• Ground Based Actions
• Multiple Joint Movements
• Three Dimensional Movements
• Train Explosively
• Progressive Overload
• Application of Periodization

• Split Routine
• Hard / Easy System
• Specificity of Training
• Interval Training
Medical History

It is important to determine the medical history of the student prior to engaging in the training program. The strength and conditioning coach must require athletes to undergo health care provider screening and clearance prior to participation.

Specific pre-participation screening and clearance is defined in the National Strength and Conditioning Association’s Professionals Standards and Guidelines.

As a result of the pre-participation screening and clearance, an athlete may be determined to have physical limitations. If so, the sport coach, doctor, athletic trainer, parent, athlete and strength and conditioning coach should all be aware of the condition and the necessary course of action should be taken.
As high school strength coaches, or the person in charge of the lifting program, you may answer to a variety of bosses. Many times the sport coach or administrator may ask the strength coach to implement something that doesn’t seem to make sense. It may be something they read about in the newspaper, saw on television, or possibly a new fad being introduced somewhere nearby.

A program based on scientific research will eliminate the need to try all the new gimmicks that come along. A program based on proven facts and not an over zealous marketing or advertising campaign will have better long term results and the strength coach will be able to justify the program to parents, athletes and administrators.

No one should ask a strength coach to implement something the he or she does not believe in.

There are only so many exercises that can be included in a program. Each exercise that is added has to be better than an existing one. The same is true for the equipment used. It’s fine for equipment in your facility to come from different companies but if the piece of equipment does not contribute to the improvement of performance it should be replaced with something that does.

The list of lifting exercises and the drills that you have chosen should be the best for improving performance.
The principles outlined, when applied correctly, will maximize physical development for athletes in power sports. Developed by Boyd Epley and Mike Arthur of the University of Nebraska’s Husker Power program, the principles are based on scientific research that has proven to be the most effective way to train athletes for power sports.

Good technique and increased strength will increase lean body mass. Lean body mass improves the performance indicators which then improves sport performance. This program is the most effective way to improve lean body mass and the four performance indicators.

Some coaches will want to skip ahead to look at the recommended program but the smart ones will study these principles. They may not agree with them, but that doesn’t change the facts. If a coach is doing drills or lifts that do not meet the criteria in these principles they should ask themselves to justify what they are doing. They may be putting their athletes at risk.
Sport skills are almost always initiated by applying force with the feet against the ground. Newton’s third law states, “For every action there is an equal and opposite reaction.” This means when an athlete exerts a force against the ground it causes an equal and opposite reaction in the direction of movement propelling the athlete along the ground.

Athletes should have their feet on the ground during the execution of the major lifts. Coaches should select lifting exercises that apply force with the feet against the ground, such as the squat, hang clean, or push jerk. The more force athletes can apply against the ground, the faster they will run, and the more effective they will be in sport skills.
The body’s ability to stabilize joint actions contributes to proper neuromuscular coordination of the multiple joint actions needed for most sport activities. The initial action of throwing the football originates from the muscular contractions of the hips and legs exerting a force from the ground in a backward direction. The earth, being more stable because of its large mass, does not move, and the reaction to this force is exerted through the athlete in a forward direction.

As the athlete extends his legs against the ground his ankle, knee, and hip joints stabilize as the reaction force transfers to the torso. The torso rotates and then stabilizes as the muscular force is relayed to the chest and shoulders, and then to the arms and wrist, which displays the greatest motion.
Coaches and athletes need to include the squat as a major exercise in their sports conditioning programs. Equipment companies continue to come out with new leg press machines with new features such as heavier weight stacks or independent weight stacks.

Still they are machines you have to sit on. Consider them machines for fitness or at best for injured athletes. There is no leg machine that substitutes for the squat for athletes to improve performance.

