Periodization Part I – History and Physiological Basis

Researched and Composed by Jacob Wilson, BSc. (Hons), MSc. CSCS. and Gabriel "Venom" Wilson, BSc. (Hons), CSCS.

Abstract

The purpose of this paper was to analyze the concept of periodization. It is subdivided into sections discussing adaptation, the historical basis and physiological basis of periodization.

Introduction

Adaptation can be defined as an acute or chronic modification of an organism or parts of an organism that make it more fit for existence under the conditions of its environment. In this context, modification is triggered by a change in the environment. These changes are known as variation, and can occur quantitatively through an increase in magnitude of a given stimulus, or qualitatively through introduction of novel or unaccustomed stimuli. For the human athlete the environment can be thought of as training conditions, with subsequent adaptation occurring in response to variation in these conditions.

Perhaps the most thorough description of training stimuli was provided by Kraemer (1983 a, b, 1984 a, b, c, d, e, f, 1988, 2004). Utilizing statistical analyses Kraemer (1983) developed an approach to operationally describe any workout protocol through identification of five specific acute training variables. These variables consist of the (1) choice of exercise, (2) order of exercise, (3) number of sets performed (4) rest period lengths and (5) resistance used or intensity of exercise. Given the above combinations, a virtually endless quantity of training sessions can be developed, each yielding somewhat differing adaptations. Kraemer (1984 f, 1988, 2004) also identified the need for individualization. That each program must be prescribed in the context of the uniqueness of the individual. Typically prescriptions are issued based on the stage that the learner is in for the specific criterion task performed (Fitts and Posner, 1967), as well as the goal or outcome desired. The situation becomes more complex when the scope is broadened to how each training session fits into a week long period. In this case, exercise frequency must be addressed. When broadened to medium to long term planning, each week must fit within the context of a month, a year, and finally a career.

Periodization is the science which seeks to take both acute and chronic training variables, and organize them into manageable periods, in such a way as to elicit optimal adaptations. The periodization concept has been progressively studied throughout the last century. The purpose of this paper was to review both the historical and physiological basis for periodization.

Historical Basis for Periodization

Periodization was originally used to describe photoperiods of the sun (Stone, 2004). Scientists noticed that athletes typically performed better during the summer season, with lower performance in the winter season. Mang (1928) and Pikala (1930) expanded on this by postulating periods of training based on internal biorhythms in human beings. These rhythms are daily (circadian), monthly (circa trigtan) as well as annual (circa annual), and are thought to govern energy needs and availability of nutrients. For example Melatonin, which is related to the onset of sleep rises at night, as well as growth hormone which stimulates the release of fatty acids to fuel the human body during this fasting period (Knowlden, 2002, 2003, 2004). Annual rhythms would govern greater activity in the summer months, and lowered activity in winter months, which is manifested in some animals in the form of hibernation (Wilson, 2004). However, the lowered training performance noticed may have simply been due to greater food supply during the summer months than winter months. Pedemonte (1986) suggests that seasons and climates, cannot be the basis for periodization (though it certainly influences it). If it was the cause then it would be impossible for athletes living in colder climates to appropriately prepare for competition, and peaking could only occur in the summer months. What has provided the basis for periodization can be found in the transition from short to long duration training protocols.

At the beginning of the last century structuring training for long periods was not highly investigated as scientists suggested that only a few weeks were needed to prepare for competition. For example Butowskik (1910) wrote that ‘ we already have tried to prolong preparation up to 5 to 6 weeks, but always we have noticed that athletes instead of becoming versed, grow week.’ As further illustration Murphy (1913) suggested that in all sport events “ the athlete has to devote 8 to 10 weeks to training. Nobody should train hard for a longer period.”

Of revolutionary importance was work performed by Kotav (1917) who went against the grain by suggesting the use of long uninterrupted training periods. Longer periods of training called for the need for an organized, periodical formulation. In this context Kotav (1917) proposed that training should be divided into three phases. These included a general fitness stage, a preparatory stage to develop specific musculature relevant to the sport, and a specific phase in which the athlete mainly practiced their event.

Pihkala (1930) of Finland refined the idea of periodization by publishing a series of principles. First he addressed that a program must incorporate a proper ratio of work to rest. Secondly he suggested that a long term program should begin with higher workloads to prepare the athlete, at relatively lower intensities, and that these should reverse as the athlete neared competition. He also created a year long training cycle, which consisted of a preparation phase, spring phase, summer phase, and rest phase. The preparatory phase developed a general base for fitness in muscular, cardiovascular, and respiratory systems. The spring and summer phases were focused on developing motor skills and were generally attained through competition. While the rest phase, was a period of active rest.

