure 53. Unidirectional organization of week-cycles for speed-strength types of sports (I. N. Mironenko, 1979)

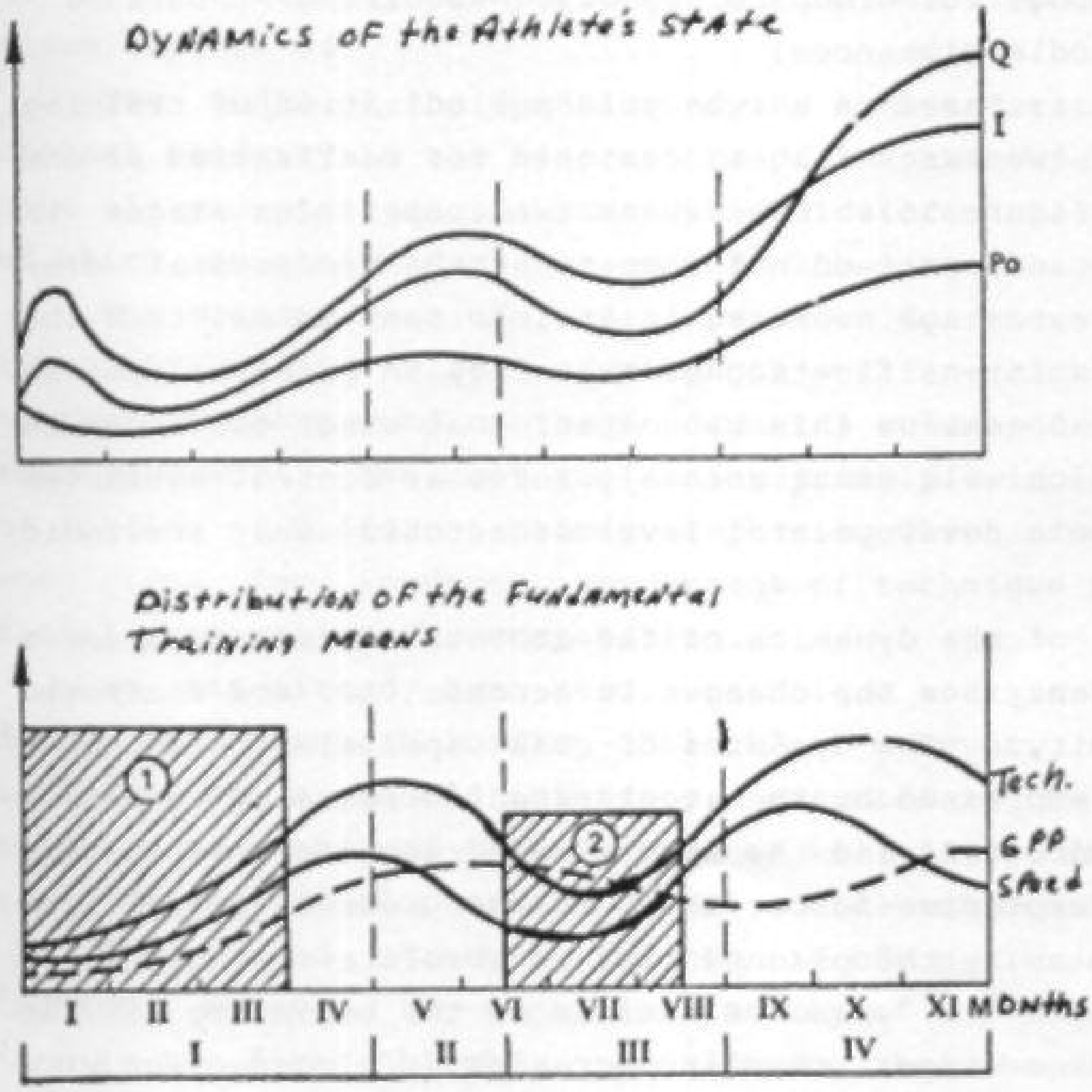


Figure 54. A model of training construction for types of sports requiring explosive effort: I- the first preparation stage, II- the first competition stage, III- the second preparation stage, IV- the second competition stage

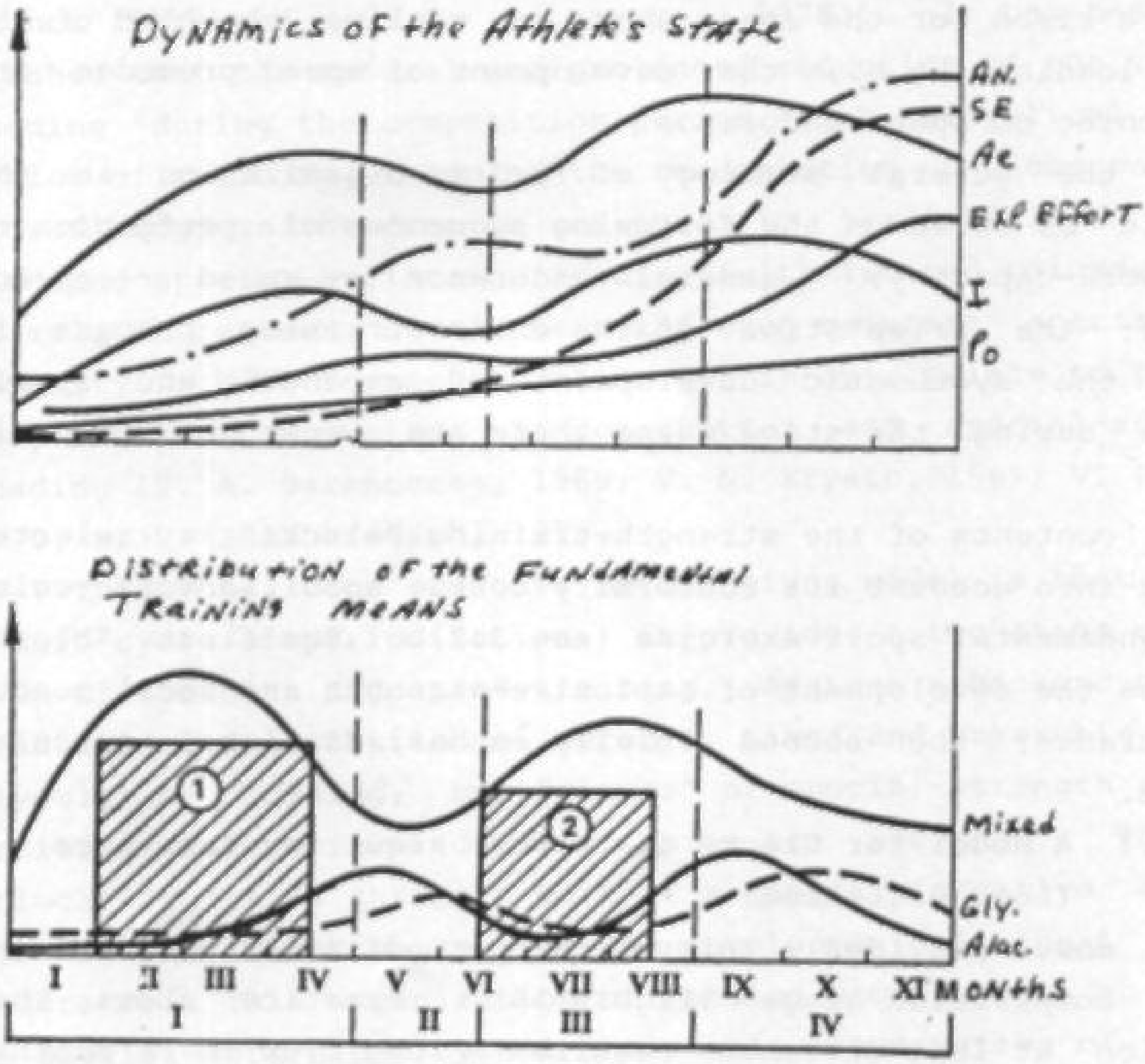


Figure 55. A model of training construction for types of sports requiring endurance (middle distances)

The organization of loading provides two strength "blocks"; executed simultaneously, along with special work in a mixed aerobic-anaerobic regime (MR). The ratio of aerobic to anaerobic work changes during the year cycle. There is a predominence of aerobic-loading in the first preparatory stage; in the second stage the work is chiefly at the TANE level. There is an increase in the volume of aerobic loading once again in the second competition stage; its role here is restoration work. Speed-work (primarily in the anaerobic-alactic zone of energy-acquisition — Al) and the perfectioning of speed-endurance (chiefly in the anaerobic-glycolytic zone of energy-acquisition — Gl) are timed for the stage where one realizes the LLTE of the strength-loading, i.e., the development of speed precedes the perfectioning of speed-endurance.