Unfortunately if athletes are left to their own they will choose exercises that will improve their appearance rather than ones that will improve their performance.
Neutral Squat

To develop the quadriceps, thigh adductors, gluteus maximus, and hamstrings. When done correctly, full squats strengthen the muscles, ligaments, and tendons surrounding the knee. The core muscles are developed to a large degree by keeping the torso erect. The squat is the best exercise to develop lean body mass.
As You Prepare to Squat

**Neutral Pelvic Girdle**
- **Correct Position**

**Lordatic Pelvic Girdle**
- **Incorrect Position**
Body Position When Doing Push-ups and Planks

Neutral Pelvic Girdle
Normal Curvature of the Spine
Correct Position

Lordotic Pelvic Girdle
Excessive Curvature of the Spine
Incorrect Position
Strength and conditioning programs should be based on exercises and drills involving multiple joint actions to improve athletic performance. Two conditions must be met to be effective;

1. First, each joint must be firmly stabilized before movement occurs.

2. Second, the multiple joint actions must be timed in the proper neuromuscular recruitment patterns.

Training multiple joints will help develop coordination or the ability to generate explosive force and will generate more force than any single joint can.

Isolating on single joint actions might work for body builders to improve their appearance and it might work for rehabilitation for an injury, but athletes need to concentrate on activities involving multiple joint actions to have a transfer of training in performance improvement.

Single-jointed exercise such as bicep curls, leg curls, or leg extensions contribute little to improvement of performance, but are included in the program to build muscle mass and muscle balance. The recommended program in this book is balanced to include at least one exercise for each major muscle group in the body.
Sport skills require multiple joint actions timed in the proper neuromuscular recruitment patterns. Otherwise you have no coordination or the ability to generate explosive force.

Some people have natural coordination and will learn multiple joint exercises, drills, or sport skills easily while others will require coaching and disciplined effort to learn the correct technique.

Tiger Woods and Michael Jordan are examples of athletes that have exceptional natural coordination.

Use of a video camera to record lifting technique on the squat and hang clean might be the best instructor. Ask a certified strength coach to watch your form and try to develop the best technique you can on these two major exercises.
**Triple Extension**

This figure shows the acceleration phase of sprinting with the body positioned in a straight line with the ankle extended (figure 1). When executed correctly, the body is also positioned in a straight line at the ankle position performing a hang clean (figure 2). During the extension, the body is positioned in a straight line at the ankles, knees, and hips. The summation of force generated by the triple extension is greater than any other force possible by the body.

Acceleration of a joint action is a key factor in the proper execution of sport movements. Most athletic movements involve the triple extension where the force is generated in a .2 or .3 seconds. Force is also generated on the hang clean in .2 or .3 seconds. The greater the force applied the greater the acceleration.
The body’s ability to exert force depends on its position. The hang clean puts an athlete in the best leverage position to develop force while the power clean from the ground can create problems for beginners.

Some coaches have taught the power clean for years without any problems and will defend it strongly but most will benefit by teaching the hang clean to beginners instead.

Some beginners have trouble getting into proper leverage position when performing the power clean as they bring the bar from the ground to just above the knees.

Teaching the hang clean should allow beginners to learn how to execute the triple extension and generate maximum force. The power clean can be done in the lifting program but only if proper form is accomplished.

The Hang Clean will be used as an official test in the NSCA Index Championships.

An athlete in the “hit” position. From this athletic “hit” position movement is possible in any direction whether you’re cutting to the left, hitting a golf ball, or spiking a volleyball.
One of the great advantages of the hang clean and power clean over most other exercises is their explosive nature. Most exercises require deceleration at the end of the movement but these explosive lifts allow acceleration through the motion.

For example, the squat is great for building strength but you have to slow down at the end of the lift. You could jump off the ground to accelerate but the weight would have to be extremely light to be able to perform the lift safely because you have to land with the weight. Gains would be minimal and it is not a safe way to train.

Generally speaking, the squat is for building strength and the hang clean for developing power. If velocity does not increase during the movement, acceleration is not possible.

The recommended off-season program calls for two days per week focused on exercises building strength and two days per week focused on exercises developing explosive power. Only explosive lifts have transfer of training to sport movements.
Sport skills involve movements in the three planes of space simultaneously:

1. Forward – Backward
2. Up – Down
3. Side – to – Side

Using free weights as much as possible in the selection of lifting exercises will help gain strength in all three planes.

Strength programs should improve functional strength with exercises approximating these skills. Only free weights allow movement in three dimensions simultaneously. This makes the transfer of strength and power easier to merge with the development of sport skills.

The first casted selectorized weight stack and multi-station machine was made in Germany in 1829. So machines have been around for a long time but limit the development of sport skills.

