The Development of the Russian Conjugate Sequence System

by **Tom Myslinski**
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Dr. Robert J. Robertson, Advisor

Abstract

A significantly unique method of developing the strength of a nation through its population ignited the era of potent physical education program in the former Union of Soviet Socialist Republics. Victories were a reflection on the country, not on the individual. However, the demise of the Union in 1991 foreshadowed the end of the reign of athleticism.

Prior to this, their hold on athletic supremacy was undeniable and can be best explained by the following comparison. At the 1984 Summer Olympic Games in Los Angeles, in which the USSR and its Eastern Bloc allies boycotted, the American athletes captured 174 total medals. A few weeks later, the boycotting countries staged the 1984 Friendship Games in Moscow and the following results were humiliatingly noteworthy. In track and field, of the forty-one gold medals in Los Angeles, twenty-eight of those final results were surpassed at the Friendship Games. In addition, in the swimming competition, five world records and a total of forty swimmers exceeded the time of their American competitors (74). The difference was a superior methodology of training.

Known as the Conjugate Sequence System, the Soviets were able to develop it so thoroughly that results as above were commonplace. Initially, the System involves a concurrent training of several motor abilities (means) or a wide multi-lateral skill developmental approach. This provides the base framework for the neurological construction of all subsequently developed motor skills. As the athlete passes through maturation and is able to functionally specialize, a foundational motor skill pool exists from which the athlete is able to pull. Future adaptive restructuring is highly specific and is dependant upon the ability to maintain strength and skill qualities already gained while raising limiting motor qualities. The Conjugate approach is emp loyed to control and consistently redirect the desired specific training-effect. This is preservation procedure and is accomplished by simultaneously training all necessary motor abilities with a constant renewal and reestablishing process, promoting a steady, permanent adaptation while securing the desired training-effect, thus elevating the athlete's functional potential.

Origins

The concept of the conjugate sequential system is translated from the Russian coupled successive system. This system evolved from the concurrent system, or the multi-lateral skill developmental approach found in the sport schools of the old Eastern

Bloc countries, and most recently in China (7)(16)(18)(21)(27)(40). As an objective, these schools' goals were to identify, select, and train, young athletes with the potential to succeed in regional, national, or international arenas. They believed that if children were encouraged to develop a variety of skills, they would quite possibly experience success in several sporting activities. As the developing young athlete displayed further interest, and demonstrated and displayed potential, they were nurtured along the path of athletics. Through systematic identification and recruitment, priority was given to the selection of those young athletes thought most likely to benefit from intensive sports training and to produce championship results in top-class competition (8)(9)(10).

The schools' selection was based upon the assumption that the requisites for a sport can be identified at a youthful age and subsequently perfected through general to eventual specific training. As the child biologically develops, their ability becomes much more dynamic. This allows the coaches to identify the pre-pubescent athlete's developing traits and place him/her properly within the sport that meets their individual qualifications. Further selection, assessment, and evaluation were a continual process, each time resulting in a greater refinement of direction and level of training for the young athlete. This process was the first step in the development of the Process of Achieving Sports Mastery (PASM, based on the Russian abbreviation of PSSM)(48)(59).

The foundation of the Russian PASM is rooted in the research of A. Novikov, "the father of Russian physical education," and N. G. Ozolin's research on the concurrent system of long- term training (32)(34). This systematic type of application is valid only for athletes of lower qualification and

"involves the parallel training of several means or motor abilities, such as strength, speed, and endurance, over the same period, with the intention of producing

multi-faceted development of physical fitness. This method is based on experimental evidence that adaptation elicited by the separate components of the complex training work is not simply a summation of the separate training effects, but the synergistic result of the interaction of the effects of each stage of training. This interaction produces a new physical state with a significantly greater work potential than would have resulted from the non-systematic use of the same means, even at increased volume" (49).

Simplified, this multilateral approach consists of the utilization of many different methods by many different means in order to foster and develop the young sportsman's adaptation level. The rationale underlying this system was as the pre-adolescent athlete developed a well-rounded athletic base rooted in general physical preparation (GPP); his overall motor potential would correspondingly rise. Over time, this stimulus would trigger a response of adaptation, so that the demanding training loads that eventually occur during specialized physical preparation (SPP) would not distress the body. This direct relation between the central nervous system (CNS) and physical training plays a paramount role in the athlete's adaptation to the stimulus because new training loads create new coordination's. This neurological supercompensation forms the basis for the developing motor skills and perfects the cooperation among the various systems of the body including the athlete's metabolic mechanisms. As the young sportsman matures and attains higher stages in the PASM, the foundation of all subsequent motor systems evolves from the solid establishment of GPP, thus the concurrent system (9).

GPP – The Growth of Trainability

At an early school age (approximately 6.5-9 years old ± 1 year), the initial preparation stage begins. This stage is the cornerstone in the pursuit of PASM and is characterized by the progressive development of motor skills through a traditional multi-faceted motor preparedness and the creation of a functional groundwork for specialized

perfecting of motor abilities. Its exclusive goal is to expose young athletes to a wide variety of physical fitness skills, thus stimulating a healthy development and increasing their functional capacities, motor abilities, and knowledge base. Additionally, exposing the pre-adolescent sportsman to a well-rounded curriculum negates the effects of early specialization and elevates their overall adaptation level.

For example, an extensive range of calisthenics, exercises from many different sports, and children's games are introduced at this stage. Particularly, preference is given to the elementary movements that provide low neurological resistance, but serve a foundational role, such as running, jumping, climbing, tumbling, swimming, and throwing. The amount of sport-specific exercise is limited and constitutes only a 5-10% of the total training volume. Within this percentage, the objective is on education and the gradual introduction of the sport specific basic fundamentals and techniques (24).

Harre, from the former East Germany, conducted an experimental longitudinal study, while Nagorni, from the former USSR, carried out a descriptive longitudinal survey regarding youth developmental programs. Their results yielded similar, significant findings. Over a period of 14 years, Harre sampled a large population of children, from the ages of 9 to 12 years old, dividing them into two groups. The first group was exposed to the traditional North American, early specialization program. While the other group followed the general, multilateral approach and developed their sport specific traits simultaneously. The results, found in Table 1, conclude that a multilateral training regimen is superior in the early stages of development and promotes a strong, stable foundation for athletic success.