So, the general strategy of loading organization in the year-cycle is based on the following sequence of perfectioning special-work-capacity: general endurance -- speed -- speed-endurance; the orientation of the entire training process is towards the systematic development of strength and speed-endurance during the stage where there are important competitions.

The contents of the strength-training "blocks" is selected by taking into account its conformity to the specific work regime of the fundamental sport exercise (see 3.2). The first "block" emphasizes the development of explosive-strength and local muscular endurance; the second chiefly emphasizes local muscular endurance.

4.3.3 A Model for Groups of Sports, Requiring Endurance (Long Distances)

The model provides a unicyclical periodization of training with one competition stage (figure 56). Practice shows that competition at long distances requires a long (up to 6 months) preparatory period; which is necessary for creating stable accommodative reconstructions within the organism, sufficient for preserving the special-work-capacity for a period of 4-5 months during the competition period. Therefore in the given case, with respect to the predominence of low-intensity work (relative to other groups of sports), the date for the realization of the organism's CAR is moved back, which is taken into account in the model.

The model has yet another distinguishing feature. With unicyclical periodization, stable sport results are achieved in the competition period if the rise in the loading during the preparatory period occurs gradually (the mean-monthly increase is between 7-14%); if during the competition period, there is not a sharp drop in the volume of loading, and if, the portion of loading executed within the zone of anaerobic energy-acquisition is not increased (V. B. Gilyazova, 1978). It has been established that the natural and prolonged reduction of the volume of loading during the competition period (with unicyclical periodization of training) leads to the readaptation phenomenon, which is reflected in the drop in non-specific, trainability. Competition and special-assistance loading (with limited volumes) cannot stimulate further development and even maintain special work-capacity. With respect to this, it is appropriate to periodically raise the volume of competition and special-assistance loading (V. A. Baranovsky, 1969; V. N. Kryazh, 1969; V. P. Muzis, 1970; S. V. Zhikharevich, 1976).

Therefore, one feature of the given model is that within a single-cycle of periodization, it provides a two-stage organization of strength and speed training. Against a background of the traditional distribution of aerobic, mixed and anaerobic (chiefly glycolytic) loading, two "blocks" of special-strength and speed (chiefly anaerobic-alactic) training are included. The first "block" contains strength work of a general-formative emphasis; the second block emphasizes the development of local muscular endurance. This organization of loading provides for an increase in special-work-capacity and the stable preservation of it in the competition period; right up to the important competitions in the X and XI months.

The model of state dynamics, provides for achievement of maximum aerobic productivity at the beginning of the competition period, and some decrease. There is a gradual rise in special-strength-endurance {Se) and absolute-strength (Po), up to the stage of important competitions.

4.3.4 A Model for Groups of Sports, with Tri-cyclical Periodization of Training

The model is intended primarily for individual-game types of sports and single-combat sports (figure 57). It includes three large-stages, with preparatory and competition micro-stages. The first stage is oriented chiefly towards special-physical-preparation; the second — to perfectioning technical mastery; the third — to readiness for the fundamental competitions. Depending on the competition calendar and the peculiarities of the training objectives in the year-cycle, the length of the third stage can be increased by shortening the duration of the second stage. In certain cases a two-cycle model of training construction can be employed with this group of sports.

The model of the sportsman's state dynamics provides for the achievement of maximum aerobic productivity (Ae) in the second stage, then some decrease. Absolute-strength (Po) rises uniformly; strength-endurance (SE) accelerates more at the end of the third stage. Explosive-strength (I) reaches maximum at the beginning of the second and at the end of the third stages.

The loading includes three strength "blocks". The objectives of the first are to develop absolute and explosive-strength; the second -- strength-endurance; the third -- chiefly explosive-strength and to create conditions for utilization of the LLTE of the strength-loading during the fundamental competitions stage.

The first and third "blocks" of strength work are executed in combination with special work within the mixed (aerobic-anaerobic) zone of energy-acquisition (Mi); the second — with work in the anaerobic (chiefly alactate-anaerobic and anaerobic-glycolytic) zone of energy-acquisition (An). The fundamental volume of speed (Sp) and technical-tactical (T) preparation is executed against a background of the realization of the LLTE "blocks" of the strength work.

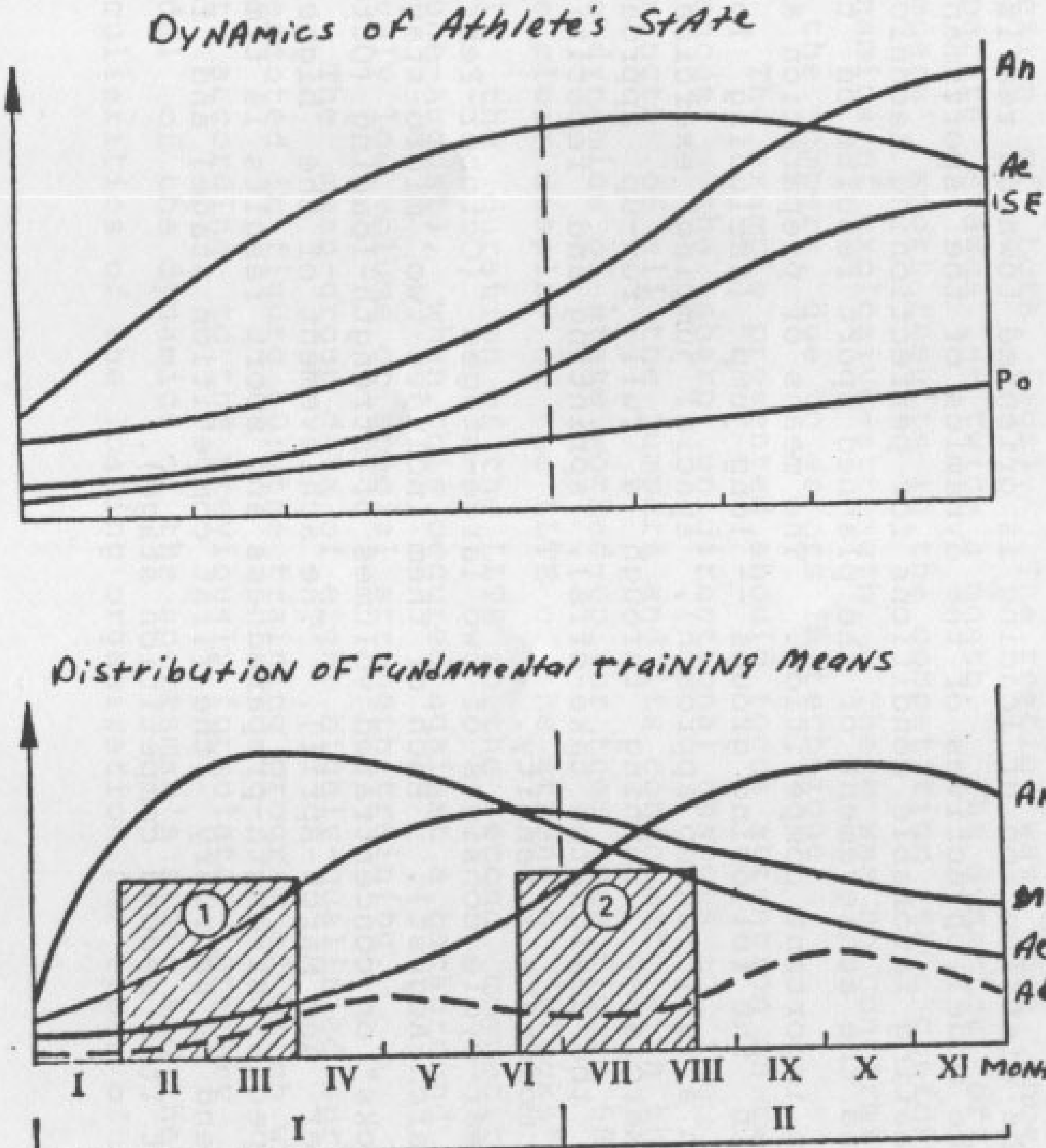


Figure 56. A model of training construction for types of sports requiring endurance (long distances): I- preparatory period, II- competition period