For example, when you use free weights, the muscles regulate and coordinate the movement pattern of the resistance, while machines use lever arms, guide rods, and pulleys to dictate the path of the movement. Therefore machines limit the development of muscle synergism.
Synergism

Synergism occurs when several muscles act together to produce a coordinated joint action. Only exercises using free weights allow synergism. The balancing action of synergistic muscles develops joint integrity better than machines.

For example, exercises using seats for support restrict the body from stabilizing properly; when doing leg presses the adjustable board substitutes as the stabilizer and the back and stomach muscles are not required to stabilize the torso isometrically as they would during the squat.

When the torso is stabilized correctly, the body allows the legs and hips to work as a unit with the back and stomach muscles to perform the squat. The carry over value is on the field or court when stability is needed to perform the sport skill.
Train Explosively

The amount of force required for a given activity is generally regulated by the use of two different types of motor units found in the body;

1. Fast twitch muscle fibers
2. Slow twitch muscle fibers

Keeping it in general terms, these muscle fibers vary greatly in their ability to generate force.

Power sport athletes are interested in developing fast twitch fibers while cross country or distance runners rely mostly on slow twitch fibers. There aren’t many long distance runners with bulging muscles. Their slow twitch muscles rely on the oxygen system for muscular endurance and not much strength or power is developed. Athletes that lift weights explosively will develop their fast twitch fibers which means they can generate a force up to four times greater than a slow twitch fiber, but not much endurance is developed.
The number of fibers a fast twitch fiber innervates is greater than with a slow twitch fiber, and the contractile mechanism of fast twitch muscle fiber is much larger.

In most cases, power sport athletes are born with a higher ratio of fast twitch fibers, which allows them the natural potential to be powerful if they train correctly. There is a difference between being strong and being powerful. Athletes need to train for both.

Training explosively with free weights allows more fast twitch muscle fibers to be recruited and in return improves an athlete’s performance potential. Athletes must concentrate to recruit the maximum force.

There can be no horseplay in the weight room and no horseplay during competition. Athletes must learn to focus to recruit maximum force on each lift, drill, or play.
A motor unit is made up of a motor nerve and the group of muscle fibers that it attaches to. When a motor unit is stimulated, it will either contract fully or not at all.

All contractions are of the same intensity because a muscle cannot contract harder at one time than another. In a relaxed muscle very few motor units are active.

Just enough are stimulated at any one time to keep the body from collapsing. This is known as muscle tone.

To lift a weight it is necessary for the brain to call on more motor units to become active so the muscle can contract. The number of motor units that are activated is related to the amount of weight to be lifted, or the amount of weight you think you will be lifting. The greater amount of weight lifted, the greater the number of motor units activated to perform the lift.
If the force requirement is high and the athlete knows it, then a lot more motor units will be called upon to do the job. Through training, the body learns to recruit more and more motor units so that more force can be generated and more poundage used. Sometimes the body is fooled into thinking the force will be high and it is not.

For example, if you tell someone to pick up a heavy suitcase that you have emptied beforehand, you’ll have a demonstration of motor unit recruitment as they generate too much force to lift the empty suitcase they think is going to be heavy.

During training your brain determines how many motor units will be required to complete a task. A little variety in the training program keeps the body guessing and helps prevent a situation where the brain only sends a few units to do the work that used to require several.

In a situation like circuit training where an athlete might use the same weight on each station over and over for several months the body will learn to recruit less motor units to do the work and development will be limited.
Progressive Overload

Progression is defined as the act of moving forward toward a specific goal. The load or amount of weight lifted for each exercise is the most fundamental component of a strength training program. It entails continued improvement until the target goal has been achieved. The application of the load has a crucial impact on maximizing performance and keeping injuries to a minimum.

Overload happens when the body responds to training loads greater than normal. The overload causes the muscle tissue of the body to go into a catabolic state or to break down. The body then adapts, through good nutrition and rest, by developing more strength or endurance to handle the overload.
Some coaches have added chains or bands to their lifts in an attempt to provide an overload during the lift. Actually this is the opposite of what an athlete needs. To be explosive we must train with acceleration through the movement. Adding a chain or band actually slows down the movement and the movement gets harder as the bar is moved through the range of motion. That kind of training will not provide for the explosive overload needed in power sports.