EARLY SPECIALIZATION	MULTILATERAL PROGRAM
• Performance improvements were immediate	• Performance improvements were continuous
• Best performances between 15-16 because of early adaptation	• Best performances over 18 due to physical and mental maturation
• Performance inconsistencies within competitions	• Performance consistencies within competitions
• By 18, many athletes quit or "burnout"	• After 18, many athletes were starting to "come into their own"
• Forced adaptation accounted for a high rate of injuries	• Gradual adaptation accounted for a low rate of injuries

Table 1. Comparison between Early Specialization and Multilateral Development (15)(31).

The authors Haubenstricker and Seefeldt state that, "…readiness to learn is unique to each individual," and "Individuals are always in a state of readiness to learn something at any point during their lifespan. The challenge is to match an individual's readiness with appropriate learning tasks (17)." In support of this view, Filipowicz and Turowski, determined that among children, physical qualities that determine sport talent are poorly differentiated, thus all athletic abilities highly correlate. As the maturation process begins, these abilities gradually diverge so there is a lesser correlation among them. This naturally occurring separation is similar to what occurs in the initial preparation stage. Initially, all abilities improve due to physical training and with gradual adaptation over time, the progress slows down and ultimately limits itself to the specific exercises trained (13). In other words, as the level of trainability increases, the transference of physical traits decreases resulting in specific adaptations (76). Therefore, through the incorporation of a multi-faceted physical education program, a wide training effect is realized. Prescribed exercises that are general in nature, but specific in function, allow

improvements even though they are different than those of the desired sport type. This eliminates the hazards of repetitive stresses, early specialization, and the potential losses from focusing on short-term gains at the expense of long-term goals.

In contrast, as the athlete matures and advances into PASM years, the role of GPP changes but the thought process "get fit to train before training for competition" remains the same. Gradually, the amounts of GPP exercises are reduced, become more difficult, and reflect the contents of the athlete's specialty. Contents or means, in this sense, do not indicate sport-specific, but rather they are selected on the basis of the changing needs of the developing athlete (41). Medvedyev (28) describes the exclusive role GPP plays in the overall training regimen with the following three functions:

1. "the formation, strengthening or restoration of the habits (skills), which play an auxiliary, facilitatory role in sport perfectioning."
2. "as a means of educating abilities, developed insufficiently by the selected type of sport, raising the general work capacity or preserving it."
3. "as active rest, assisting the restoration processes after significant, specific loading and counteracting the monotony of the training."

Essentially, these exercises consist of any means that elevates a certain trait developmentally required within the athlete, or characteristically found within the sport itself. This secures the multilateral development of physical abilities, especially the abilities neglected by sport-specific exercises (61).

PASM's structure and success ultimately depends upon the functional base provided by GPP. All ensuing content of SPP is constructed on the framework provided by GPP, while the continuous content of GPP depends on the requirements of SPP. Therefore, GPP must guarantee constant progress for PASM to continue and flourish. But the rational combination of the two methods must be regulated. Any excessive

volume of GPP work causes a reduction in the necessary volume of SPP and results in deterioration of the mature sporting form. And any excessive reduction in GPP volume at the expense of SPP reduces the functional base, restricts progress, and results in elementary movement illiteracy (24)(73).

Movement Dynamics

The underlying principle surrounding the creation of GPP can be found in the fundamental element governing all sports - movement. In Verkhoshansky's original research on the biodynamical structure of movement, we find the Principle of Dynamic Organization (68). Within this, he describes athletic performance as a complex interaction of many movements, and sport now becomes a problem solving activity in which movements are used to produce the necessary solutions. Since these movements are created and regulated by the CNS, our goal in training should be to enhance that efficiency in order to solve the problems associated with learning a new motor task. The ability to create and recreate successful, rhythmic motor programs changes continuously while the body consistently searches for a more efficient interaction between the structures of the motor complex. The effectiveness to use one's motor potential to achieve success is the essence of skill acquisition.

Initially these motor programs are weak and unpredictably scattered across the movement spectrum. Not only is the gross motor act as a whole dynamically unstable, but also so is the young athlete's perceptual ability. Then, as adaptation occurs from the imposed loading, the ability to effectively manage the new motor skills develops. Now, with repetitive practice of a motor act, the range of variation decreases, and the

interaction between the neuro-muscular systems can be coordinated through specific patterns of simultaneous and sequential actions, and accurately regulated over shortened periods of time.

As this motor system becomes integrated, it is now able to react and functionally evolve as a whole. It possesses a certain flexibility that allows it to now cope with strong external stimuli without disrupting its functional effectiveness. This becomes possible because of the biodynamic structure's ability to adapt to the internal effects caused by external events. In general, the biodynamic structure consists of the sum of all external and internal forces acting on the body while it performs a specific motor task.

Even though these conflicting interactions appear to operate independently of one another, they react simultaneously and are dependent upon one another, to an extent that increases motor learning. The total sum of external interaction forces the dynamic or reactive adaptability of the internal system's structure, whereas the internal interaction forces the reactive adaptability of the external system's movement over time. But the control of the external interaction on the motor complex is only possible through the internal biodynamical structure (48)(68).

Each of these previous discussed factors is involved in the process of solving motor tasks and directly influences the results. Therefore, each must be considered when one is analyzing the biodynamical structure and it's influence on the working-effect of the movement. From this, one is able to select the special motor skill tasks to facilitate learning.

Applying the Principle of Dynamic Organization to the research of Shumway-Cook and Woollacott, who proposed a three-stage model of readiness for the acquisition

of motor skills for children, we find a step-by-step progression that takes into consideration the internal and external interaction forces on the development of a motor skill (45). As a side note, I felt the authors' suggested progression was to condensed for beginners. Initially, there should be a greater separation of stages to account for the development of the simple motor act to a complete motor system. Revised and in sequence, they are now as follows:

1. Repetition of the fundamental motor act using the proper form.
2. Repetition and implementation of the motor act into the complete motor program using proper form.
3. Repetition and implementation of variations (drills) of the motor program using proper form.
4. Repetition and the introduction of simple environmental changes using the proper motor system.
5. Repetition of variations under environmental changes using the proper motor system.
6. Continue and introduce problem solving and sport specific strategies in a competitive setting.
7. Introduction of the actual sport, only if the individual is developmentally ready.

The one common element that is consistent within the list is the word "repetition." It is important to remember for effective learning to initially occur, the learner must be able to pay attention to the proper form of the fundamental motor act. Only then is the learner able to proceed to the next stage of skill development. Repetitions that are inefficient result in wasted practice, time, and an incomplete motor program. However, repetitions that are developmentally appropriate, yielding positive feedback on the knowledge of results, generate advances towards skill acquisition and perfection.