According to Pedemonte (1986), the idea of year round training did not spread until the 1940s through 50s. Pedemonte (1986) suggests that the popularization of year long training is what ultimately generated the key question of ‘what are the rules

that govern training periodization.' In this time period, forms of periodization such as the Pihkala (1930) model discussed above were governed by playing season schedules.

However, Letunow (1950) suggested that this was the wrong approach, and that scheduling of training should be weighted more heavily on the physiological state, needs and training status of an organism. In this context, Matvejev (1977), considered by many to be the true father of scientific periodization suggested that periodization was not simply a plan, but an objective set of laws that govern the training process.

These laws dictate the need for variation to bring about adaptation and rest to avoid overtraining and accommodation (see physiological basis for periodization below). In this context, Plisk (2004) defined periodization as programmed 'variation in training means (content) and methods (load) on a cyclic basis.' Kraemer (2004) adds that along with variation, periodization includes planned rest periods to augment recovery and restoration of an athletes potential. Zatsiorsky (1995) furthers this concept by suggesting that periodization is a division of a training season, typically 1 year long, into smaller more manageable intervals with the ultimate goal of reaching the best performance during the primary competition(s) of the season and that ultimately periodization is a trade off between conflicting demands.

Basis for Periodization

The physiological basis of periodization is grounded in four main adaptation models. Each of these models attempts to explain how an organism modifies itself in response to magnified or novel stimuli.

General Adaptation Syndrome

Seyle (1936, 1956, 1974) in breakthrough research on stress described what is known as the General Adaptation Syndrome, comprised of three stages. These are known as the Alarm Reaction Stage, Resistance Stage, and Stage of Exhaustion.

1. Alarm reaction stage – Here the introduction of a stressor, leads to a decrease in performance. This decrease in performance is accompanied by a fight or flight response as well as the release of various stress hormones such as adrenaline, and cortisol. In training, the stress would be in the form of a change in the environment manifested through manipulation of acute training variables. This change would result in overload of the system.

2. Stage of Resistance – The organism's defense mechanisms fight to gain resistance. This is known as adaptation and is characterized by elevated levels of homeostasis. In training this could manifest itself in muscular hypertrophy, enhanced neural drive, or metabolic adaptations.

3. Stage of Exhaustion – If the stimulus is continuous then accommodation or monotony occurs. Accommodation is a Biological law which states that the response of a biological object to a given constant stimulus decreases over time. This means that when an athlete trains the same way for extended periods of time, they either plateau or experience maladaptation. The maladaptation according to Seyle reflected similar symptoms to the Alarm reaction stage, and was the result of a

depletion of the organisms defense mechanisms caused by chronic stress.

In periodization models, this translates to a need for variety in training to avoid accommodation, and programmed rest to allow for complete adaptation.

It is important to realize that the transition from the stage of resistance to exhaustion is multileveled.

1. Overreaching followed by rest for example, can lead to adaptation
2. If the overreaching stimulus is not removed then overtraining occurs (chronic overreaching symptoms)
3. If the stimulus is still not removed then sickness and or death of the organism results.

Rest and variation (which can allow for rest of specific stressors) allows full adaptation, while avoiding monotony and maladaptation. Following the cycle a new stage of preparedness is reached and the organism can train at a higher level. Therefore cycles accumulate and summate adaptations, thus escalating the organism closer and closer to his or her genetic potential.