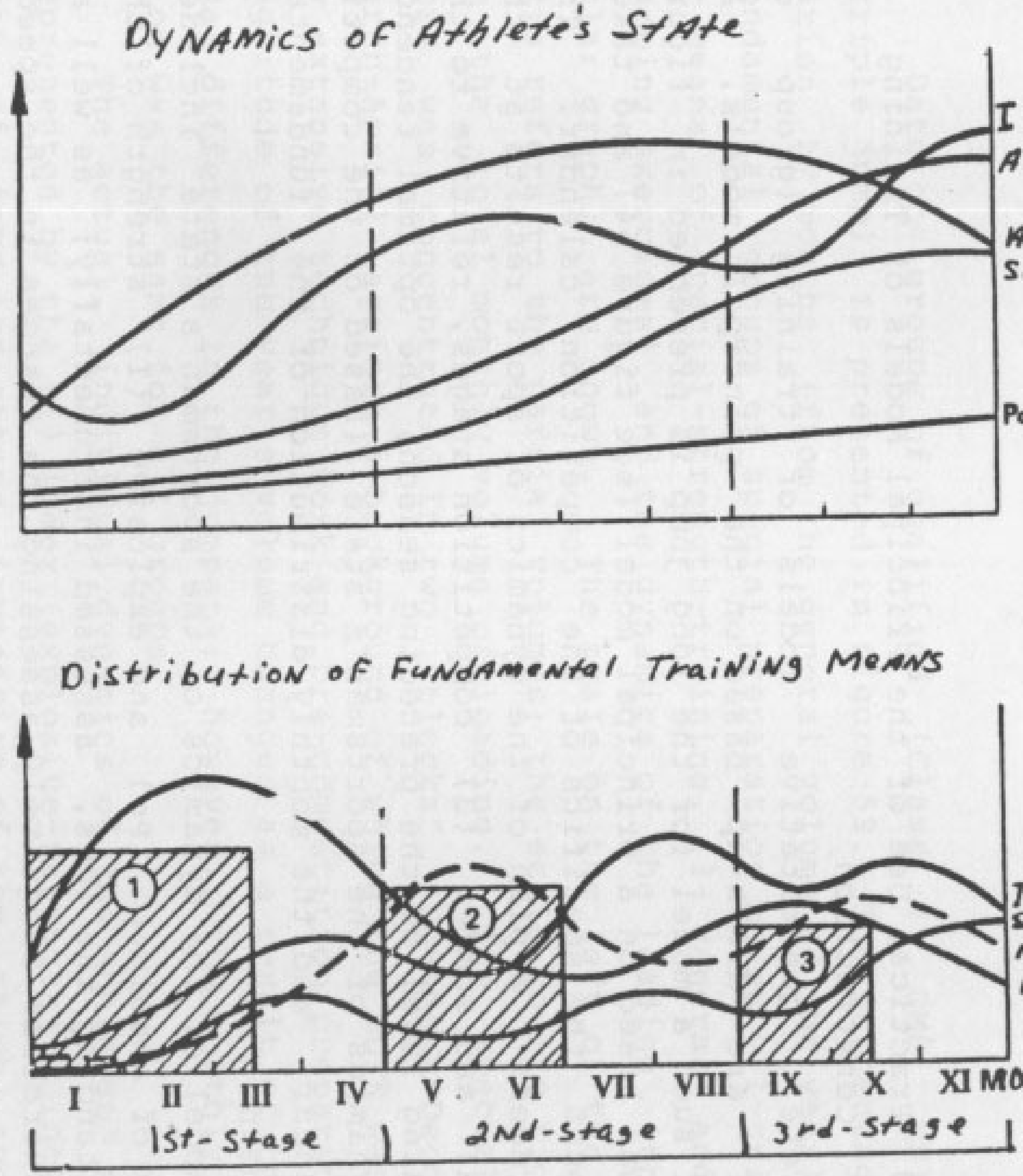


Figure 57. A model of training construction for tri-cyclical training periodization

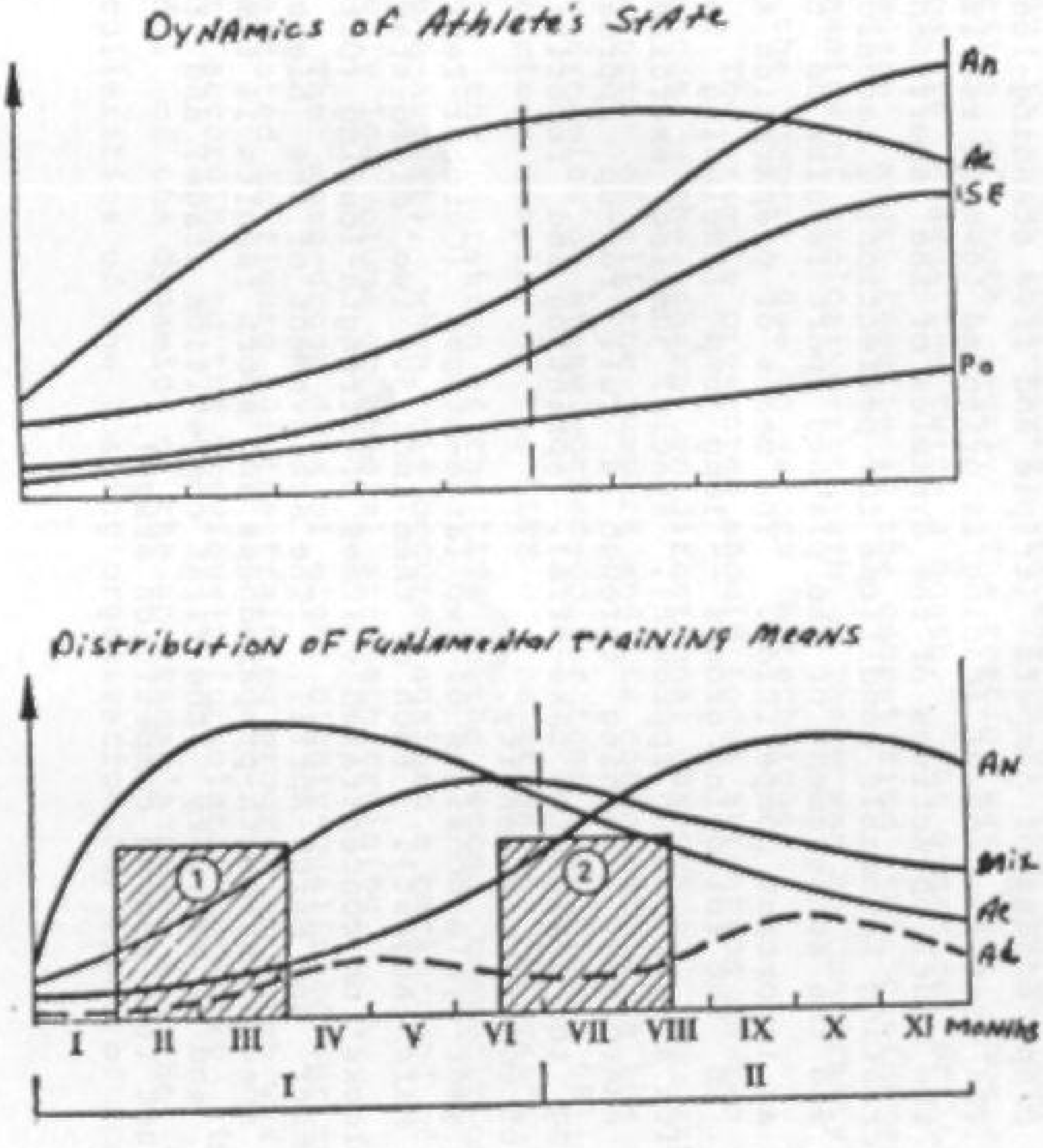


Figure 56. A model of training construction for types of sports requiring endurance (long distances): I- preparatory period, II- competition period