Muscular strength is developed only when you use the overload principle. By using the overload principle, you work your muscle beyond what is normal. The muscle responds by adapting to the work imposed.

The individual who is just a novice to strength training will find making strength improvements a spontaneous process. Eventually the individual reaches a point where progress becomes stalled and improvements seem almost impossible. This is when a systematic approach that involves progressive increases is necessary to continue to produce good results.
Projected Max

When the coach wants to know the strength level of an athlete, have the athlete pick a weight they think they do for a set of 4 or 5 repetitions. They may only get 3 to 4 reps or they may even get 7 or 8 reps. If they get 10, they are to be stopped. Technique seems to fall off rapidly on most lifts after 10 reps and more than 10 would be measuring muscular endurance not strength.

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NSCA Poundage Chart

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Some schools keep a lower end computer in the weight room at all times for the athletes to determine their one repetition maximum (1RM). This method of 1RM is actually called a projected max. The athlete is not actually lifting the exact weight that is recorded as their 1RM but is lifting a poundage for a few repetitions that would equal the 1RM. School records can be based on a projected max. This feature is available free on the www.nsca-lift.org website.

Some high schools have this site open during their max lift day to determine the projected max for their athletes. The problem with trying to determine strength levels or school records by just doing one repetition maximum is timing. The athlete may be strong enough to lift a certain poundage but their timing may be off a bit and will barely miss their goal weight. Then it becomes difficult to assess how much they might have lifted.
Intensity

Intensity and volume are the key factors used to progressively increase the overload. The use of heavier loads increases the intensity. Adding more repetitions increases the volume. Each method causes specific adaptations.

Increasing the weight and keeping the repetitions low develops strength and power. Increasing the number of repetitions and keeping the weight lighter causes improvement in endurance and muscular size. Strength coaches adjust the intensity and volume of the program to produce different results.

Intensity expresses the magnitude of maximum muscular effort. A 100% intensity equals the maximum load that a person could lift for one repetition. Whether it is a 1RM or a projected 1RM doesn’t matter when the strength coach uses it to assign poundage’s for the workout.

75% (Intensity) of 300 pounds (1RM) = \(0.75 \times 300 = 225\)

Use the 1RM 225 pounds for the workout.
Volume

In strength training, the most common way to determine volume is by multiplying the number of sets by the number of repetitions to determine the total number of repetitions done. This can be done for a single exercise, the entire workout, a week, a month, or a year.

The volume of the training load plays an important role in the long-term planning of a strength program. Most studies indicate that muscular adaptations correlate with increases in volume.

There is an inverse relationship between volume and intensity. The volume increases as the intensity of the load decreases. Excessive volume can cause drops in strength gains and eventually cause overtraining. One method used to monitor overtraining is the vertical jump. If the vertical jump goes down the volume of training is too great.

Three sets of 10 repetitions is a Volume of 30

\[ \text{Volume} = (3 \times 10) = 30 \]
Amount of Rest

Another factor used for overload adaptation in the recommended off-season programs is controlling the amount of rest between sets. A change in the amount of rest will affect the training adaptation.

Two or three minutes rest between sets is normal in off-season programs using more than 70% intensity to produce muscle mass.

By reducing the rest interval to a minute twenty between sets and using intensities of 50 to 60%, lean muscle mass gains are seen much quicker. However, athletes can not maintain the intensity for more than four weeks.

Using the same combination of sets and repetitions over an extended period causes strength to eventually plateau and diminish. The neuromuscular system grows accustomed to the same stimulus and becomes stale.
Untrained individuals respond favorably to most programs, thus making it difficult to evaluate the effects of different training programs for high school age athletes.

Trained athletes show much slower rates of improvement. A review of Dr. Bill Kraemer’s literature reveals that muscular strength increases approximately 40% in untrained, 20% in moderately-trained, 16% in trained, 10% in advanced, and 2% in elite over a period of up to two years. This data shows a specific trend toward slower rates of progression with training experience.

Coaches need to change the repetitions and sets as the body adjusts to the demands in order to bring about new gains. Strength will eventually plateau and diminish using the same combination of sets and repetitions over an extended period.

