Periodization Research and an Example Application

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History and Research

DESPITE PERIODIZATION (THE CYCLING OF SPECIFICITY, INTENSITY, AND VOLUME OF TRAINING TO ACHIEVE PEAK LEVELS OF PERFORMANCE FOR THE MOST IMPORTANT COMPETITIONS) BECOMING A COMMON WORD IN STRENGTH TRAINING AMONG STRENGTH AND SPORT COACHES, ATHLETES, FITNESS PROFESSIONALS, AND SPORTS RESEARCHERS, SCIENTIFIC RESEARCH CONCERNING PERIODIZED STRENGTH TRAINING IS SPARSE IN THE WESTERN WORLD. THE PRIMARY SUPPORT FOR PERIODIZED STRENGTH TRAINING SYSTEMS IS BASED ON OBSERVATIONAL EVIDENCE, ANECDOTAL INFORMATION, DEDUCTION FROM RELATED STUDIES (SUCH AS OVERTRAINING RESEARCH), AND A FEW MESOCYCLE-LENGTH PERIODIZATION VARIATION STUDIES (28). SIFF (24) PROVIDES A COMPREHENSIVE REVIEW OF THE HISTORY AND RESEARCH RELATIVE TO PERIODIZATION. THAT INFORMATION IS RELIED UPON HEAVILY IN THIS SECTION.

The importance of proper organization for enhanced performance can be traced to ancient cultures such as Rome, Greece, and China because their ability to survive depended largely on the military capabilities of their armies. In a formalized sport setting, the Greeks of more than 2,000 years ago prepared for the Olympic Games by allocating a preliminary training period of at least 10 months a year (24).

The foundations of modern periodization were developed in the Soviet Union around the time of the Russian revolution. Kotov (1917), who divided training into general, preparatory, and specific stages, wrote one of the earliest textbooks on periodization. The general stage was aimed at development of the cardiovascular—respiratory and muscular systems, whereas preparatory training of about 2 months duration was dedicated to enhancement of muscle endurance and strength. In the specific stage, the athlete was prepared for a given sporting event in 2 parts: initial and primary training (24). But this was still not a definitive methodology of periodization.

Two books that established the methodology of periodization were Scientific Foundations of Training by Gorinevsky (1922) and The Basics of Training by Birsin (1925). Some of the early applications of periodization were implemented in sports such as track and field by Vsorox (Basic Principles of Training Athletes, Moscow, 1938), in skiing by Bergman (Training Programs and Periods of Training in Skiing, Moscow, 1938), and in water sports by Shuvalou (Swimming, Waterpolo, Diving, Moscow, 1940) (24). In Finland, Pikhala published the document Athletism (1930) that centered on a series of basic principles, especially the prevention of overtraining using an undulated rhythm of training by alternating periods of training and conditioning with rest. Similar to other sports scientists of this period, Pikhala’s plan was based on the traditional importance of the climatic seasons rather than on the advantageous predetermined phases of loading (24). Grantlyn (1939) authored an article entitled “Contents and General Foundations of Training Preparation” that was based on the practical experience of athletes and general research findings. In the article, he divided the annual training cycle into 3 distinct phases: preparatory, main, and transitional. The transitional period comprised 2 stages, namely gradual detraining to test and active rest using methods of general physical preparation of reduced intensity (24).

In England, Dyson (1946) became one of the first western sports...
scientists to popularize periodized training using both western and eastern training methodology in his work entitled “A New System of Training.” The publication represented a 5-phase system of periodization for athletics (noncompetitive preparation period—5 months, precompetitive period—1 month, initial competitive period—6 weeks) (24). Ozolin (1949) stressed the importance of considering the competitive calendar and climatic factors in periodization in his important text “Training the Athlete.” Critically, he emphasized the importance of active rest as an essential component of the transition phase to maintain and improve performance preparation. Letonov (1950) published “Reflection on the Systematic Formulation of Training In Sovietsky Sport,” which discouraged the formulation of training protocols on the basis of the competition calendar alone. He felt that the stages of training were a consequence of physiological processes. The only flaw to his thinking may have been his failure to recognize that the training loads affected these processes in turn (24). Hettinger and Mueller (1955) established that lowest trainability occurred during the winter months and highest trainability took place in summer and autumn, with a dramatic decrease in trainability on the onset of winter (24).