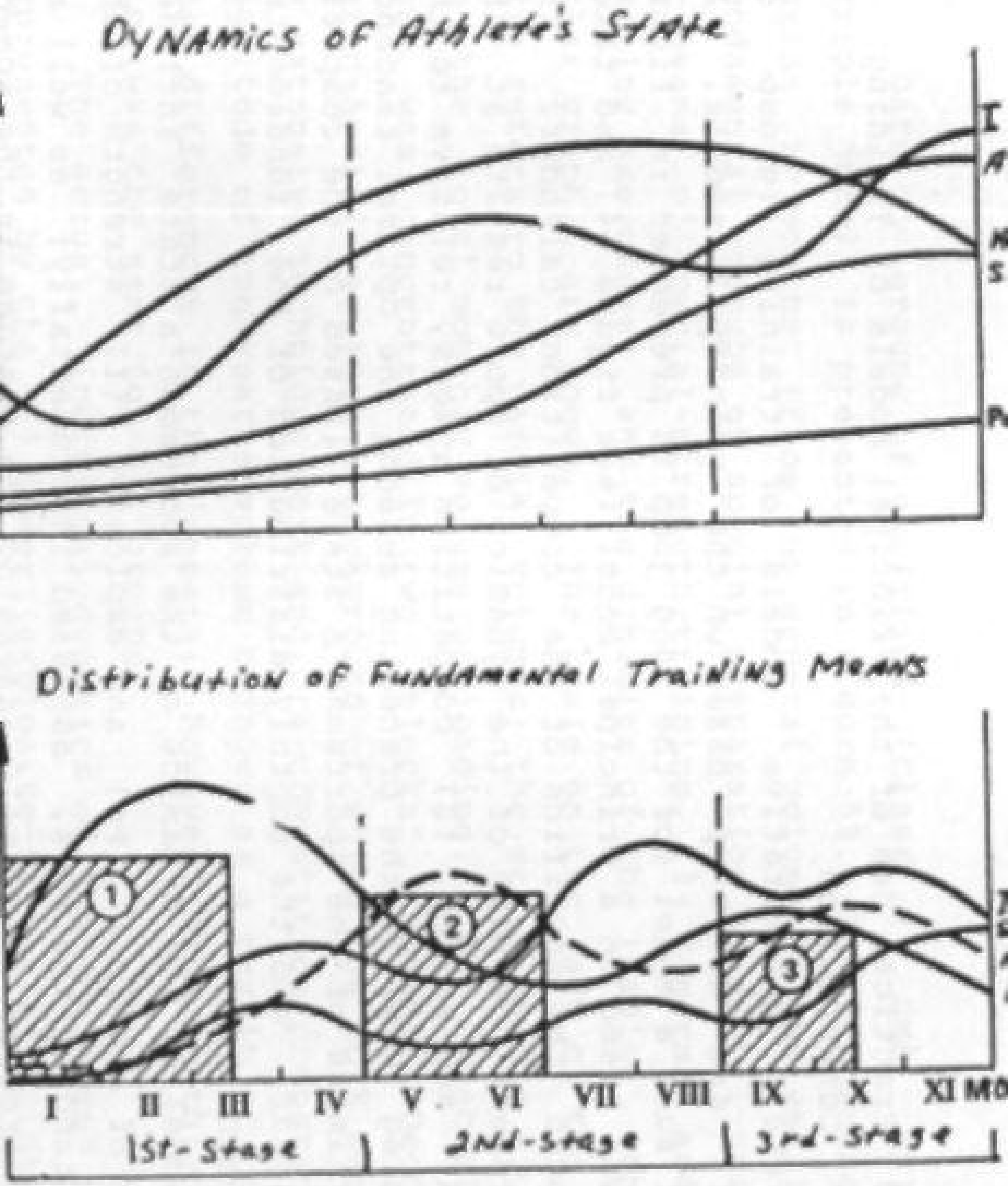


Figure 57. A model of training construction for tri-cyclical training periodization

4.3.5 Practical Use of the Principal Models of Training Construction

Concrete, quantitative models of training (group or individual) are drawn-up based on the principal models. An example of such a model for the long jump is presented in figure 58; it was based on a principal model (see figure 54) and takes into account the specifics of the competition calendar. The model includes: a plan of the dynamics of sport results at the winter (A) and summer (B) competition stages, relative to the corresponding level of the preceding season; the optimal tendency in the dynamics of the sportsman's state (based on the competition calendar) and the monthly distribution of the fundamental training means.

The model of the dynamics of the sportsman's state includes indicators of absolute (Po) and explosive (I) strength of the muscles extending the legs, assessed instrumentally; as well as control exercises adequately assessing the changes in the speed-strength preparedness of jumpers (triple and five standing-long-jumps). The distribution of loading is oriented towards realization of the model objectives of the dynamics of the sportsman's state; creating favorable conditions for perfectioning technical mastery and the achievement of the planned sport results on the date of an important competition. The means of preparation are combined in the following groups — long jump (including long jumps with a full run-up approach), special jumping exercises, barbell exercises, running through a full run-up approach (including the designated take-offs), sprinting and repetition running of moderate intensity.

The year-cycle consists of two large-stages (October-February and March-August). Each of them includes two micro-stages with "blocks" on concentrated volumes of strength-loading (October-December and March-April). The achievement of the highest level of special-strength-preparedness and sport results is timed for the end of February (the first competition stage) and for July-August (the second competition stage).

Data on groups of qualified (Class 1, CMS, MS) jumpers (triple jump) is presented in figure 59. The percentage distribution by months (from the general volume of the year) of the fundamental groups of special preparation means (1-triple jump, 2- means of special-strength-training, 3- general and special jumping exercises) and the dynamics of the loading (the rectangular graph) are shown. The scale on the left of the ordinate axis refers to the partial volumes; the scale to its right refers to the total monthly volume of loading. The special-strength work was concentrated in two "blocks" (November-December and March-April) against a background of which the LLTE was realized by extensive technique work and pre-competition preparation. The magnitude of the year's volume changed as a result of the individual differences in the jumpers; however, the monthly distribution was the same for all groups.

The actual, individual dynamics of the athletes' state were represented by the (I) index (explosive-strength); including the mean of four indicators (extension of the thigh and plantar flexion of both legs). The testing was done once, and in separate stages -- twice a month. The dynamics of the four jumpers' sport results in the competition stage conformed to the dynamics of explosive-strength. There was no conformity for two of the jumpers, due to errors in technique.

The example presented should focus attention on two circumstances: the sharp unidirectional changes in the explosive-strength of all the jumpers and its conformity with the model of the dynamics of state worked-up for them (see figure 58); and to the clear display of the LLTE of the strength "blocks", especially the duration of the LLTE in the second competition stage (June-August), when this occured against a background of a relatively low volume of special strength-training.