"Transfer of Trainedness"

"Were it not for this power, every sensation would leave no track, no trail; every sensation would be perceived the same way on the millionth time as on the first time…" I.M. Sechenov (43).

While the fundamental physical qualities that are biodynamically developed under the concurrent system are displayed at a rapid rate during the initial years of PASM, the young athlete's body reacts to any stressor with all of its survival mechanisms and emerging motor abilities. This biological ability of the body to acclimatize itself to the various external and internal influences is the physiological foundation of long-term training. By fully and effectively raising the functional specialization of the motor apparatus with an optimum level of stimulation through a progressively sequenced choice of training means, the biodynamic structure is undergoing adaptation at successively higher levels of performance. This process of adaptation has been studied extensively through the research of Folbrot's, Weigert's Law, and Selye's, GAS Theory (14)(44).

Applying these models, Soviet psychologist L.A. Orbelli (33), described the adaptation process as the essence of all physical exercise in the statement "transfer of trainedness." It has generally been defined as the inherent ability of all living organisms to master new activities, and within this structured process the organism adapts and elevates itself to a higher level. This naturally occurring dynamic process constantly strives to attain a state of equilibrium. As long as the self-correcting individual system maintains a balance with the environment it can grow and thrive. When its stability is disrupted, the organism ceases to develop and progress.

Relating this phenomenon specifically to athletics, Charlie Francis (personal communication September 12, 2002), Canada's premier sprint coach, discusses adaptation and the ability to control these variables under cause-effect relations.

"A body under recovery will always seek homeostasis. So it is always better to undertrain than to overtrain. You will still supercompensate, but not to the degree. Once you overtrain, your body will plummet and fight to retain a balance. Smaller CNS demands over a longer period of time result in more acceptance and greater improvement. While the rush to get more done leads to uncertainty down the road."

"Transfer of trainedness," according to Zimkin, is positive initially due to the high correlation between homogenous and heterogeneous motor skill development in beginners. But as sporting proficiency grows and qualification levels rise, this transfer phenomenon fades away because of the length of time the specific exercises are used, and the narrow specialization in developing the mature sporting form. As the adaptative responses become more selective to the specific components of the training stimulus, they result in a lesser effect on the development of the unique, desired physical traits. A negative "transfer of trainedness" is now observed, which allows improved performances in variations of the main exercise, but not within the main exercise itself. This transition signifies a turning point within the development of the young athlete from the general multilateral program to an initial specialization stage, and interestingly, corresponds with the middle of puberty (approximately 13±1 years old). Now, as the rate of "trainedness" grows, the principle of specialization increases as well as the means used to develop it. Thus, the internal effects on the biodynamic structure will be reflected externally and determine its final function (5)(9)(79).

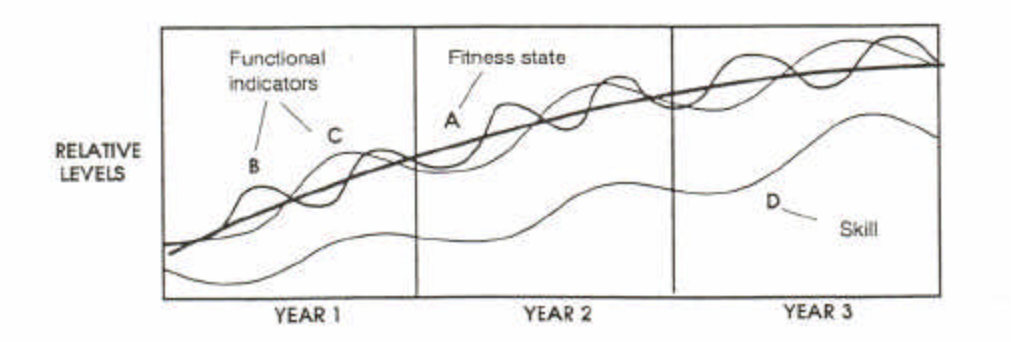

Figure 1. The dynamics of adaptation in sports training over several years (Siff and Verkhoshansky, 1999) (54).

Adaptation to the Cumulative Loading Process

According to the "transfer of trainedness," it appears that there is much diversity between the beginning and the advanced athlete. Not necessarily, in effect these athletes use essentially the same exercises, but vary greatly in the variation, volume, intensity, and functional cost of their loading. [Research from Menkhin (30) has shown that the traditional rule of thumb "as intensity increases, volume decreases" is incomplete, whereas it ignores the factor of functional stress. Essentially, he quantifies any high intensity exercise (94-100%) involving a maximal amount of motor unit involvement as extremely taxing on the CNS and should be factored in on this equation.] In the mastery stage (≈18 and up), training becomes individually specialized, with the goal realizing maximal athletic and peak physical potential. There is a substantial increase in the frequency and intensity of workouts, while specific training loads are increased to approximately 70% of the total training volume (36)(39).

Furthermore, specialization requires the ability to objectively evaluate the training-effect of the imposed stimuli. As sporting proficiency increases, the training-effect of the means prescribed decreases, but a sequential accumulation of loading

involving more effective means, determines the length of time the cumulative training-effect is preserved. Thus, the primary training stimuli exhibits the strongest training-effect at the greatest rate of adaptation. Consequently, the less intense the training-effect, the less intense the adaptation that follows. Together, these combined effects provide a functional base on which to build PASM and influences the outcome of the athlete's entire structure. With that said, any superfluous work that does not directly impact or improve performance should be controlled or eliminated. Any adaptation created that is not specific leads to developmental delays in PASM.

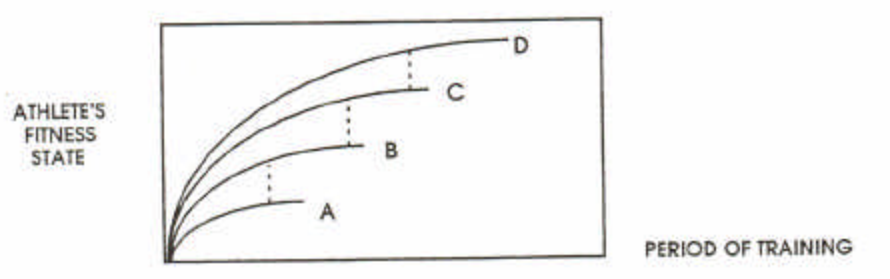

Figure 2. The effect of a sequence of training means with different training-effects. The dashed lines show where one training means is replaced by a successive one with different training potential (46).