Regarding strength training, Hettinger (1961) devised 4 features of training, which provoke supercompensation (adaptation of muscle tissue through various biochemical, structural, and mechanical adjustments that result in increased performance) (24, 32). The 4 features were (a) production of adequate muscle tension is central to all muscle training, (b) 1 single maximal strength effort per day is sufficient to maintain progress, (c) maximum training effect does not require prolonging muscle tension to the point of fatigue, and (d) the maximum training effects are derived by muscle tension of no less than 40–50% of one’s single repetition maximum (RM) (24). Matveyev summarized the modern concept of periodization on the basis of these earlier ideas as well as his own preliminary work (19). Matveyev divided the training year into distinct phases, each with different characteristics and special application to training strength and power athletes (17, 23, 24). Despite some modifications made by sports scientist on the basis of the physiological characteristics of different sports, the length of the sports season, and the individual characteristics of various athletes, the fundamental concepts presented by Matveyev remain valid and widely used today (6, 11, 27).

The alteration of high-, medium-, and low-intensity sessions and phases of training alone facilitates recovery and adaptation to intense training more effectively that the use of monotonic increase in loading from phase to phase. The high-intensity training sessions would strongly activate the relevant muscles, whereas the low-intensity training sessions will enhance restoration (8, 9). Additional research has demonstrated the importance of periodizing variation in training, particularly regarding lower intensity days. Several studies have attempted to analyze models of periodized strength-training programs (1, 13, 14, 16–18, 20, 21, 23, 30, 31, 33). These studies were performed at a time period (7–24 weeks) consistent with mesocycle length. Ten (14, 16–18, 20, 21, 23, 30, 31, 33) of these studies found that periodized strength-training models provided a statistically significant improvement in one or more of a variety of performance standards relating to power, strength, or endurance when compared with linear strength-training models.

**Support, Goals, and Phases**

The appropriate manipulation and sequencing of volume (the total amount of weight lifted per exercise, training session, microcycle, mesocycle, macrocycle) and intensity (level of muscular activity that can be quantified in terms of power) guide the final outcome of a training program (12, 27, 28, 32). Higher volumes of work should produce greater gains in strength and power measures (12). It is possible to observe strength and power improvements without marked changes in body mass or body composition in moderately trained subjects (17, 30). Training at relatively higher intensity levels is related to more complete neural activation, which is a potential argument for the necessity for higher intensity levels (10). Different physiological stimuli (hypertrophic versus neural factors) likely interacted in different ways to produce the gains in maximum strength observed between linear versus periodized strength-training studies (1, 13, 14, 17). Prolonged training periods (months) with relative higher intensities and little variation (linear training) can result in neural fatigue, which is indicative of overtraining (10).

The highest power outputs may be realized at 40–80% of 1RM (largest amount of weight that can be lifted for 1 complete repetition of a particular exercise) or 60–100% of RM (largest amount of weight than be lifted for a specific number of complete repetitions) (34). Training specific movements with a higher exercise intensity (i.e., high power) can produce greater effects on power- and speed-related performance than can linear strength
training. Periodization is strongly related to transfer of training effect and performance outcomes (28). To alter beneficially a variety of performance variables, particularly those concerned with power and speed, a mesocycle should progress from an emphasis on gaining strength to an emphasis on speed and power movements (28).

The primary goals of periodization are the reduction of overtraining potential and peaking at the appropriate time or providing a maintenance program for sports with a specific season (28). Goals are met by appropriately manipulating volume and intensity factors and by appropriately selecting exercises. Periodized programs are typically divided into 3 distinct stages or phases (28, 32). The macrocycle is the largest division, which typically constitutes an entire training year but may also be a period of many months up to 4 years (Olympic athletes). Macrocycles typically comprise two or more mesocycles divided into several weeks to a few months. The number of mesocycles is dependent on the goals of the athlete and, if applicable, the number of sport competitions, contained within the period. Each mesocycle is divided into 1 week to 4 weeklong microcycles, which focuses on daily and weekly training variations (32).

Each of these phases has different goals and requires different degrees of variation. The initial or preparatory period occurs during the time of the year when there are no competitions and only a limited number of sport-specific skill practices of game strategy sessions. The prime focus of this phase is to establish a base level of conditioning to increase the athlete’s tolerance for more intense training. Conditioning activities begin at relatively low intensity and high volumes (hypertrophy phase) and progress to moderate/high intensity with moderate/high volumes (strength phase) to high intensity and low volume (power phase) (28, 32).

The primary goal of the competition period is to enable the athlete to reach peak strength and power through further increases in training intensity accompanied by decreases in training volume (32). Additionally, skill technique and game strategy emphasis increases significantly as time spent on physical conditioning decreases proportionately. The competition period may vary from a few weeks to several months. Prolonged competition periods require some manipulation of the intensity on a weekly or microcycle basis. For sports with multiple major contents spread across multiple weeks or months, the goal is to preserve strength, power, and performance levels by following a maintenance program of moderate volumes and intensities (2–5).