The mean-group data of eight highly-qualified sprinters is presented in figure 60; the training program of which was worked-out according to the previously formulated primary aims, the model of the dynamics of the sportsman's state and the specific peculiarities of the loading organization for types of sport with

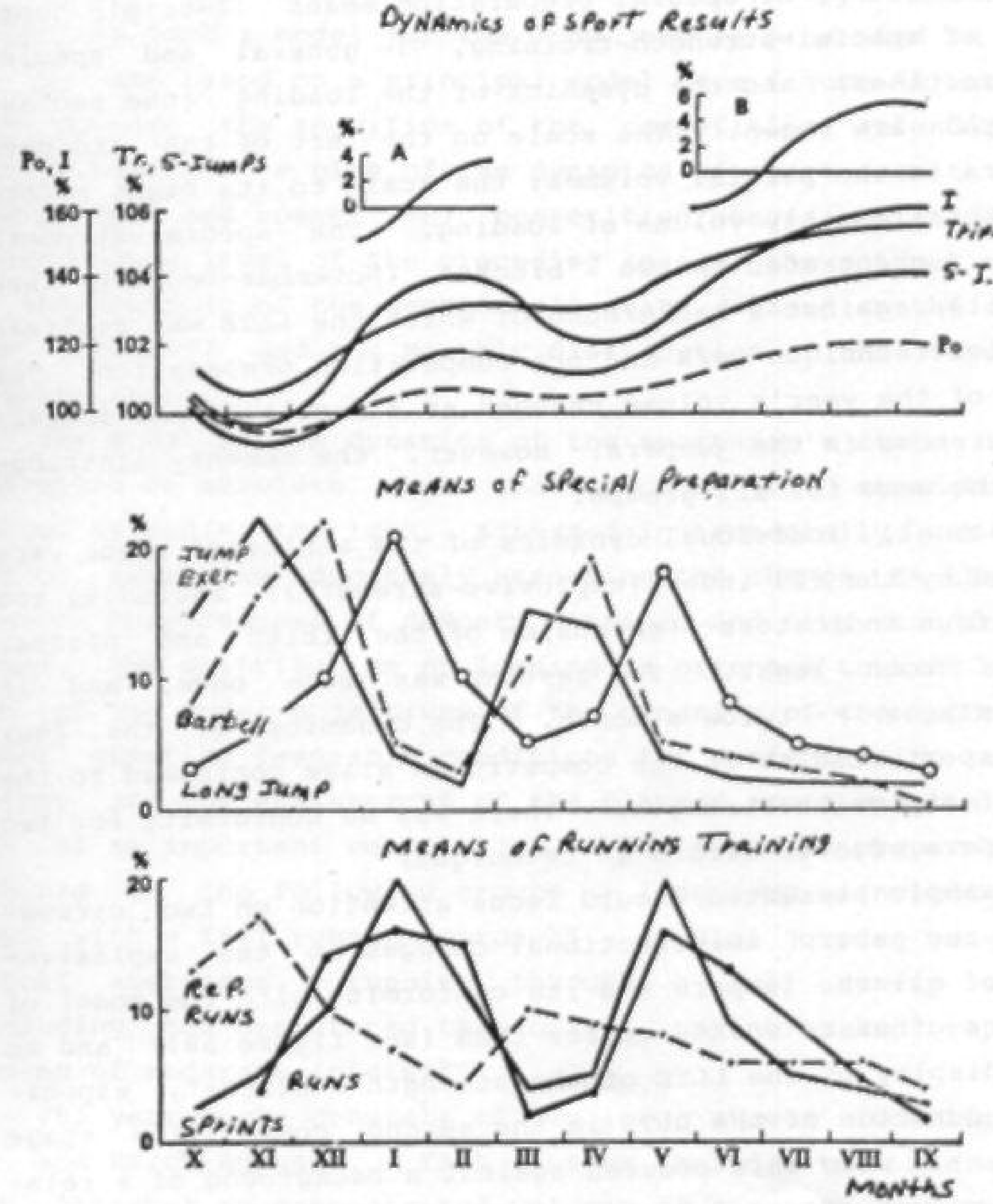


Figure 58. A quantitative model of training construction for qualified long-jumpers

a cyclic structure of movement. The model of the dynamics of state is based on the competition calendar and includes the absolute (Po), explosive (I), and starting (Q) strength indicators, and the results of ten standing long-jumps.

The program of loading provides two "blocks" of SPP (November-December and March-April). Resistance exercises, including barbell movements (1), make up the fundamental contents; specialized jumping exercises (2), executed simultaneously with running in the aerobic (6), mixed **(5)** and partial glycolytic (4) zones of energy-acquisition were also included. Speed work (3) is done primarily against a background of the realization of the LLTE of specialized-strength-loading.

This organization of loading provided realization of the model objectives of the dynamics of the sportsman's state and the achievement of high maximum running speed (Vmax); as well as running 30 M with a low start during the period of important competitions. The mean-group improvement in 100 M results was 0.16 seconds, in comparison with the preceding year.

It is interesting to note that the general-year volume of loading was changed during the course of training, with respect to all of the training means, relative to the planned. The volume of strength-loading, in particular, was increased by 7%, and the volume of running in the various zones of energy-acquisition was reduced 16-25%. This was due to the constant control and correction of the training process; as a result of which the discrepancy between the actual and the objectives of model of the dynamics of the sportsman's state and the speed-strength indicators did not exceed 5% in the competition stage.

So, the material presented is indicative of the high practical effectiveness of the already formulated principal aims of programming training and the drawing-up of principal models of training construction in the year-cycle. The appropriateness of the models of the dynamics of the sportsman's state in the year-cycle and their practical use through programming of training has been corroborated.