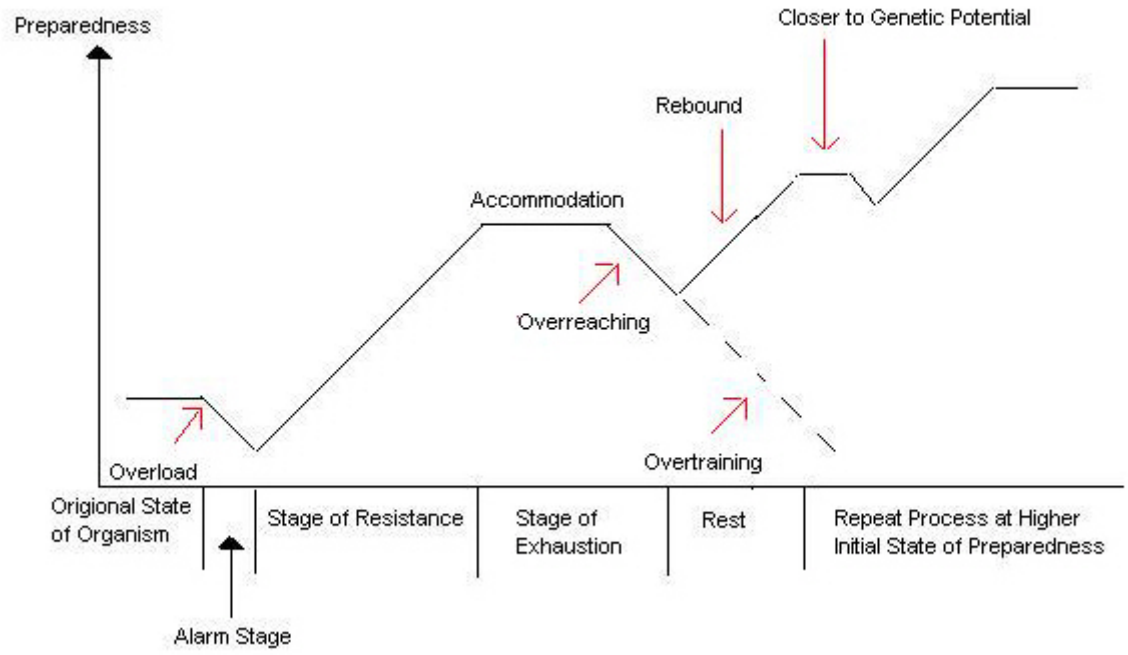

Figure 1.0 Hans Seyle's General Adaptation Theory

Figure 1 graphically depicts Hans Seyle's General Adaptation Theory. The organism progresses from an original or untrained state, through Alarm, Resistance and Exhaustion Stages. If the stress is removed through rest defenses are allowed to recover and a rebound effect is seen revealing a new state of preparedness. If the stress is not removed, accommodation, followed by overreaching and overtraining occur. Each period of training represents a repeat of the cycle of the syndrome; and each period is triggered by a change in the surrounding environment.

One Factor Theory

The One Factor, or Supercompensation Theory is a simplified version of the General Adaptation Theory and is clearly based on a cause and effect mechanism. Its simplicity makes it extremely useful as a scientific model, due to the law of parsimony (given two theories of equal predictive ability, the simpler explanation should be selected).

The One Factor theory views an athlete's state of readiness as the concentration and or absolute amount of a biological substance (Zatsiorsky, 1995). The most utilized example is the amount of glycogen stored in a muscle.

Training is said to result in depletion of the biological substance which lowers the athlete's state of readiness. When rest is allowed a period of recovery occurs, which is followed by a period of supercompensation in which the organism increases the biochemical substance over habitual levels. It should be noted that three possibilities exist during the rest period (Zatsiorsky).

1. Restoration period = Too short: level of readiness decreases.
2. Restoration period = Right length: readiness increases
3. Restoration period = Too long: no change

In this context, the athlete must therefore select out an optimal rest interval between sessions, to ensure that the subsequent training session coincides with the supercompensation phase. The athlete again must be exposed to a stimulus great enough to deplete the organism, or supercompensation will not be stimulated.

In this model, the length of the restoration period is contingent on prior depletion, as is the supercompensation effect. Therefore greater depletion requires greater time periods to compensate and hopefully supercompensate.

This concept has led to a short period of overreaching known as the 'shock cycle.' During a Shock cycle, the athlete trains in such a way as to accumulate fatigue or depletion, followed by a longer than normal rest period. This combination is thought to lead to an even greater supercompensation effect. An example would entail training a body part three days straight, followed by greater rest periods between sessions.

Fitness fatigue model

Wilson and Wilson (2005 a, b, c) have covered the Fitness Fatigue Model in depth in their three part series on the Taper. An overview of their research is as follows:

Taper Part 1 – Provides an In Depth Discussion of the Fitness Fatigue Model

Taper Part 2 – Provides and In Depth Discussion on How the model can be applied to a taper.

Taper Part 3 – Provides an overview of article one and two in a simplified manner.

The Fitness Fatigue model has its roots in Hulls work, but is credited to Banister et al. (1975). They proposed that the stimulus provided by training, termed the training impulse acts to produce two internal effects on the organism. These are classified as fatigue (negative effect) and fitness (positive effect). Performance or readiness is calculated by subtracting fatigue from fitness. The model also predicts that fatigue originally is greater in magnitude than fitness. However, the fitness lasts longer than the fatigue. It is for this reason that strength detriments immediately following a workout are greater than strength gains seen in subsequent days following. In this context the athlete must alternate work which provides the training impulse, with rest periods to dissipate the fatigue.