Current work, in the operational state, contains a "superimposing" after-effect on the immediate, delayed, and cumulative training process. This new stimulus is added to the previous work and reflected on the permanent state. Depending upon the neurological cost of the task(s), the body's response to loading can be viewed as an adaptative reconstruction/supercompensation (short-term improvement) or overtraining (short or long-term deterioration). Both these positive and negative training-effects are specific to the site applied, and reflected in the athlete's current state, changing daily. With careful periodization an initial negative effect can eventually be viewed as a positive, thereby leading to a stable adaptation. Therefore, the cumulative training-effect is the sum of the

internal effects on the biodynamic structure caused by the immediate and delayed training-effects viewed externally (6)(71).

In order to assist this adaptative process, the programming and organization of the training-effect(s) is the base criterion for determining the success in the quest of PASM. The sportsman's current state is the reflection of all the former methods and means used to enhance sporting proficiency. All future progress is limited to and dependent upon the objective assessment of the training regime, consistency, and the optimal sequencing of all possible methods and means. This progressive increase provides the basis of SPP and determines the direction for all feasible means employed thereafter, achieving the desirable trait combinations specific to the athlete and the sport's demands. Through research and experience, Siff and Verkhoshansky (50) have provided some general guidelines to optimize the prescription and planning of the cumulative training-effect on the athlete's permanent state:

1. "The training effect of any means diminishes as one's special physical fitness increases."
2. "The means used should provide the optimal training effect relative to the one's current functional state."
3. "The after-effects of previous work alters the training effect of any subsequent method."
4. "The training effect of a complex of means is determined not only by the sum of the stimuli, but also their combination, order of succession and intervals of separation."
5. "The contents of special strength training should include a complex of specific stimuli and produce the strength fitness required for the given sport, based upon the athlete's level of sports mastery."

Applying these generalizations, L.S. Homenkova researched "the influence of aggregate loading on an athlete's entire system." These cumulative training-effects, their wide variations of loads, and their specific load characteristics are presented below.

Objectives	Overall Load	Volume	Intensity	Complexity	Psychological Intensity
1. Improve the body's functional capacity, increase GPP	moderate – heavy	moderate – heavy - maximal	light – moderate	light - moderate	light
2. Creating the SPP to meet the functional demands of the event	moderate – heavy	moderate – heavy – maximal	Moderate	light – moderate – heavy	light - moderate
3. Adaptative Reconstruction or Supercompensation	heavy – maximal	moderate – heavy – maximal	moderate – heavy – maximal	light – moderate – maximal	moderate – heavy - maximal
4. Solidifying and maintaining the functional state (morphological and biochemical changes)	moderate – heavy	heavy – maximal	moderate – heavy	light – moderate – heavy – maximal	light – moderate – heavy – maximal
5. Acquiring motor skills, techniques and tactics	light	moderate – heavy	moderate – heavy – maximal	light – moderate – heavy – maximal	light – moderate - heavy - maximal
6. Solidifying motor skills, techniques and tactics	heavy – maximal	light – moderate	heavy – maximal	heavy – maximal	light – moderate – heavy -maximal
7. Active restoration after a training session or competition	light – moderate	moderate – heavy	Light	light	light
8. Active restoration for the CNS – changing to another exercise	moderate – heavy	light – moderate	moderate – heavy	moderate – heavy	light -moderate

Table 2. Training objectives and the level of training loads (20).

Russian physiologist A.A. Ukhtomsky summed up this plasticity, or adaptative reactivity feature of the body as "Work build organs." He explains,

"Living matter has a powerful capacity for assimilation and restoration, a capacity that constantly replenishes its routine, everyday expenditures. This capacity for compensatory assimilation is so powerful that it often causes the working organs to accumulate matter and, more specifically, working potential. A stimulus arouses processes within an organ that expends or diminishes its potentials; however, it also arouses assimilative processes that compensate for these expenditures. These reciprocal processes often compensate not only for the past expenditures, but also accumulate working potential that surpasses the level they were at before the work took place" (19).

SPP – The Preserving and Elevation of Trainability

In order to achieve high sport prowess, the role of specificity in sport as in nature, dictates there is no such thing as absolute versatility. It is impossible to train for and attain contrasting motor abilities such as maximum power and maximum economy. The simple realization that sport specialization is a specific functional reconstruction of the motor apparatus and the physiological system reflects the natural, selective course of adaptation (24)(48). While adaptation over time is contingent upon the functional development of the organism's motor potential and the ability of the athlete to fully realize it. Within this realm lies the essence of sports mastery (68).

The role of specificity is dependent upon the athlete's sport. The keys lies within the ability to logically examine the motor mechanisms involved, and specifically apply those needs to the athlete. With GPP firmly established, the right proportion of SPP is sequentially introduced and critical to the development of the athlete's sport ability. These essential exercises, delivered with the appropriate means, may be exact (competition exercises), similar (preliminary exercises), or dissimilar (developmental exercises) in nature to the specific requirements of the given sport (29). Over the course of many training years, consistent external stimuli causes an internal accumulation of training-effects, from which various traits arise. Within these traits, that are precise in function, are found the necessary motor abilities required of the athlete's specific sport. Initially, general traits, for example absolute strength and speed, are formed that are biologically interrelated, mutually independent, and constructed individually. Eventually, they provide the foundation and influence the manufacturing of new, improved specific traits, for example starting and accelerative strength, which cumulatively raise the athlete's specific motor qualities and capabilities. Under the body's direction of

accommodative restructuring, there is a unifying effect of these separately developed physical traits exposing new motor abilities, from which the mature sporting form arises (48)(68).

Once established, specific traits yield the essential characteristics that govern the functional specifics of sport performance. The qualified sportsman's training goal now shifts from a developmental aspect to one of maintenance. Specific training-effects that are now vital to maintaining desired traits are trained using a complex system of means. Systematically employing the conjugate method results in a sequentially, repeated repetition of similar training stimuli. This preservation procedure simultaneously trains all necessary traits with a constant renewal and reestablishing process, promoting a steady, permanent adaptation while securing the training-effect, thus functional potential. A positive "transfer of trainedness" becomes quite noticeable, indicated with a linear rise in SPP and sporting results (68).

As stated above, an increase in sports achievement highly correlates with the growth in the athlete's motor abilities, resulting from specific training influences. The extent of further functional restructuring is highly specific and occurs only within the most actively participating systems. While the length of time specific traits are preserved is conditional upon the appropriate allocation of specific means. Yuri Verkhoshansky (48)(69) described four common characteristics that preserve this adaptation ability as "The Principle Aims of Special Strength Training." They are as follows, followed by a brief explanation:

1. "Converging the partial effects of strength training means." Over time, the results of sequential loading causes an accumulation of training-effects which merge to form the necessary traits that are required for success in the mature sporting form.