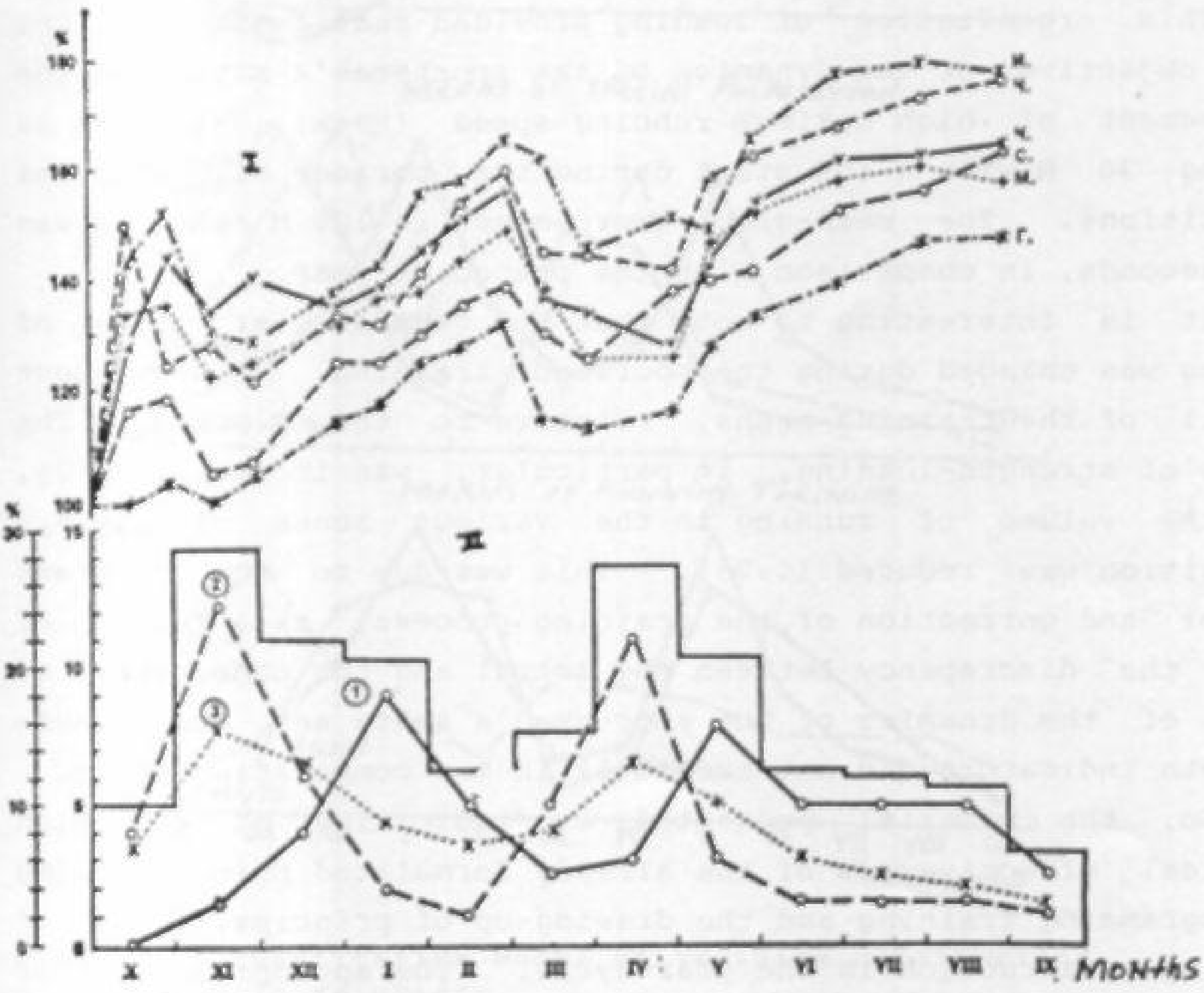


Figure 59. The dynamics of the loading volumes (II) and explosive-strength (I) of triple-jumpers during a year-cycle

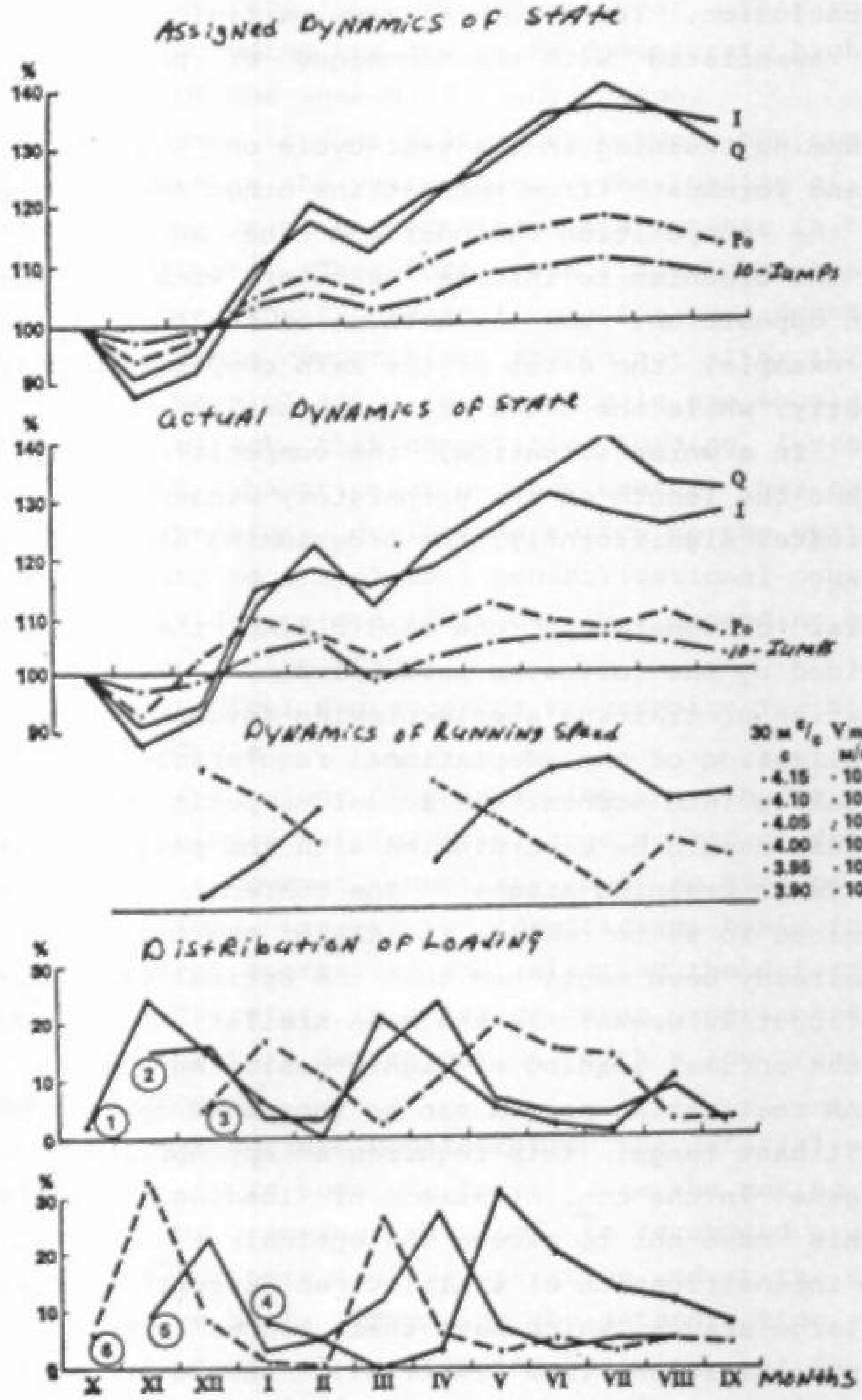


Figure 60. Dynamics of the volumes of loading and control indicators during a year-cycle, of highly-qualified sprinters (A.V. Levchenko)

By way of conclusion, let's look at some partial but important questions, associated with the technique of programming training.

When programming training in the year-cycle one should turn attention first and foremost (from amongst the other factors and conditions) to the competition calendar and the adaptational regularities of the organism to intense muscular work. These factors can be in opposition; usually because of the competition calendar. For example, the dates of the main competitions may change significantly, while the dates of traditional competitions remain the same. In a worse situation, the competition season can be extended and the length of the preparatory stages shortenend; which complicates significantly, the programming and organization of training.

Under similar circumstances one should find the optimal method, being guided by the following principles.

1. Organization of training should provide favorable conditions for the realization of the adaptational regularities of the organism, while taking into account the actual competition calendar. The calendar should be co-ordinated with the periods and duration of the large training stages. The contents of these stages are determined so as to realize the CAR of the organism.

2. It has already been mentioned that the optimal CAR realization period (about 20 weeks) is the mean-statistical figure, with respect to the optimal loading of highly-qualified athletes. However, the CAR realization period can be increased or reduced within an insignificant range; this requires an appropriate increase or decrease in the concentration of loading. It is important in this case not to exceed the optimal time limit, since excessive intensification of training can disrupt adaptation. Shorter large-stages, which have their place, for example in tri-cyclical periodization (see figure 57), should not shift the objective of the full realization of the organism's CAR to the next stage.

3. To determine the boundaries of the large-stages, one should be guided only by the dates of the main competitions, for

which the athlete is preparing all year. This rule should not be broken (including the desire to demonstrate high results at the beginning of the season) for any reason.

4. There is some difference between the contents of the two large-stages in the year-cycle. The loading of the preparatory micro-stage is more specialized and intense in the second stage, than the first. Therefore, the first large-stage should always be considered the fundamental base for the second. The interests of intermediate competitions should not alter this objective.

5. When planning the year-cycle one should be aware of the negative affect that competition loading (associated with the significant exhaustion of nervous energy) has on the sportsman's state. Therefore, during the switch to the next large-stage, it is necessary to stipulate a rehabilitational pause, the duration of which is determined individually, depending on the difficulty of the competition stage.