Currently this is the dominating model, which governs periodization, and has given rise to the concept of the taper. The model predicts that chronically over weeks of training, fatigue accumulates. Therefore a period in which the training impulse is lowered is needed before competition so that the underlying fitness can be truly revealed. As an example an athlete first hits a plateau and responds by increasing the training load. Following this gains are seen. However, another plateau is reached. Once this occurs the load is again increased but without subsequent gains. The athlete then lowers the training load, and experiences gains. This is known as delayed transformation of gains, and is thought to occur due to the dissipation of accumulated fatigue.

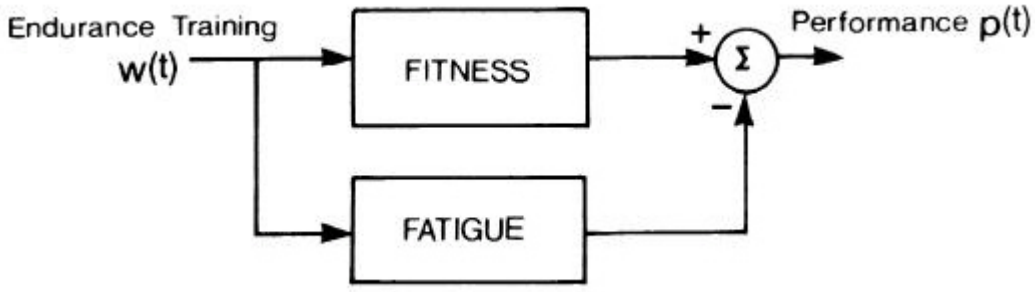

Figure 2 – Fitness Fatigue Model of Human Performance

Figure 2 graphically depicts the Fitness Fatigue Model of Human Performance. Where w(t) is the training impulse, fitness and fatigue are internal factors, E represents the summation of these two variables, and p(t) represents performance.

Sequencing Theory of Periodization

The Sequencing Theory is based on several concepts, such as specificity of fatigue and successive potentiation. Specificity of fatigue suggests that fatigue is specific to the exercises utilized during a training session. It also suggests that the transfer of fatigue from one exercise to another will reflect the number of shared variables between those exercises. This information can be utilized in several ways. For example, a very important component of strength training is the total amount of work performed in a session. By alternating workouts such that the previous workout trains musculature with little shared components to the musculature trained in the current workout, more overall work can be performed. For example, training biceps in the morning and back at night would lower the work capacity of the back workout. Therefore periodization, in both acute and chronic training attempts to

properly sequence such that one period of training does not negatively effect a subsequent training period.

Successive potentiation theory seeks to acutely and chronically program exercise sequences, in a manner which utilizes transfer from one method to another. This takes periodization to a new level of scientific prowess, as it not only avoids fatigue through sequencing, but actually attempts to enhance successive workouts through properly ordering them. A classic example in chronic training is to train peripheral factors followed by central factors. Bench press strength exemplifies this approach. The skill of bench pressing requires a large learning component. This means that the participant learns to activate as many motor units (the most amount of muscle) as is possible to lift as much weight as possible. However, if the motor units recruited contain small amounts of muscle then only a small amount of weight will be able to be lifted. One method of periodization requires the athlete to begin by entering into a hypertrophy or muscle building phase, which increases the peripheral (muscle cross sectional and contractile ability) factors. It then follows this with strength and power phases in which this new capacity is translated into specific preparedness such as the ability to recruit more motor units.

Summary

Early theories of scheduling suggested that training periods should only last weeks in length. However, in the 1940s – 50s athletes began to realize that year long training had a potent effect on adaptation. This led to the need for greater organization of the training plan. In this context Letunow (1950) suggested that the scheduling of training periods should be weighted heavily on the physiological state, needs and training status of an organism. In this context, Matvejev (1977), considered by many to be the true father of scientific periodization suggested that periodization was not simply a plan, but an objective set of laws that govern the training process. Four adaptation models were presented which attempt to explain these laws. The first was the General Adaptation Theory, which proposes that the organism cycles through three stages of adaptation. The second was the One Factor Theory, which views adaptation as the effect, with depletion of a biochemical substance as the cause. The third model was the Fitness Fatigue Theory, which views readiness as the difference between fitness and fatigue. The fourth model presented was the Sequencing Theory based on specificity of fatigue and successive potentiation.