Periodization adds variety to the program by using different combinations of intensity, volume, exercises, and drills throughout the training season. This variation helps avoid overtraining and stimulates peak performance.
Hans Seyle’s general adaptation syndrome depicts how the body adapts to training. If there is no variation in the training stimulus, performance gradually levels off and leads to overtraining. An approach to offset this problem is a system of training called periodization. There are three distinct phases of adaptation to a strength training program during the long-term application of the overload principle.

1. Alarm Stage: This occurs during the first couple of weeks when starting a strength program. The muscles are in a mild state of shock and muscle soreness occurs along with a temporary decrease in strength as the muscles are forced to adapt. Poundage’s should be kept low the first week or two to avoid causing the muscles too much adjustment.

2. Resistance Stage: During this state the body begins to adapt to the stress of the strength program by growing stronger. The athlete makes good gains and feels good and performance improves.

3. Exhaustion Stage: Performance eventually plateaus and diminishes when the same strength and conditioning regimen is used over an extended period. If cycling is not done correctly overtraining results and strength will gradually begin to level off and eventually no progress is made. The neuromuscular system simply becomes accustomed to the same stimulus and becomes stale.
Cycling progressively varies the training load preventing strength gains from leveling off. In this program a cycle starts off with a base phase, which progresses to a strength phase and finishes with a peak phase. Phases are different combinations of volume and intensity each translating into different responses by the body.

The base phase represents the greatest area or capacity of volume while the top of the pyramid or peak phase represents the least amount of volume done. More time is needed to develop the foundation or base phase. The height of pyramid represents the magnitude of intensity. The program goes from high volume/low intensity to low volume/high intensity.
The primary objective is building a base of muscular size. Scientific studies show high volume workouts build muscle mass. Building muscle mass increases the potential to build greater strength and power later. This base phase also causes a reduction of body fat.

Bodybuilders have developed very large muscles with high volume workouts with short rest intervals. However, high-volume workouts won’t stimulate muscle growth unless the intensity is adequate. The 3 sets of 10 have an average intensity of 70% with a volume of 30 repetitions in the recommended program.

The muscle size increases through the process of tearing down and rebuilding muscle tissue. The lifting stresses individual muscle fibers and causes a breakdown. The body then adapts and the muscle increases its cross-sectional size to meet the demands of future workouts. As the muscle increases in size the athlete is able to handle greater loads in training. The muscle responds by growing larger again.

There is a positive correlation between the cross-sectional size of a muscle and the amount of force it can apply. The larger the muscle fibers become through strength training, the greater their capacity to apply force. It is important to note that muscle size can only be accomplished by increasing the size, not the number of muscle fibers.

Work large muscle group exercises before small muscle group exercises. Work multiple-joint exercises before single joint and higher intensity exercises before lower intensity exercises.
Development Phase (explosive-3x3 & strength-3x5)

A strength phase calls for moderate volume and high intensity. The rest periods should allow the athlete to completely recover before attempting the next set. The amount or rest between sets and exercises significantly affects the metabolic, hormonal, and cardiovascular responses.

Longitudinal resistance training studies have shown greater strength increases with longer versus shorter rest periods between sets. Two to three minute rests versus a minute twenty rest during this strength phase.

The strength phase works best if it is preceded by doing several weeks of the base phase first. If you have 12 weeks to do a training program, do at least four or five of base phase (3 sets of 10 repetitions) before changing to the strength phase (3 sets of 5 repetitions). The strength phase has an average intensity of 80%.

The athlete will need to increase the amount of weight used on the major lifts since they are only doing five repetitions in place of ten. By using more weight and lifting it fewer repetitions, the athlete will notice significant increases in strength.

If you have more than twelve weeks to work with you might repeat the Base and Strength phase before moving on to the Peak phase. Save the Peak phase until three to four weeks before the season.
Peak Phase (explosive-4/3/2 & strength-10/8/6/4/3/2)

This phase builds on the base and strength phases by developing explosive power. Power is the combination of strength and speed. For this reason, the volume is kept low allowing athletes to lift poundage's with speed. The 3 sets at 4, 3 and 2 have an average intensity of 85% with a total volume of 9 repetitions.