4.4 Logical Sequence for Programming Training in the Year-Cycle

The technology of programming training is a complex procedure involving a sufficiently large number of determinations, its complexity, however, consists not so much of the quantity of determinations, as in the insufficient basis for choosing the main logical operations and selecting the determination for each of them. Therefore in practice, even experienced coaches need to make an uncertain determination, with a low probability of a correct prognosis.

By taking into consideration the material of the preceding chapters, it is possible to regulate the making of a determination when programming-training; to recommend a definite sequence necessary for this logical operation and at the same time to show an objective basis for making the determination. So, when faced with the task of programming training, it is appropriate to adhere to the following sequence of logical operations (each determination is made by taking into account the determination made in the preceding operation).

1. Determining the Increase in Sport Results and the Date of Achievement. This is the primary objective of training; the concrete requirements of programming conditioning the necessary, quantitative parameters of the training contents. Here, a multi-sided objective assessment of the sportsman's potential and the competition calendar are the basis for making the determination. One takes into consideration the athlete's preparation in the preceding training stages and those displacements, at his level of mastery, which can actually occur in the current year. The determination is expressed by a prognostical model of the dynamics of the sport results, relative to the competition calendar.

2. Determination of the Displacements in Special Physical Preparedness and the Technical-Tactical Mastery of the Athlete: is necessary for ensuring the target-increase in sport results. The determination is based on an objective assessment of the sportsman's special preparedness, analysis of the rate of improvement in functional capabilities in the preceding stages and identification of those capabilities which need to be enhanced. The determination is expressed by the concrete targets, relative to the functional indicators and characteristics of technical mastery, which need to be achieved at the instant of performance in important competitions.

3. Quantitative Models of the Dynamics of the Sportsman's State in the Year-Cycle. The competition calendar, the level of special-physical-preparedness and the dates of the main competition are the basis for making the determination. The determination is reflected in the graphic tendencies of the dynamics of essential, functional indicators; such that these indicators are at their peak at the instant of the main competition.

4. Determination of the Composition of the Means and Methods: is the mode of stipulating the required increase in special-physical-preparedness and technical-tactical mastery. The determination is made based on the assessment of the training potential of the means and methods, as well as the desired increase in special-physical-preparedness.

5. Determination of the General Volume of Loading, with Respect to all of the Training Means, is necessary for selecting the objectives, associated with the physical, technical-tactical and competition preparation of athletes. The actual assimilation of the loading in the preceding stages and the conjectural forms of loading organization, of different primary emphasis, is the basis for making a determination. The concrete volume of loading, relative to the fundamental groups of means, characterize the determination.

6. The Division of the Year-Cycle into Large Stages, is determined by the structure and strategic objectives of the periodization of training. The determination is made by taking into account the competition calendar and the optimal dates, necessary for complete realization of the organism's CAR.

7. The Distribution of Loading in the Year-Cycle, is in conformity with all of the means securing the realization of the target dynamics of the sportsman's state. The determination is based on careful analysis of the preceding training stages, principal models of training construction, for the specific type of sport, and the principal objectives of programming training. The determination is expressed by the quantitative dynamics of the loading, relative to the fundamental means of training in the year-cycle.

8. Specifying the Organization of Training Loads in the Large-Stages of Preparation. The determination is based on the principles of large-stage construction, the peculiarities of the LLTE of concentrated strength-loading and the forms of the organization of loading of different primary emphasis. The determination is expressed by a detailed training program with a specific distribution of loading in all of the micro-cycles, preceding the large stage.

4.5 Managing the Course of Training

Material which has been presented (see 4.3, figures 59 and 60) clearly characterizes the objectives and technique of managing training. Management is the control over the course of training and its stipulation (if necessary), in accordance with its effectiveness. Management is based on a comparison of the real dynamics of training from previous target standards. Sport results and the indicators which reflect the changes in technical mastery, the sportsman's state under the influence of training and competition loading, can serve as the previous target standards. One corrects the course of training by alteration of the' appropriate parameters of the loading.

So, the technique of managing training is extraordinarily simple and obvious. It is still being developed. In our time management of training is distinguished from its prototype only by more objective ways of assessing the athlete's special preparedness.

For example, two individual cases of training management are cited in figure 61; they are based on a comparison of the actual dynamics of explosive-strength (I) indicators from an earlier model.

The training program (for the Triple Jump, I) was well constructed and did not require correction. The actuall explosive-strength of the leaping muscles even exceeded the standard of the second competition stage (May-August); and in July, the athlete executed the norm for master of sport. The sportwoman's (Long Jump, II) program was not well constructed. Her volume of loading in the first strength "block" (October-December) proved to be insufficient and included an excessive portion of strength "proper" exercises. Therefore, in order to reach the target explosive-strength dynamics, corrections in the training were made in January by increasing the portion of intense speed-strength means. The quantity of depth-jumps were increased in the second "block" of strength-loading (March-April). As a result, the explosive-strength indicators were successfully "pulled up" to the model; however, technique suffered. The sportswoman's results at the winter competitions were low because of the loss of technique. The intensification of the second "block" of strength-training raised explosive-strength slightly above the models; however, it was not stable. The sport results were distinguished by stability in the second competition stage.

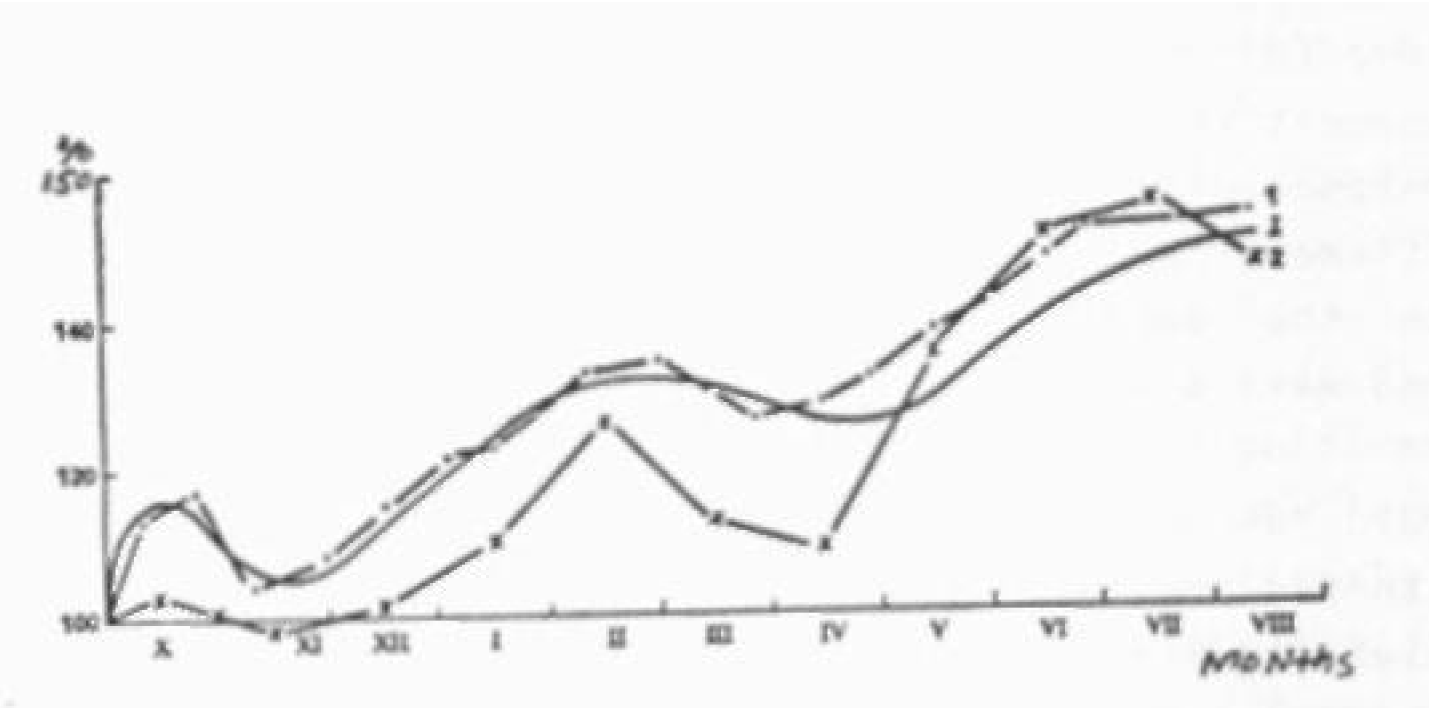


Figure 61. Management of training according to a model of the athlete's state

but on the whole, were successful. In July the sportswoman executed the norm for CMS (candidate for Master of Sport, Ed.).