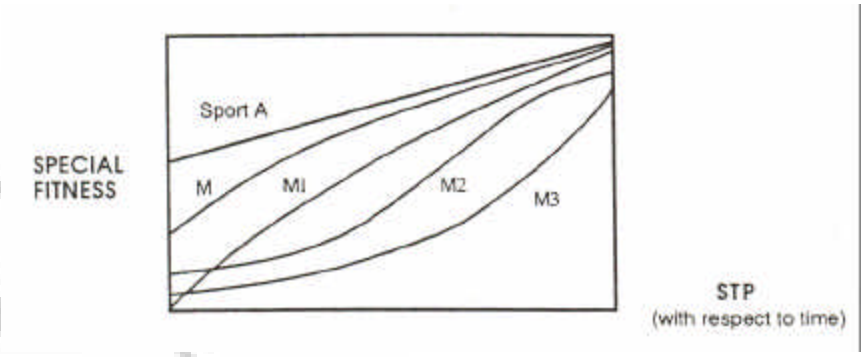

Figure 3. The aim of converging the partial effects of different strength-training means. STP is the Sports Training Process or PASM. M1, M2, and M3 refer to the different motor abilities, while M is the key motor ability. (Siff and Verkhoshansky, 1999) (55).

2. "Accelerating specific adaptation." To allow selective adaptation to occur, the construction and introduction of SPP must be introduced sequentially and based upon the specific demands required from the athlete's specific sport.
3. "Specific correspondence of the training effect." At each stage in PASM, the appropriate selection of training means must reflect and secure the athlete's current motor potential.
4. "Maintaining the strength training effect." As sporting proficiency rises, the successful preservation of training-effects depends upon the systematic sequential loading and the introduction of more effective training means.

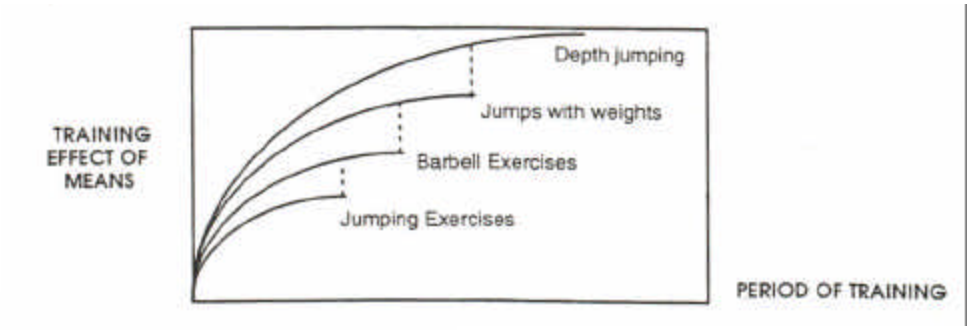

Figure 4. The conjugate sequence method of organizing speed-strength loads for explosive strength of jumpers. The dashed lines indicate when one type of training means is changed to the next training means (47).

A Simultaneous Sequential System

As training progresses through the high sports mastery stage and into international class, abrupt changes within the biodynamical structure do not occur and general traits become relatively stable. These traits do not satisfy the particular motor requirements of the athlete's sport, but are essential for the separate creation of specific traits, which secure and support the motor demands of the specific motor act. As a result, the unique construction of all traits are displayed through their specific characteristics and preserved through individualized motor programs. Since emerging specific traits cannot be directly transferred to sporting performance, they create a functional potential that is greater than the sum of the contributions of their corresponding general traits. This progressive functional change, or continual refinement of traits, is a prerequisite for improved performance, allowing growth through the Principle of Dynamic Organization. Adaptive reconstruction now effectively secures the neurological base that creates an organizational foundation for the mature motor ability to arise (48)(68).

At this juncture, where sport skill becomes the greatest, the concentration of all previous training-effects cumulates and is reflected on the athlete's permanent state. A

situation now exists where the elite athlete is already accustomed to increased levels of neuro-stimulation and experiencing a low or possibly negative "transfer of trainedness." Future reconstruction becomes highly specific and is dependent upon the ability to maintain strength and skill qualities already gained while increasing limiting motor qualities. Eventual improvements are conditional upon the parallel distribution of loading. Distributed with an equally sequenced development of sport-specific skills, and a progressive increase in strength through a series of specific, structured means (2)(23)(26).

"The conjugate sequence system (CJSS) involves successively introducing into the training programme separate, specific means, each of which has a progressively stronger training effect, and coupling them sequentially to create favourable conditions for eliciting the cumulative effect of all the training loads. The conjugate sequence use of unidirectional means, integrated by separately developing individual, specific motor abilities, can be an invaluable method of organizing SPP …" Siff and Verkhoshansky (51).

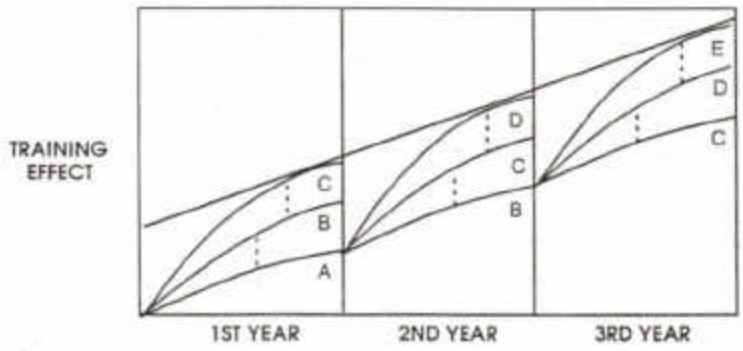

Figure 5. Application of the conjugate sequence method of organizing speed-strength loads in multi-year training. A, B, C, D, and E are the training means that constitute the complex sequence (based on Verkhoshansky, 1977) (64).

For qualified athletes in this stage, it is necessary to separate concurrent training from conjugate training through unidirectional loading. Multilateral programs inevitably function against specialization and hinder the body's structural-functional potential.

Similarly, concentrated or unidirectional training involving too many traits at once reduces effectiveness [Zatsiorsky (77) recommends training no more than two to three strength elements or traits at once] due to motor amnesia created through an abundance of "superimposed" training-effects on the athlete's permanent state. In this manner, the CJSS does not reject the concurrent system as the fundamental foundation of long-term training, but only continues it so it can fulfill the necessary motor requirements of the highly qualified athlete. While general training-effects are preserved, specific training-effects are emphasized through unidirectional loading causing a stable and permanent adaptation on the athlete's current state (48)(68).

