

ENGINEERING an ATHLETE



ROGER NELSEN JR.

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-Roger Nelsen Jr.

Warning:

This book and the material it presents is intended for educational purposes only. Before starting a training program consult your physician and make sure you're healthy enough for physical activity. Apply the information contained within this text at your own risk. The author takes no responsibility for injuries sustained while training.

*This book is dedicated to my family
and friends, without whom I would have nothing.*

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1

Engineering an Athlete

The human body is an absolutely amazing machine. Organelles combine to make up cells, which combine to make up tissues, which combine to make up organs, which combine to make up organ systems, which ultimately combine to make up organisms, and the whole thing runs like clockwork. The beauty isn't just in its marvelous design though, but in its function as well.

Sports are more than just games, they're art, and athletes are artists. But rather than creating their masterpieces with paint and canvas, or string and bow, athletes generate art through motion. Watching a high level athlete play, move, and generally express their physical abilities is akin to watching a living, breathing symphony in action. Each section of the body syncs up in perfect harmony and the end result is grace, power, and beauty the likes of which most people could only dream of replicating.

When one sees someone who is truly great at what they do, regardless of whether that's sprinting, or throwing, or even table tennis, their ability is both unmistakable and awe inspiring and anyone with athletic aspirations of their own wants to perform similarly. The path to greatness is rarely easy, or even obvious though, and most people get lost along the way.

With so much information out there on how to train, it's easy to find one's self taking a less than optimal route. Conflicting information comes in from all sides and without an almost prohibitively large amount of study it's difficult to know how to separate the wheat from the chaff, but that's where this text comes in. It's the author's intention to outline the components that make up great athletes and explain how said components fit together and should be trained in order to see the best results.

The book will start by explaining the characteristics which make up athleticism and will then proceed to outline a progression meant to instill proper movement patterns, strengthen relevant tissues, and generally prepare the body for high intensity sport work. Once the body is ready, sport-specific training will be covered in detail with instructions on how to tailor programming for individual sports

and athletes. All in all, the book looks to take one from novice to seasoned and capable pro. And though the target audience for this text is primarily anaerobic sprinting and jumping athletes, the principles discussed within are applicable to every sport with a slight amount of tweaking.

It should be said now that regardless of how smart one trains, if their heart isn't behind it they'll be shooting themselves in the foot. While the intent here is to approach training in an almost mechanical sense, forgetting to account for the human spirit dooms one to failure. In order to reach their peak, one needs to train smart, train hard, and pour their heart and soul into their work, and even then, greatness isn't guaranteed. Not everyone can be great, but everyone can be better, and the primary goal here is to help everyone reading this book to capture their potential to the fullest.

-Roger Nelsen Jr.

2

The Building Blocks

What makes a great athlete? A simple question, but one with no simple answer. Generally speaking, great athletes are a combination of God-given talent, proper training, hard work, and consistency. More than that though, they're a combination of physical qualities. The exact balance of qualities varies from athlete to athlete and sport to sport, but everyone draws from the same pool of characteristics.

Making things as simple as possible, the components of fitness, or the building blocks with which trainers work, can be broken down into five interdependent categories: **strength**, **speed**, **endurance**, **mobility**, and **skill**. As noted, each component of athleticism interacts strongly with the others, but is still separate enough to warrant being placed in its own category. Skill especially bleeds into the four other categories, but it does still need its own section.

By manipulating each of the five components, one can build an athlete for any sport. Naturally however, not all athletes will require the same degree of components. Citing some more extreme examples, the strength and endurance levels of marathoners and shot putters will differ significantly, as will the mobility and skill of a gymnast versus a rower. The need for differing qualities is obvious when looking at such polarized examples, but it's necessary to note more subtle cases as well. The components are not general one-size-fits-all qualities. The strength needed to sprint fast is not necessarily the same strength needed to lift big weights, nor is the endurance needed to play a football game the same endurance needed to swim a 400 meter breaststroke. Within each quality there are variations that need to be understood, and this chapter will cover them in detail.

Strength

Strength is the ability of the body to generate tension and it is reliant on the muscles, tendons, and nervous system. The nervous system tells the muscles how to function, the muscles generate

tension, and the tendons transmit that tension to the skeletal system to create movement. If there's one weak link in the chain, the entire process will be disrupted and the result will be sub-par performance or even injury.

Starting first with the muscles, as large muscles typify strength, the muscles contract to generate tension. How hard they contract (absent involvement from the nervous system) really depends on only two factors: size (cross sectional area), and fiber type distribution.