So, the technique of managing training involves assessment and control of the sportsman's state, careful calculation of the loading executed and analysis of the interdependencies between them. Therefore, it is necessary to be guided by the following principles.

1. First of all one should select the most essential and informative characteristics in order to objectively assess special-physical and technical-preparedness; as well as the state of the sportsman's "psychic spheres". These characteristics can be obtained by employing special instrumental methods or control exercises (pedagogical tests). One should seek all possible ways of obtaining such characteristics, to be found in the special literature.

2. Control over the course of training can only be effective if one carries-out regular observations of the dynamics of the sportsman's state. When doing this: a) testing should be done with a strict periodicity of 1-2 times per month, independent of the periodization and structure of the training stages; b) the testing procedure should not be excessive, burdonsome or require much time and energy from the athlete; c) it is necessary to keep the testing conditions constant, to exclude the possibility of chance factors affecting the results.

3. Management requires a systematic (within a monthly periodicity) comparison of the real and target characteristics of the training. If there is a discrepency, it is necessary to carefully analyze the situation, determine the cause for such a discrepency and make a determination to correct the training program.

One should consider yet another important circumstance associated with the technique of managing training. First, this is an exceptionally simple thing and therefore it's astonishing that coaches have not taken it seriously, up till now. Second, this is only one, purely utilitarian aspect of a coach's job. However, employing of the simplest techniques of management is a source of unique material, the accumulation of which can make an invaluable contribution to further extending the theories and methods of training; and, in particular, the problem of programming. If the coach accepts this, he has taken the first step toward essentially augmenting his methodical experience and professional erudition; raises his labor to the level of creative activity; and then — to a scientific-practical experiment.

The coach's planning, calculation and documentation is extraordinarily important for programming training. Unfortunately a totally unpermissible, scornful attitude has developed, in both theory and practice, towards documentation. However, documentation is not simply an auxiliary responsibility, indicative of the coach's efficiency, but an important attribute of his professional mastery; upon which the success of his students' preparation is primarily dependent.

Planning documentation is, first of all, a formalization of the ideas upon which the strategies of the sportsman's preparation are based, an ideal reconstruction of the forthcoming training, requiring a quite specific, simple response to the infinite number of questions of both a principal and partial nature. The worked-out plan of the documentation is a stimulus to the coach's logic, mobilization of his creative possibilities; and finally, a way of supplying insufficient knowledge, necessary first of all for prognosis, adduced as an outcome of a certain variant of training construction.

The accounting documentation, reflecting the actual parameters of training and acting as an objective basis for assessing its significance, is of no less significance.

The form of the documentation plays a significant role in raising the informativeness, the practical significance and is of scientific-methodical value for the coach. The form should provide clear and accessible contents for its material; and chiefly, this material should reflect the principal strategic features of training construction. The following basic forms of documentation for programming and control of training can be recommended.

1. A Principal Model of the System of Training Construction in the Year-Cycle. The model should clearly and laconically reflect the general strategy and the principal organization of the training. Therefore, it should be constructed in a graphic form; for example, like that presented in figures 54-57. The principal model is a good school for the coach's professional thinking. At the same time the graphic form of the model of training construction is expressive and makes it easy for the coach to convey his ideas to the pupils. The extent to which they understand his ideas, will for the most part, determine the success of the training.

2. A Quantitative Model of the Training Construction System (group or individual). It is worked-out on the basis of the principal model and includes a quantitative model of the dynamics of the most essential indicators of special-physical and technical-preparedness; taking into account the competition calendar.

It stipulates the general year-volume of loading in all of the training means and its distribution by months; oriented towards realization of the target-model dyanmics of special-preparedness. The year-cycle of training for qualified athletes (long jumping, see figure 58) can serve as an example of the aforementioned model of training construction.

3. A program for the large-stage of preparation is worked-out with a weekly periodicity in the organization of the loading. The stipulated, concrete distribution of means of different primary emphasis (according to micro-cycles), takes into account the objectives of the large-stage and the individual peculiarities of the athlete's preparation. These are the fundamental working documents, in accordance with which, the coach organizes and controls the training.

4. The sportsman's individualized chart includes the dynamics of the training load actually executed, with respect to the fundamental means, as well as the corresponding alterations in the control characteristics; reflecting the dynamics of the sportsman's state and his sport results. The examples in figures 59 and 60 illustrates the contents and form of such a chart. The composition of the chart is an important condition for the control and management of training, and chiefly, for the subsequent analysis of its effectiveness and conclusions as to what follows.

CONCLUSION

Programming is a new and better form of planning training. The necessity for programming is an outgrowth of today's requirements; its potential for cultivation has been made possible by the entire course of the development of science and the practice of sport. However, only the first step has been taken in this direction. We hope that it serves a practical prupose, and at the same time, points specialists in the direction of further scientific search.

Considering the novelty of the problem, it is natural, that far from all of the questions (even the limited ones stipulated) will receive exhaustive elucidation. Those directions of scientific search, in which one should seek the answers to these questions, have been ascertained. With respect to this the most prospective areas are the study of the regularities of long-term and the organism's so-called compensatory adaptation to intense muscular work; and observation of the principal tendencies in the dynamics of the sportsman's state during prolonged training stages, depending on the assigned loading (its contents, volume and organization).

It's obvious that further search in these directions is impossible without active participation of sport physiologists and biochemists. It is necessary for them to overcome the traditional narrow-minded descriptive and explanatory functions by which they have been guided up till now; to see the training process in all of the complexity of its contents and organization, and to understand its role in solving the problems emanating from this. It is very important to point out that it is impossible to solve these problems by observation of only physiological and biochemical mechanisms. It is impossible to separate, as is customary, the industrious motor apparatus from the mechanisms and source of energy-acquisition for muscular work; and to examine them "in general", outside of their inter-conditional functional perfectioning; under specific conditions of systematic specialized training. The pitfalls of such a separation become apparent when one attempts to extract some practical recommendations, even from interesting experimental material.

Further elaboration of the programming question should be carried-out by taking into account its general pedagogical principles, and based on a special experimental search. It is important to point-out with respect to this, that it is unacceptable to understand programming as the following of some instructions, prescribing a rigid order in the organization of training. Furthermore it's also senseless to view it as the creation of an algorhythm for chess. Programming in sport is an art, which is based on specific principles, allowing the coach creative initiatives in making the final decisions.

In this book such principles are most clearly expressed by the models of training construction in the year-cycle. However, practical utilization of these principles for programming requires further elaboration of numerous -partial** methodical questions. The latter concerns the ordering of loading in the large training stages and their composition in the micro-cycles; as well as rational ways of combining the contents of these micro-cycles into a system, taking into account the specific type of sport, the assigned loading, the period of training, the athlete's qualification and his individual peculiarities.

It is the coach's role to solve such questions. His pedagogical mastery and methodical experience should, in this case, have the decisive voicei but only if he has sufficient knowledge of sport physiology. This is important for the practical utilization and the further perfectioning of the principles of programming training formulated in the book and for the very same coach's professional preparation.