This synthesis of planned cumulative training-effects is a product of blending quantitatively diverse traits that are developed separately over time. The summation training-effect is not just a consequence from the gradual accumulation of training-effects, but the interaction of effects each trait exhibits upon the other. Their independent development becomes dependent upon a continual, unidirectional elevation resulting in their simultaneous utilization. This progressive change acts as a prerequisite evoking more powerful training-effects for continual improvement and refinement of specific trait development and combinations. Construction through evolution produces a higher functional potential, which supports a greater motor capacity for high-level performance skill perfection (68).

Dyachkov originally examined this interrelationship of training variables or conjugate method in 1964. Formerly known as the "method of combined development of physical qualities and technical mastery," it stressed the concept of training duality and was initially applicable to all athletes regardless of their qualification level (11).

Follow-on research continued this view and determined as long as there was a simultaneous, sequential development of required specific traits with frequent changes in training targets, and nontargeted specific traits were maintained with retaining loads, there was a linear increase in technical skill, strength, and speed. This positive correlation between motor abilities or means was observed during the unloading phase, rather than the loading period signifying an adaptive reconstruction, or a positive "transfer of trainedness" (Figure 6b). Likewise, the Western periodization approach, or the rotational, unidirectional separation of these motor abilities did not exhibit the same effect, due to the time and efforts spent focusing on a specific direction while the concurrent development of other traits are ignored. Over time, this resulted in de-adaptation or a detraining effect, with the level of nontargeted traits diminishing considerably. Additionally, this conventional style of unidirectional training through rotating means with long intervals allows only the development of the competitive sporting form only once a year (Figure 6a). While a simultaneous, unidirectional system of multiple targets, prescribed through specific means permits the competitive sporting form to be obtained two to three times a year (77).

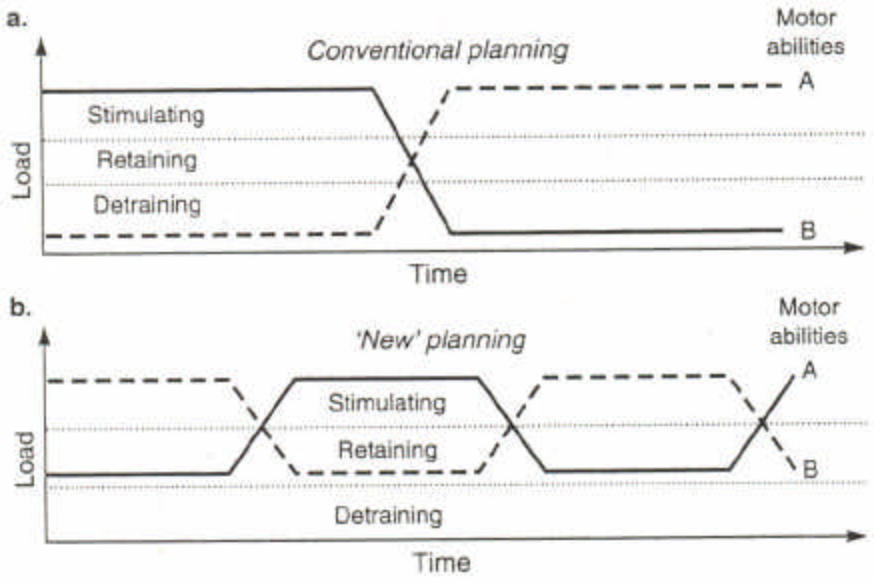

Figure 6a & 6b. Two variations of timing training loads during a preparatory period (preseason). Two motor abilities, a and b, are the training targets. Upper figure: long intervals of accentuated (targeted) training with stimulating and detraining loads (untrained mean or motor ability). Lower figure: short intervals of the targeted training with stimulating and retaining loads (78).

Additional supportive research from Vorobeyev, 1966 (72); Andrianov and Vorobeyev, 1969 (1); Kuznetsov, 1970 (25); Verkhoshansky, 1970, 1972 (62); Slobodyan, 1972 (58); Tatyan, 1974 (60); Savin, 1974 (42); Pletnev, 1975 (38); and Khodykin, 1975 (22), clearly showed that using this conjugate or mixed approach and merging the particular regimes of muscular work raises the functional potential of an athlete. As a result, the absolute effect of SPP is significantly greater when a combined regime of various means and methods are employed, than when they are employed individually and not sequenced over time.

Khodykin investigated the systematic use of heavy resistance training, plyometrics, and electromuscular stimulation (EMS) on elite athletes. Variations of trials were performed with each containing a different arrangement of training means. He concluded that EMS followed by plyometrics produced a larger strength training-effect

than plyometrics followed by EMS. Yet, the largest training-effect was observed when the EMS, plyometrics, and heavy resistance training were applied simultaneously (22).

Verkhoshansky investigations further substantiated the employment and administration of the CJSS. He concluded that SPP depends on the following factors listed in the order of importance: regime (motor requirements of sport) – means (motor abilities within those requirements) – methods (training stimulus) – system (type of application) – volume (amount of application). In this context, the resulting cumulative training-effect is a product of the repeated and systematic repetition of similar training stimuli. And the creation and preservation of specific traits can be obtained only when the possibilities of the preceding factors have been fully exhausted (68).

Another in particular stated the introduction of many different methods with many different means produces an overlapping effect caused by maintaining many different volumes. Since the CJSS is based on the exploitation of the delayed training-effect it is necessary to preserve this effect on the athlete's permanent state through the insertion of restoration phases consisting of either general or specialized work of low to moderate volume following periods of high loading. This permits an "active" state of rest for the nervous system and essential work for the muscles in order to secure the adaptation.

On the basis of practical experience and experiments, Yuri Verkhoshansky (71) illustrates the integral nature of the CJSS.

"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."

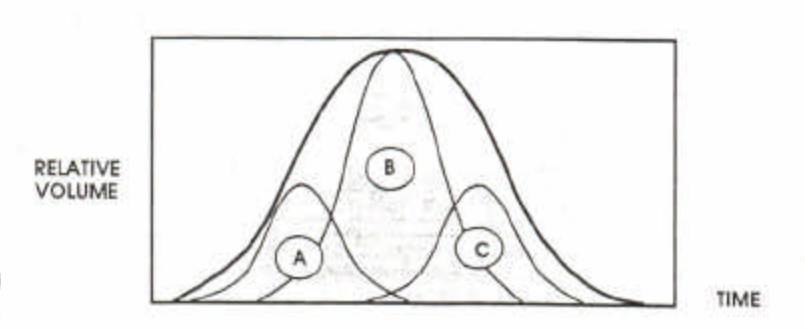

Figure 7. Structure and contents of exercises within a typical concentrated loading volume for speed-strength sports. A = jumps, B = weights exercises, C = plyometrics depth jumps. Note: Each block does not represent precise content and only one mean of training (Verkhoshansky, 1977)(63).