Jacob Wilson
President Abcbodybuilding / The Journal of HYPERplasia Research

jwilson@abcbodybuilding.com

Gabriel “Venom” Wilson
Executive of Bioenergetic Research
Venom@abcbodybuilding.com

References and Sources Cited

Kraemer (1983) Exercise Prescription in Weight Training: Manipulating Program Variables. *National Strength and Conditioning Association Journal*, 5, 58-61

Kraemer (1983) Exercise Prescription in Weight Training: A Needs Analysis. *National Strength and Conditioning Association Journal*, 5, 64-65

Kraemer (1984, a)Program Design: Manipulating Program Variables: Exercise Prescription: Number of Sets *National Strength and Conditioning Association Journal*, 6, 47-47

Kraemer (1984, b), Program Design: Manipulating Program Variables: Exercise Prescription: Needs Analysis *National Strength and Conditioning Association Journal*, 6, 47-47

Kraemer (1984, c) Program Design: Manipulating Program Variables: Exercise Prescription: Order of Exercise *National Strength and Conditioning Association Journal*, 6, 47-47

Kraemer (1984, d) Program Design: Manipulating Program Variables: Exercise Prescription: Choice of Exercise *National Strength and Conditioning Association Journal*, 6, 47-47

Kraemer (1984, e) Program Design: Manipulating Program Variables: Exercise Prescription: Rest Periods *National Strength and Conditioning Association Journal*, 6, 47-47

Kraemer (1984, f) Program Design: Programming: Variables in Successful program design. *National Strength and Conditioning Association Journal*, 6, 54-55

Kraemer (1988) Exercise Physiology Corner: Factors in exercise prescription of resistance training *National Strength and Conditioning Association Journal*, 10, 36-42

Kraemer (2004 a) The use of Science In Exercise Prescription Degelopment *National Strength and Conditioning Association Journal*, 26, 56-70

Fitts, P. M, & Posner, M. I. (1967). Human performance. Belmont, CA: Brooks/Cole.

Stone, H. (2004) Roundtable Discussion: Periodization of Training Part I. *National Strength and Conditioning Association Journal*, 26, 50-69

Pinkala, L. (1930). Athletics Munick

Mang, P (1928) Running, Jumping, and Throwing Events

Knowlden, A. (2002) Z-Factor, *Journal of HYPERplasia Research*

Knowlden, A. (2003) Z-Factor 2, *Journal of HYPERplasia Research*

Knowlden, A. (2004) Z-Factor 2, *Journal of HYPERplasia Research*

Wilson, Gabriel (2004) An Investigation of the Satiety Mechanism: A Research Initiative. *Journal of HYPERplasia Research*

Pedemonte, J Foundational Basis for Periodization I, *National Strength and Conditioning Association Journal, 8, 26-28*

Butowskik, A.D. (1910) Course on the History and Methodology of Physical Exercise in Moscow.

Kotov (1917) Olympic Sport

Murphy, M. (1913) Training in Athletics Berlin.

Pinkala, L. 1930. Athletics Munick

Letunov (1950) Reflections on the Systematic Formulation of Training: 'Sovietskii Sport',

Matveyev (1977) 'Fundamentals of Sports Training'

Matveyev, L.P. Modern procedures for the construction of macrocycles. *Mod. Athl. Coach.* 30:32–34. 1992.

Matveyev, L.P. About the construction of training. *Mod. Athl. Coach.* 32:12–16. 1994.

Plisk, (2004) Roundtable Discussion: Periodization of Training Part I. *National Strength and Conditioning Association Journal*, 26, 50-69

Plisk, (2004) Roundtable Discussion: Periodization of Training Part I. *National Strength and Conditioning Association Journal*, 26, 50-69

Kraemer (2004 b) Roundtable Discussion: Periodization of Training Part I. *National Strength and Conditioning Association Journal*, 26, 50-69

Zatsiorsky, V.M. Science and Practice of Strength Training. Champaign, IL: Human Kinetics, 1995.

Selye, H., (1936) A Syndrome Produced by Diverse Nocuous Agents, Nature (July).

Selye, H., (1956) The Stress of Life, New York, McGraw Hill.

Selye, H., (1974) Stress Without Distress, New York, Philadelphia, J.D. Lippincott, Co.

Wilson, J., and Wilson, G., Tapering Part I. Journal of Hyperplasia Research. January, 2005. (a)

Wilson, J., and Wilson, G., Tapering Part II. Journal of Hyperplasia Research. January, 2005. (b)

Wilson, J., and Wilson, G., Tapering Part II. Journal of Hyperplasia Research. January, 2005. (c)

Banister, E. W., Calvert, T. W., Savage, M. V. (1975) A systems model of training for athletic performance. J. Sports. Med. 7, p.57-61.

© ABC Bodybuilding Company. All rights reserved. Disclaimer