More power is produced when the same amount of work is completed in a shorter period of time, or when a greater amount of work is performed during the same period of time. A program consisting of movements with high power output using relatively light loads has been shown to be more effective for improving vertical jump ability than traditional strength training with heavy resistance.

Heavy resistance training may actually decrease power output unless accompanied by explosive movements. While 85% is used for increasing the force component of power, a lighter 30 – 60% load can be used at an explosive velocity for increasing fast force production.

The lifting program should go from high volume/low intensity to low volume/high intensity. The Hang clean, Jammer, or Push jerk are recommended as these exercises have been shown to require rapid force production. Drop single joint exercises during the Peak phase to prevent overtraining.
Most fitness training programs include three workouts per week, not three successive days, but three alternate ones. For example, a Monday-Wednesday-Friday schedule, or a Tuesday-Thursday-Saturday program. This approach gives the muscles a one day rest on the off days before repeating the program. The muscles are worked three times a week.

The modern sports conditioning programs use a much better program called a split-routine. This is a very efficient and widely used principle in stimulating gains. It simply means splitting the body parts and working them on alternate days.

The split routine used with this program is divided by explosive lifts and strength lifts and by speed/power and agility drills.
For example, do half of the program on Monday and Thursday and the other half on Tuesday and Friday. The split routine allows half of the body to recover and rebuild while the other half is worked.

The benefit of the split-routine is that there is at least two full days of recovery before working a particular lift again. The split-routine also allows the athlete to include speed and agility drills, without over-training.

The program calls for speed and agility drills to be done before the heavy lifting workout. Train four days per week, working each lift twice, and allowing at least two days rest (recovery) in between. Plan to take Wednesday off, in addition to the weekend, because the body will need the time to recover.

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<td><strong>Friday</strong></td>
<td>Strength Lifts</td>
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Most people believe that training as hard as possible every time is the key to greater strength gains but that is not the case. When an athlete has a great work ethic it is easy to think they are working harder each and every workout. That would be a fast ticket to burnout. A great work ethic includes training smart and that means only training hard on scheduled days to train hard. The fact is an athlete can make more progress over longer periods of time if they do not work at maximum loads during each workout.

The Hard-Easy System helps eliminate overtraining and mental burn-out. With it, there is only one hard workout per week per body part. The other days are light workouts. With only one heavy workout load a week per body part, the body will be ready both physically and mentally as the loads become greater.
One mistake coaches make is overloading the athletes with too much too early. It is better to have them focus on technique the first few weeks and gradually increase the load. Following the Split Routine Principle; Monday should be heavy; Tuesday should be light; Wednesday is a rest day; Thursday should be light; Friday should be heavy.

Back off or unload on the workouts by reducing the intensity. The hard days will consist of doing three sets at an average intensity of 75 percent and the easy days consist of three sets of ten with an average intensity of 65 percent. The intensity will be different for each phase of the program. Generally you will drop the intensity 10 percent from the previous week to the unload week.

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The order of exercises refers to the sequence of exercises preformed in a training session. The order of exercises will develop the basic framework for the workout.

Properly ordering exercises can ensure the greatest training effect, maximizing technique, minimizing fatigue and minimizing the potential for injury.

If the program is to select exercises and perform one or more sets before going to the next exercise there are three basic concepts to keep in mind:

- Start with large multi-joint movements and progress to single joint movements.
- Start with high technique movements and move to less technical movements.
- Start with fast movements and go to slow movements.
The primary objective of conditioning is to improve the energy capacity of an athlete to improve his performance. Unfortunately, a large number of coaches believe doing aerobic distance running in their conditioning program prepares athletes in power sports to sustain energy levels through the end of a game.

According to Dr. Michael Stone, building an aerobic base contributes little to the improvement of a football player’s performance. This may seem controversial and hard to believe, but it is based on how the body works and how the body gets energy to perform work.

If we look at how the body gets energy we find that energy is supplied to the muscles through food we eat. This food cannot be used immediately, it must be broken down into adenosine triphosphate or ATP.

ATP is the immediate energy source for all muscle contraction. ATP for muscle contraction is made accessible by the interaction of three energy systems that can be represented by a hydraulic model of three interconnected storage tanks.
The first tank represents the ATP-PC energy system. ATP can only be supplied and regulated to the muscle via the tap from the first tank.