The major goal of the peaking phase is to ensure that the athlete is at peak strength and power (32). The phase is characterized by very high-intensity and very low-volume training activities. Typically, this period can only last for 3 weeks because prolongation of this phase can potentially lead to overtraining and decreased performance (3–5, 22).

The transition or active rest period serves to provide a break between high-volume training and high-intensity training between the preparatory and competitive period (3–5). Furthermore, this period also focuses on nonsport-specific recreational activities performed at low intensities with low volumes (32). After a prolonged competitive phase, it is important for an athlete’s long-term progress to allow time to rehabilitate any injuries and to rest, physically and mentally (3–5). Additionally, a 1-week unloading period may be used to prepare the body for the increased demand of the next phase or period.

### Periodization Application

In the design and application of a periodized strength-training program, the conduction of a needs analysis (analysis of the performance and fitness needs of both the activity and the individual athlete involved in the sport) is essential (2, 7, 15, 27, 35). To conduct a needs analysis, the following components should be examined: (a) physiological and biomechanical requirements of sport, (b) injury profiles of sport, (c) each athlete’s strength and weaknesses, and (d) available facilities, equipment, and budgeted resources. The phases typically used during the preparatory, competition, and peaking period are hypertrophy, strength, and power (2, 7, 15, 19, 22, 24, 27, 32, 35).

The hypertrophy phase is a training period where the primary goal is to increase muscle development or a strength-endurance base in the case of strength-power athletes. The goal is to develop an endurance (muscle and metabolic) base for more intense training using strength and conditioning activities that may be specific or nonspecific to the sport. Flexibility training involves dynamic, static, proprioceptive neuromuscular facilitated (PNF) stretching. Resistance training includes sport-specific or nonsport-specific exercises at high volume and low intensity. Metabolic training includes a balance of aerobic or anaerobic (strength-power athlete) interval activities. Speed training focuses on high-volume, low-intensity technique training.

The strength phase is a training phase where the major goal is to increase maximal muscle force (2, 7, 15, 19, 22, 24, 27, 32, 35).
During this phase, running programs progress to interval sprints of moderate distance, plyometric activities become more intense, jumping activities may be introduced, and strength training becomes more specific to the sport. Flexibility training involves dynamic, static, and PNF stretching. Resistance training includes specific exercises of moderate volume and intensity. Metabolic training focuses on anaerobic interval training. Speed training uses moderate volume technique training, including towing and downhill running.

The power phase is a training period where the major goal is to increase the speed of force development of the muscles or increase muscle power (2, 7, 15, 19, 22, 24, 27, 32, 35). Strength training progresses to increased intensity; speed work intensifies to near contest pace. Full recovery is recommended between bouts of exercises and speed-training drills, which may include sled-towing sprints against resistance and the incorporation of uphill and downhill sprints. Flexibility training involves dynamic, static, and PNF stretching. Resistance training includes sport-specific exercises of low volume and high intensity. Metabolic training uses short work intervals with full or near full recovery between intervals. Speed training focuses on high-intensity, low-volume activities.

The competition phase is a position of the training year that begins with the first competition phase and ends with the last competition. The competition phase may last anywhere from a few weeks to a few months. The athlete should reach peak condition during this phase characterized by very high intensity and very low volume in training activities (2, 7, 15, 19, 22, 24, 27, 32, 35). Flexibility training involves dynamic, static, and PNF stretching. Resistance training includes low-volume, high-intensity, sport-specific exercises. Metabolic training uses sport-specific intervals with full or near full recovery between intervals.

The peaking phase is based on the premise that a better-conditioned athlete will hold a peak longer (2, 7, 15, 19, 22, 24, 27, 32, 35). Four general considerations should be analyzed for this phase: (a) number of competitions necessary to reach peak performance, (b) strategy to maintain top athletic form, (c) program design to ensure that the best performance will occur at the right time, and (d) teaching the athlete how to handle the psychological stress of competition. Flexibility training involves dynamic, static, and PNF stretching. Resistance training incorporates very high-intensity, very low-volume, sport-specific exercises. Metabolic training uses sport-specific intervals, with full or near full recovery between intervals is used for metabolic and speed training.

The transition phase is a short (1 week) phase of light training where the goal is to recover physically and mentally from previous training (2, 7, 15, 19, 22, 24, 27, 32, 35). Activities are done at a low volume and low intensity. No psychological stress from training or competition should be present. Recreation games and light, unsupervised training are emphasized during this phase.