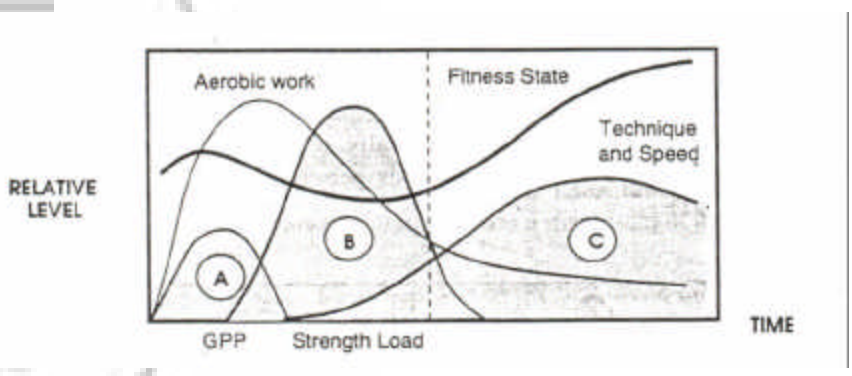

Figure 8. A model for constructing training over a large mesocycle for speed-strength sports. A is the block of concentrated strength loading, while B and C refer to the types of training identified in the diagram. Note: Each block does not represent a precise training design (Siff and Verkhoshansky, 1999) (56).

During the 1970s, the original conjugate method was first employed by Olympic lifters in the Dynamo Club from the former USSR, but popularized in the 80s by Anatoliy Bondarchuk, 1976 Olympic hammer champion and current National team throw and strength coach, and the Soviet hammer throwers. In both instances, their winning percentages are extraordinary because for the last 30 years, they have dominated world competition. Originally, the Olympic lifters had approximately 20 to 45 SPP exercises, which were grouped into two to four exercises per workout, while the hammer throwers

SPP work consisted of nearly 120 exercises, which were grouped into 12 complexes of 10 exercises per complex. All exercises or complexes were individually selected and rotated as often as required, depending upon the changing needs to allow continual growth of the athlete. This structured, sequential introduction, allows revolving trait targeting, with the most efficient exercises, particular for each individual athlete, to be saved for the training prior to the most important competitions. In addition, technical skill and competition exercise training was developed simultaneously (57)(77). Interestingly, Bondarchuk also observed when a strength complex was rotated, there was a slight deterioration in the good sport form, but after adaptive reconstruction, performance would once again increase revealing a stable adaptation with a higher functioning permanent state (Figure 9). On a side note, the original conjugate system has been modified considerably since 1980. The training means and methods are now rotated and repeated at various times during the macrocycle. Since conjugate's structure preserves the cumulative training-effect, a gradual reduction of 20% in total training volume is not uncommon.

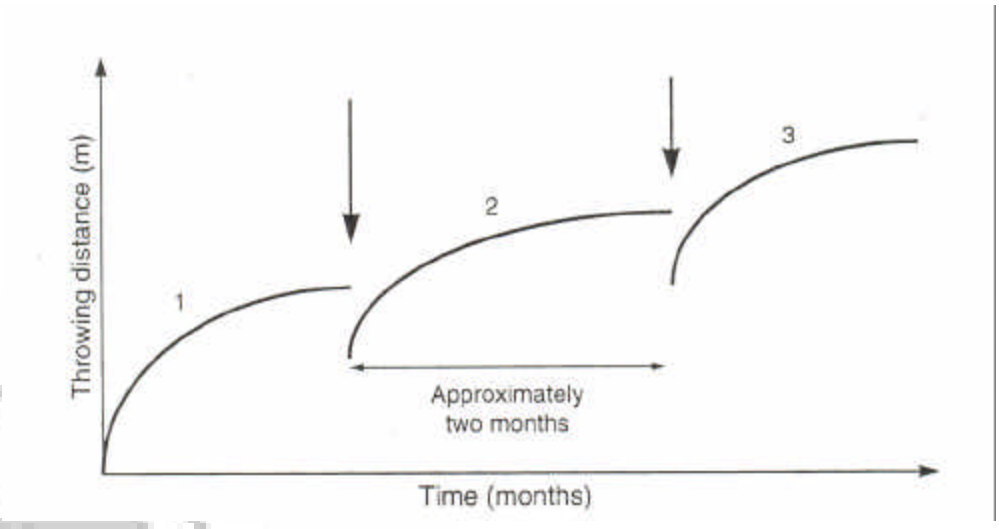

Figure 9. The influence of periodic changes in exercise complexes (vertical arrows) on the performance of hammer throwers. Note: The diagram is based on the concept developed by the USSR National Olympic team head coach A.P. Bondarchuk, 1980 (3).

Criterion of SPP

Revisiting the Principle of Dynamic Organization states sporting efficiency is dependent upon the reactive adaptability of the biodynamic structure. All viewed movements or regimes exist as a product of internal and external interactions, and are subject to a constant state of change since different sporting conditions require different displays of strength. In the simplest sense, motor acts are displayed with similar muscle contraction patterns, even though individual muscles can simultaneously and consecutively contract in various ways. And regardless of whether or not a muscle produces or does not produce movement in a joint, the resulting contraction process still remains the same. Thus, the differences between the working effects of the muscle lie not within the muscle itself, but within the nervous system (4)(75).

Through adaptive reconstruction, the nervous system secures and actively participates in every other functioning system of the athlete. Initially, all individuals are created equal with general traits originating from the same systems. Eventual athletic

specialization requires specific training-effects that instruct the body to respond according to how it is trained. This gives rise to specific traits that correspond to the main emphasis of the specific motor regimes, inherent to the athlete's sport. The CJSS, as a result, mixes regimes and selectively introduces SPP exercises that ensure and preserve a positive "transfer of trainedness" with the most active organs displaying an increase in functional hypertrophy. This astonishing ability of the neuro-muscular system to adaptively evolve allows a vast range of working possibilities in order to satisfy all motor regimes and functionally specialize (65)(71).