The tap is regulated by nerve stimulation from the central nervous system. High intensity short duration activities such as the 10 yard dash or hang clean are performed using energy supplied from ATP energy system.

The energy from this source can be supplied immediately, and the amount of force generated by muscle contraction is high. But the amount of energy readily available to muscle is limited.

During high intensity exercise ATP is depleted within six seconds. If intense exercise is continued for more than six seconds, the energy needed is supplied from the second tank or the lactic acid energy system.
Lactic Acid System

The release of energy supplied to the contractile mechanism is now slower because the opening of the outlet from the second tank is smaller. Therefore, the amount of force generated is reduced.

ATP from the second tank is released from the breakdown of glycogen in the absence of oxygen. Through this process a metabolic by-product called lactic acid accumulates. The highest accumulation of lactic acid is reached during activities that last from one to three minutes.

If the second tank is emptied, too much lactic acid accumulates in the muscle which causes pain resulting in a loss of coordination and force production which often happens at the end of a 400 or 800 meter race.
Oxygen System

The third tank represents the oxygen system. This system is more specific to the slow twitch muscle fibers used during activities requiring endurance over a long duration at low intensity.

The diameter of the outlet from the third tank is very small reducing the flow of ATP even more and generating less force but provides for hours of contractions.
Train In the Correct Energy System

The first step in setting up a conditioning program is to determine the major energy system utilized for the sport. If necessary video tape a game and time how long an athlete works versus how long they rest in between bouts of work. When specificity is applied to conditioning, it refers to training the same as you play in competition.

Fox and Mathews of Ohio State determined the energy system requirements for most sports years ago. The sport of football is not a long continuous activity. Each play involves an effort of 100% intensity for roughly five seconds. Between each play there is an average of 50 seconds rest which includes timeouts and penalties. The demand for ATP is high during a play, and as the play ends, the ATP tank is almost drained. The energy tank refills to almost maximum capacity between plays allowing maximum intensity for the next play.
That’s the part that some coaches fail to realize. The refilling of the ATP energy tank continues to happen even in the fourth quarter. During a play, the first tank is emptied and refilled during the rest between plays. This process is repeated each play. Therefore, the energy supplied during a football game is predominately from the ATP energy system.

So why do we still have football coaches having football players doing distance running? Some coaches say they understand distance running is not the correct energy system for power sports such as football, basketball, baseball, etc. but they do it for mental toughness.

All coaches need to learn what the appropriate energy system is for their sport and what drills train that system.
The athlete’s success will be largely dependent on speed, power, and agility so why not incorporate a conditioning program that has drills and activities that involve speed, power and agility?

The drills should be short and intense simulating game like actions. We still have coaches out there taking shot putters and having them run a 1.5 mile for time. Drills should mimic the needs of the sport as closely as possible. If an athlete performs explosively the drills should be done explosively.
Conditioning programs for power sports should be based on interval training principles. Interval training is work or exercise followed by a prescribed rest interval. The program should be adjusted based on the needs of the sport. For football include work rest ratio of 1:10 with periods that are very intense with a duration of three to eight seconds and rest periods lasting at 30 to 80 seconds. Baseball, volleyball and other power sports need similar rest between drills for recovery.

Basketball and soccer are dominated by the anaerobic energy system for activities, which require high power output such as sprinting, jumping, boxing out a defender and changing direction to accelerate and decelerate. Basketball and soccer have proven to be 60 to 75% anaerobic sports depending on the style of play. The ATP-PC and Lactic Acid systems supply energy for high intensity activities lasting up to 15 seconds and 2 minutes, respectively.
Conditioning for basketball and soccer should utilize drills and activities that train these energy systems. Recovery occurs during stops in play such as timeouts, substitutions and half time. Up to 70% of ATP is replenished in 30 seconds and almost completely replenished within 3 minutes.

This tells us that explosive activities lasting only 3 – 5 seconds give basketball and soccer players ample time to recovery before the next burst of energy is required. Work to rest ratios of 1:3 and 1:5 are specific to the sport of basketball and soccer and should be used in the conditioning aspect of training.