Practical Application

The practical application section represents a model used by the author in the development of an annual macrocycle. This model may be modified depending on a needs analysis of the performance requirements of either the sport or the athlete. As an example, the strength or power phases may be increased to more traditional 4-week time periods, whereas the hypertrophy phase may be either decreased in length or eliminated. Additionally, with sports that place a tremendous emphasis on strength and power, such as football, in which hypertrophy is not necessarily a goal of the competitive phase, the model that uses the strength and power phases exclusively during this period may serve the performance needs of the athlete better.

An annual, sports conditioning, strength training periodized training cycle comprised 5 preparatory mesocycles and a competition mesocycle, with the last 3 weeks being a peaking phase (Tables 1–3). The first mesocycle is a 15-week period that includes 2 weeks of a transitional phase, 4 weeks each of hypertrophy, strength, and power phases and concludes with 1 week of active rest (Table 1). The goal of this first mesocycle is to establish the athlete’s RM during 4-week periods of hypertrophy, strength, and power. Athletes should attempt 1 extra repetition on the last set of each exercise. Each time an athlete completes 1 extra repetition on the last set, the athlete will increase the training load in the next workout by 5% or the smallest movement (whichever is larger). During the course of a 4-week period for the hypertrophy, strength, and power phases, the RM should be established for each exercise in each phase.

The second mesocycle through the fifth mesocycle represent 26 weeks of preparatory training that includes 4, 6-week mesocycles, with 1 week of active rest after every 12 weeks (Table 2). The goal is to continue to re-establish the athlete’s RM for each exercise in each phase. Upon completion of
the second–fifth mesocycles the athlete will have re-established his or her new RM for each exercise in each phase. For sports that have a competition mesocycle greater than 11 weeks, the fifth mesocycle may be modified to be a part of the competition mesocycle.

The competition mesocycle represents a minimum of 11 weeks of competition-phase training (Table 3). The goal of this phase is to use the athlete’s maximum weight established in the second–fifth mesocycles. Athletes will cycle between hypertrophy, strength, and power workouts. The last 3 weeks of the competition mesocycle should be reserved for peaking phase, where further reductions in training volume may be made while increasing training intensity to ensure the highest level of performance for the most critical competitions. Competition (C) in Table 3 represents the practical application of a periodized strength-training model used for football during the competition mesocycle.

### Summary

Periodized strength-training programs are nonlinear protocols with variables that include intensity, sets, repetitions, and exercise speed that can be manipulated such that specific training goals are emphasized during different segments of a microcycle, mesocycle, or macrocycle (7, 12, 24, 27). In addition to adjustments throughout mesocycles, there is also variation between training sessions, which is important for elite strength-training participants.

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Table 1
**First Mesocycle—Off-season (15 Weeks)**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Length of microcycle</th>
<th>Workouts per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transitional</td>
<td>2 weeks</td>
<td>3</td>
</tr>
<tr>
<td>Hypertrophy</td>
<td>4 weeks</td>
<td>3</td>
</tr>
<tr>
<td>Strength</td>
<td>4 weeks</td>
<td>3</td>
</tr>
<tr>
<td>Power</td>
<td>4 weeks</td>
<td>3</td>
</tr>
<tr>
<td>Active rest</td>
<td>1 week</td>
<td>3</td>
</tr>
</tbody>
</table>

1. **RM**—the goal of the first mesocycle is to determine the athlete’s maximum weight that can be used for a specified number of repetitions performed.
2. Each athlete should attempt one extra repetition on the last set of each exercise.
3. If the athlete is capable of completing one extra repetition on the last set:
   a. The athlete will increase the training resistances the next workout by 5% or the smallest increment (whichever is larger).
4. If the athlete is not capable of completing one extra repetition on the last set:
   a. The athlete will keep the training resistances the same the next workout.

Table 2
**Second Mesocycle—Fifth Mesocycle (26 Weeks)**

1. **RM**—the goal of the second–fifth mesocycle is to re-establish the athlete’s maximum weight that can be used for a specified number of repetitions performed.
2. Each athlete should attempt one extra repetition on the last set of each exercise on the heavy training workout (100% or higher).
3. If the athlete is capable of completing one extra repetition on the last set:
   a. The athlete should mark a + next to the training resistances to signify that the extra repetition was completed.
4. If the athlete is not capable of completing one extra rep on the last set:
   a. The athlete should mark a * next to the training resistances to signify that the extra repetition was not completed.
5. Upon completing the second–fifth mesocycle workouts in each phase, the athlete will now have his or her new RM (heaviest weight that all repetitions could be completed without an extra repetition) established.
## Table 2 cont.
Table 2 cont.