Muscle size contributes to strength in a fairly obvious way. The more muscle present, the more force it will be able to generate. Technically speaking, contraction force is limited by the amount of contractile protein present, and it is perfectly possible to have more contractile protein in a smaller muscle if the larger muscle has a significant amount of energetic hypertrophy. An extreme example of this would be the leg development of an Olympic lifter compared to a bodybuilder. It is perfectly possible for the Olympic lifter to have more contractile protein in the muscles of his legs despite smaller overall measurements, and as such his strength as demonstrated through front and back squats will typically be greater (assuming similar limb lengths). As noted though, this is an extreme example. Muscle cross sectional area (thickness) significantly correlates with maximal voluntary strength (Akagi, Kanehisa, Kawakami, & Fukunaga, 2008; Akagi et al, 2009), so odds are, if one's muscles get larger, they will get stronger.

In addition to pure cross sectional area, another quality of the muscles that limits strength is the distribution of muscle fiber within a muscle. Controlling for fiber area, type IIb muscle fibers produce more force than type IIa muscle fibers, which in turn, produce more force than type I fibers (Widrick, Trappe, Costill, & Fitts, 1996). As such, muscles with a greater proportion of fast twitch muscle fibers (type IIa and type IIb) will be able to produce more force as a same-sized muscle group comprised of a greater proportion of slow twitch fibers (type I).

The tendons, which act as an intermediary between muscle and bone, don't actively contract, but they can provide extra force in activities involving relatively high speed eccentric action. In addition to just transferring muscular forces to the bone, the tendons also act as springs, stretching to store energy during an eccentric contraction only to “snap back” to their original length and add that energy during the concentric portion of the movement (Bosch & Klomp, 2005). In some movements, such as throwing a baseball or running at top speed, most of the propulsive force comes from the tendons while the muscles just lock-up to allow the tendons to stretch and rebound optimally. Typically, the greater

the speed of movement, the more dependent it is on propulsion from the tendons.

Regardless of if they're being used to transmit muscular force or if they're the ones providing the primary drive, the tendons need to be as structurally sound as possible in order to do their job. The strength of a tendon is known as its "stiffness." The stiffer a tendon, the less it deforms under load and the more quickly it rebounds after being stretched. The stiffness of a tendon is dependent upon two variables: size (cross sectional area), and collagen formation.

Naturally, much like a rope, the thicker a tendon is, the more force it will generally be able to tolerate (Enoka, 1988). Like the muscles though, a larger tendon isn't always a stronger tendon. Tendons are made up primarily of three types of fiber: collagen, elastin, and reticulin. Collagen provide the strength (stiffness), elastin allows for flexibility, and reticulin forms the bulk of the tendon mass (Siff, 2003). Since the stiffness of the tendon is based on the collagen formation within it, size is not a 100% reliable indicator of strength.

Playing directly on the last point, the second factor determining tendon stiffness is the formation of the collagen within said tendon. The more collagen present, and the more cross-links amongst its fibrils, the stronger the tendon structure will be (Bailey, Robins, & Balian, 1974).

And finally, the last contributing factor to strength is the nervous system. As noted earlier, the components of fitness overlap and here is where strength and skill start to spill into one another. Nervous system contributions to strength can be broken down into two subcategories: intramuscular coordination, and intermuscular coordination.

Intramuscular coordination involves the control of the fibers within a given muscle group and can be split even further into three more categories: recruitment, rate coding, and synchronization. Recruitment is just what it sounds like, the number of fibers called into action to generate force. Rate coding is the discharge frequency of the motoneurons, and higher levels of rate coding are generally seen with higher levels of force. And synchronization is how well the nervous system manages to fire the muscle fibers in concert with one another, with more synchronized firing patterns leading to higher levels of force generated (Zatsiorsky, 1995).

Intermuscular coordination involves the control of muscle groups relative to one another. Here is where strength and skill directly overlap. In order to perform any complex sporting movement, all of the body's muscles need to coordinate their actions. Some tasks require more control and precision than others (juggling versus holding a ball), but all tasks require specific degrees of tension and specific

timing if they're to be conducted with any proficiency.

Intermuscular coordination won't affect the force generated by a single muscle group, but it will greatly affect the force created in more complex movements. The more muscles that are involved and the more complex the task, the more it relies on intermuscular coordination. In this way, lifting weights, jumping, sprinting, or throwing all require high levels of skill in executing their various movement patterns in order for the body to express its strength optimally (Zatsiorsky, 1995).

Beyond the neural and physiological components of strength, it is also important to note that strength is somewhat specific to contraction type. Depending on how one trains, gains in eccentric, isometric, and concentric strength will differ, with the greatest gains in strength coming in the mode(s) of contraction one primarily uses (Higbie, Cureton, Warren, & Prior, 1996; Reeves, Maganaris, Longo, & Narici, 2009; Siff, 2003). This is important because certain sports require differing levels of some types of contraction-dependent strength over others. Reactive strength, which many sports rely heavily upon, is largely dependent on a combination of intermuscular coordination, tendon stiffness (Bosch & Klomp, 2005), and eccentric strength (Miyaguchi & Demura, 2008).