While looking at the CJSS and examining the prior recommendations from Siff and Verkhoshansky, a question arises. What is the most effective regime for prescribing and predicting the optimal training plan for an athlete in a given sport? This answer is a subtle trade-off between conflicting demands that lie between the imposed cumulative effect, and its relation to the specific motor regimes of the athlete's sport. In this sense, it is illogically inappropriate to pass judgment on the absolute effectiveness of any specific regime. There exists no perfect training program or collective set of means and methods that are more effective than the rest. In fact, each regime within itself is incomplete. However, when prescribed and mixed in the right context, and at the right time, it allows every regime success, contingent on control of variables such as situation, training design (sets, reps, rest intervals, and tempo), stage of macro, meso, and microcycle, qualification level and needs of the athlete, neuro-muscular response designated by SPP direction, and resulting motor abilities acquired (68).

Supporting this view, Plekhov (38) stated,

"… it is impossible to have one best set of exercises or exercise program because there is an optimal exercise program for each "season" or specific purpose. For example,

think of your wardrobe – you have a coat, a raincoat, a jacket, a light coat, and a heavy coat. Which is best? The answer, of course, is that there is no universal attire for every kind of weather or for every season of the year."

The process of developing SPP exercises exists within the multiple motor regimes found in the sporting activity. This is accomplished by operating in the realm of the specific movement's biomechanical and energetic requirements. Employing different methods through different means requires a simultaneous and sequential application, and the ability to not view an individual exercise as a confined unit, but as a limitless, supporting element. In other words, the context in which the exercise is prescribed determines its relevance to maintaining the structure of the cumulative training-effect.

At this elite level, all training must be functional training in order to support the "motor orientation" or the inner readiness that exists in an athlete to carry out a specific skill in a precise, habitual manner (12). SPP exercises, if properly chosen, enhance this ability of the neuro-muscular system, and support the development of sport-specific technique and coordination. In Yuri Verkhoshansky's original research in the *Fundamentals of Special Strength-Training* (68), he presents a guide, or a needs analysis, based on the athlete and the sport. Termed the Principle of Dynamic Correspondence, it consists of five criteria that take into account the working effect of the neuro-muscular system and its relation to the construction of specific SPP exercises.

1. The Amplitude and Direction of Movement.

> "The criterion corresponding to the amplitude and direction of movement comes from the space characteristics relative to the movement of the body links in the competition exercises. It determines the joint involvement in the muscle group work, takes into consideration the anatomical essentials and external conditions of their work, and more particularly the direction of external counteraction of muscle pull, created by the heaviness or strength of inertia of the moving system of links, the body as a whole or the sports implement (66)."

For example, sports played in a non-programmable environment, require explosive reactive-ballistic muscular tension with definite multi-planar movement patterns. Solely installing an Olympic lifting program, or a vertical plyometrics program, improves the vertical component. However, this ignores the other directions of actions and their corresponding muscle development since these sports also contain a large horizontal and lateral component.

2. The Accentuated Region of Force Production.

> "Muscular effort changes in the course of movements and maximum force is developed at the necessary instant. In ballistic movements this instant corresponds to the beginning part of the working amplitude and in movements of mixed regimes of muscular work – at the instant of switching from one regime to another. Thus, the working amplitude always has an accentuated part at which corresponds to a specific joint angle. Based on this, the criteria of correspondence anticipates the necessity to display the required force at a specific joint angle (70)."

In this instance, time spent in the traditional "athletic stance or posture" warrants training in it. This athletic position is found at a particular joint angle, approximately 30° of knee flexion, from which the greatest amount of working amplitude is required. Operating within and overcoming this initial position requires a maximal amount of force to be developed and displayed by the athlete. In addition to the dynamic regime, utilizing isometric exercises and the static regime of muscular work allows the development of maximal torque production at this approximate angle.

3. The Dynamics of the Effort.

> "The criterion of dynamic effort (of force) is the quantitative correspondence of the dynamics of the training means to the specific sports movement. This criterion states that the intensity of the training stimulus should not be less than the encountered in the given exercise at the corresponding level of sport proficiency and should even exceed it. In other words, the effort exerted in training should not be less than the effort generated in the specific sports movement (52)."

There are two ways to develop maximal force. This can be accomplished through moving a large resistance slowly, or a small resistance, quickly. Corresponding the athlete's sport with the type of strength required in relation to movement time provides the necessary muscular efforts. In this sense, a shot putter can never generate maximal strength and speed due to a short travel time. When acceleration is the greatest, speed is the lowest; therefore, force at shot delivery is contingent upon maximal strength development. There is no neurological correlation between maximal force and maximal velocity because they are separate specific traits, constructed individually.

4. The Rate and Time of Maximal Force Production.

> "This criterion corresponds according to speed of development of maximum strength which adds to the previous criterion and has especially important significance for those conditions of sports activity where 'explosive' strength is required…Because of this, the higher the speed of movement, then the shorter the time of its execution and the less the time given to the development of working effort (67)."

Using the same shot putter from the above example, we find even though his maximal strength development has increased, performance capacity will eventually stagnate unless explosive strength or the ability to exert maximal force in minimal time is addressed. This ability to increase power, or the rate of force development, by shifting the Force-time curve to the left, is contingent upon the training of the neuro-motor apparatus. Since this display of maximal strength always depends upon muscular contraction speed, strong athletes do not necessarily possess a high rate of force development.

5. The Regime of Muscular Work.

> "The criterion of correspondence regarding the sports regime relies on determining the character of the muscular work involved. In particular, the regime of muscular work should be taken into consideration for selecting the means and

> methods of special strength training. The fact is that, depending upon the character of its execution, the same means can solve different tasks (53)."

Comparably, a shot putter's delivery throw, and an offensive lineman's punching technique while pass blocking is essentially one in the same movement, and trained using the same means applied differently. But the offensive lineman "punch" skill involves single to multiple repetitions of pure speed and quickness of an unloaded movement, while the thrower's "punch" skill necessitates powerful, single repetitions against a loaded resistance.

Conclusion

The CJSS can be summarized with the work from N.G. Ozolin (35). Below are presented the tasks that must be accomplished over the course of multi-year training.

1. "To achieve the supercompensation effect (restoration of the body and raising its functional potentials to a level higher than the pre-existing level)."
2. "To strengthen the functional potentials and the morphological and biological changes at the athlete's achievement level."
3. "To acquire motor abilities and skills in sports techniques and tactics."
4. "To strengthen motor skills in sports techniques and tactics."
5. "To actively recover from physical exercises, training sessions, and competitions (active rest)."

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