### Second Mesocycle—Fifth Mesocycle (26 Weeks)

<table>
<thead>
<tr>
<th>Phase</th>
<th>Week #</th>
<th>First workout</th>
<th>Second workout</th>
<th>Third workout</th>
</tr>
</thead>
<tbody>
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<td><strong>Second mesocycle—off-season (6 weeks)</strong></td>
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<td>Hypertrophy</td>
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<td>Day 1—Lt, 80% RM</td>
<td>Day 2—Hvy, 100% RM</td>
<td>Day 1—Med, 90% RM</td>
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<tr>
<td>Hypertrophy</td>
<td>2</td>
<td>Day 2—Med, 90% RM</td>
<td>Day 1—Hvy, 100% RM</td>
<td>Day 2—Lt, 80% RM</td>
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<tr>
<td>Strength</td>
<td>3</td>
<td>Day 1—Lt, 80% RM</td>
<td>Day 2—Hvy, 100% RM</td>
<td>Day 1—Med, 90% RM</td>
</tr>
<tr>
<td>Strength</td>
<td>4</td>
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<td>Day 1—Hvy, 100% RM</td>
<td>Day 2—Lt, 80% RM</td>
</tr>
<tr>
<td>Power</td>
<td>5</td>
<td>Day 1—Lt, 80% RM</td>
<td>Day 2—Hvy, 100% RM</td>
<td>Day 1—Med, 90% RM</td>
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<tr>
<td>Power</td>
<td>6</td>
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<td>Day 1—Hvy, 100% RM</td>
<td>Day 2—Lt, 80% RM</td>
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<td>Hypertrophy</td>
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<td>Day 2—Hvy, 102.5% RM</td>
<td>Day 1—Med, 92.5% RM</td>
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<td>Day 2—Hvy, 102.5% RM</td>
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<td>Day 1—Hvy, 102.5% RM</td>
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<td>Testing</td>
<td>Testing</td>
<td>Rest</td>
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<td>Day 1—Med, 95% RM</td>
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</table>

Note: Lt = light training resistance workout; Med = medium training resistance workout; Hvy = heavy training resistance workout; Testing = Tests measuring sport specific parameters (power, speed, agility).
1. The goal of the competition phase is to use the athlete’s maximum weight established in the second–fifth mesocycle.
2. Athletes will cycle between hypertrophy, strength, and power workouts weekly.
3. Competition A and B: weeks #1–#6 will focus on using 80% RM—light workouts, 90% RM—medium workouts, and 100% RM—heavy workouts.
4. Competition A: weeks #7–#11 will focus on using 82.5% RM—light workouts, 92.5% RM—medium workouts, and 102.5% RM—heavy workouts.
5. Competition B: weeks #7–#11 will focus on using 85% RM—light workouts, 95% RM—medium workouts, and 105% RM—heavy workouts.
6. Competition C: weeks #1–#4 will focus on using 80% RM—light workouts, 90% RM—medium workouts, and 100% RM—heavy workouts.
7. Competition C: weeks #5–#8 will focus on using 85% RM—light workouts, 95% RM—medium workouts, and 105% RM—heavy workouts.
8. Competition C: weeks #9–#12 will focus on using 90% RM—light workouts, 100% RM—medium workouts, and 110% RM—heavy workouts.

<table>
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<th>Second workout</th>
<th>Third workout</th>
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Note: Lt = light training resistance workout; Med = medium training resistance workout; Hvy = heavy training resistance workout; Testing = Tests measuring sport specific parameters (power, speed, agility).
Part of the necessity for constant training variation could be related to the prevention of overtraining (25, 26). Research (12, 16–18, 21, 23, 25, 30) has demonstrated that a periodized approach to training, even during a short-term (7–12 weeks) produces superior results, especially in previously trained subjects, compared with constant repetition programs (28, 29). Furthermore, this effect can occur even when the volume and intensity are equal across the training period (28, 29).

A well-designed periodized strength-training program will allow superior performance at the appropriate time, reduction in overtraining potential, systematic control over training variables, and excellent performance adaptation (27). A well-designed periodized training plan is not only concerned with immediate competition but also prepares the athlete for subsequent seasons (years). Therefore, periodization can and should be viewed as a method of long-term planning (years). Therefore, periodization can and should be viewed as a method of long-term planning (29). Although understanding, designing, and implementing periodized strength-training programs require time and effort, the results in athletic performance can be the difference between winning and losing. ▲

**References**


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**John Graham** is the Director of the Allentown Sports Medicine and Human Performance Center in Allentown, Pennsylvania. He serves as Vice President, NSCA Board of Directors.