The intensity and duration of the drills should directly parallel that of a game. It is imperative to allow game type rest periods between the work intervals. The athletes will recover and repeat the drills with peak intensity.

On the next page is an analysis of a randomly selected segment of one basketball player for one minute of official time. The activity of the segment is classified by intensity into one of three categories: High intensity (which includes sprinting and jumping), medium intensity (such as shuffling, setting picks and running the floor), and low intensity (such as standing, walking and slow jogging). During this span there were two offensive possessions and one defensive session.
Elapsed time / Intensity / Activity

- 14 seconds – Low (walking the ball up the court)
- 1 second – High (cuts and passes the ball)
- 4 seconds – Low (jogs to a point along the perimeter)
- 4 seconds – Medium (shuttles and sets a pick)
- 3 seconds – High (cuts to the basket for a lay-up and is fouled)
- 29 seconds – Rest (waits for the ball to shoot a free throw)
- 28 seconds – Rest (substitutions)
- 8 seconds – Medium (running back on defense)
- 3 seconds – High (denying opponent the ball)
- 5 seconds – Low (follows opponent and boxes them out)
- 4 seconds – High (sprints and jumps to rebound the ball)
- 10 seconds – Medium (runs and passes the ball up the court)
- 39 seconds – Rest (teammate shoots first free throw)
- 4 seconds – Low (stands at mid-court waiting for second free throw)
It took approximately two and one-half minutes to run one minute of actual game time off of the clock. During this one minute of play there were 11 seconds of high intensity activity alternated with 22 seconds of medium intensity and 27 seconds of low intensity activity.

During these two and one-half minutes, the player ran a total of 474 feet, and each segment of play never lasted for more than 30 seconds. Differing tempos of play may arise at various times of a game, some at a higher tempo and some slower.

Regardless of the tempo of play, the primary energy system utilized is the ATP-PC energy system, and occasionally the lactic acid system. The oxygen system is not called into play therefore interval training is needed to condition for basketball and other power sports.
General Conditioning Stations

General conditioning is sometimes referred to as “county fair”. The stations are set-up for athletes to rotate from one station to another. All athletes do the same drills as they rotate from station to station.

One of the benefits of this type of training is the camaraderie as each group of athletes finish at the same time. The general conditioning station concept will work for any sport.

The stations include basic drills that would help any power sport athlete. Athletes from a variety of sports can be mixed together or groups can be limited to athletes from one sport.

If you have a small group of athletes one coach could rotate from station to station with them to complete the circuit of stations. If athletes are assigned to each station at least one supervisor is needed at each station.

Rotate the groups throughout the program so they don’t always start at the same station. You could have six stations lasting three minutes each to begin with but the duration can be lengthened to as much as four minutes after several weeks.
All stations should have two minutes rest between to provide for recovery and for water breaks. The athletes are told they are permitted to recover between stations to allow for very explosive drills to be done at each station.

When it is their turn a 100% effort is expected each time. Another common training error that coaches make in their conditioning programs is making the rest intervals too short. In fact some coaches don’t incorporate a rest between stations.

If the rest period is too short, the amount of energy is not sufficient to meet the demands of the next maximum intensity effort, and force output will be reduced. This problem is very common.

Coaches who make the rest interval too short, cause force to be reduced, and slow twitch muscle fibers are trained not the fast twitch fibers. The athletes end up pacing themselves so they can finish the program and they end up developing endurance instead of explosive power.
Sport-Specific Stations

The athletes are divided into four corners of the field for sport specific stations. The athletes stay in their corner and do specific drills for their position rather than doing the county fair general drills.

Football and other sport coaches like the position specific drills because they mimic what they want the athlete to do at their position. A drawback of doing sport specific drills is the four corners do not finish at the same time.

Since each corner is doing drills that pertain only to their needs, the drills vary considerably from one corner to another. Some of the team camaraderie is lost but position pride is developed instead.

Just like in the county fair stations it is critical for rest to be built into the drills and between drills. If the group consists of twenty athletes, don’t have them all run at the same time.

Have two or three of them run then two or three more. While a few are running the remainder of the group is resting. This will build recovery time into the station and allow for intense effort by everyone.

Another way to ensure intensity is to time the athlete doing the drill or have them race. Timing works best with smaller groups while racing works better with larger groups.
References