Strength is also partially joint-angle-dependent. If one trains a joint at only one angle, strength gains tend to be limited to around 15-20 degrees in either direction. However, if one trains in a position where the stressed muscle is maximally or near maximally lengthened, the strength gains will effectively transfer to the rest of the range of motion (Zatsiorsky & Raitsin, 1974). This will have implications later.

Speed:

Speed, as it will be considered here, is how rapidly the neuromuscular complex is able to manipulate tension and it is reliant on both physical and neural properties. On the physical side of the coin, speed is determined by muscle fiber type distribution and muscle fascicle length (the number of sarcomeres running in series). On the neural side of the coin, speed is determined by a well practiced nervous system and specific motor patterns.

Physically speaking, speed of tension generation and dissipation is dependent on the proportion of fiber types within a muscle group. Type IIb muscle fibers contract roughly 10 times faster than type I fibers, and type IIa fibers' contraction speed is somewhere in between the two extremes (Andersen, Schjerling, & Saltin, 2000). Relaxation times follow a similar path, as type IIb fibers release tension

more quickly than type IIa fibers, which in turn release tension more quickly than type I fibers (Burke & Edgerton, 1975). With this in mind, it follows that a muscle with a higher percentage of fast twitch fibers will be able to contract and relax more quickly than a muscle group with a lower percentage of fast twitch muscle fibers.

The speed of force generation within a muscle group is also dependent on the number of sarcomeres arranged in series (which manifests as greater muscle fascicle lengths). More sarcomeres running in series allows for each sarcomere to contract over a smaller range of motion to produce a given change in overall muscle length, resulting in given movements taking less time to complete. Multiple studies have also shown that faster athletes consistently exhibit longer muscle fascicles than their slower peers (Abe, Fukashiro, Harada, & Kawamoto, 2001; Kumagai et al, 2000; Abe, Kumagai, & Brechue, 2000).

On the neural side of the equation, there is overlap between both the physical attributes that contribute to speed and the skill component of fitness. It has already been established that muscle contraction velocity is largely determined by fiber type, but fiber type, behavior, and characteristics are determined by the nature of the neural signal innervating it (Bacou et al, 1996; Barjot et al, 1998).

Beyond innervation and fiber type, the manipulation of force within one or more muscle groups is largely just a motor skill. As sporting proficiency increases, contraction speed and relaxation speed tend to increase as well (Siff & Verkhoshansky, 1999; Matveyev, 1981).

Endurance:

Endurance is the ability to perform a given task at a given intensity for a given period of time. All sports require some degree of endurance, but exactly what kind is specific to the sport, position, and even the individual athlete. Physically, endurance is dependent on the level of development of the appropriate energy pathways as well as physical strength. Neurally, endurance is dependent on sporting skill and movement efficiency. As is apparent, like the other building blocks, endurance also heavily crosses over with the other components.

When they refer to endurance, most people are referring to energy systems development. There are three energy systems, each providing energy for a certain time span before exhausting its stores. The adenosine-triphosphate/phosphocreatine (ATP/PCr) energy pathway provides the majority of the energy for activities lasting 0-3 seconds. The anaerobic glycolytic (AG) energy pathway provides most

of the energy for activities lasting 4-50 seconds. And the aerobic pathway provides most of the energy for activities lasting longer than 50 seconds (Brooks, Fahey, and White, 1996). Different sports require different levels of energy systems development based upon their pace and duration. For instance, a sprinter would need to spend most of his time developing the AG pathway, while a marathoner would focus on the aerobic pathway. Since the energy pathways are largely separate, it's important to note that, at least in this sense, endurance means different things for different people.

Continuing with the physical makeup of endurance, strength is a major determinant. The higher a given load is relative to an athlete's maximum strength, the more closely related endurance and strength will be. Higher strength levels allow for a greater "reserve." To give an example, two athletes have a competition to see who can bench press 225 lbs for the most reps. Athlete A can bench press 250 lbs for a max, and Athlete B can bench press 325 lbs for a max. Since Athlete A has a strength reserve of only 25 lbs (250-225) and Athlete B has a strength reserve of 100 lbs (325-225), it's fairly obvious who is going to be able to do more reps with 225 lbs: Athlete B. However, if their competition were to see who could bench press 45 lbs for more reps (a much lower percentage of their max lifts), the outcome would not be apparent.

Regardless of the load used, increasing maximal strength has been shown to increase endurance for cycling (Sunde et al, 2009; Loveless, Weber, Haseler, & Schneider, 2005), running (Guglielmo, Greco, Denadai, 2009; Storen, Helgerud, Stoa, & Hoff, 2008), skiing (Hoff, Helgerud, & Wisloff, 1999; Hoff, Gran, & Helgerud, 2002), and a number of other sports.

The neural determinant of endurance is the ability to efficiently perform a given movement. As proficiency in a sporting movement increases, the amount of energy spent to perform the movement decreases (Vorobyev, 1978), and as the energy cost decreases, one gains the ability to perform the movement for longer. This happens because as one becomes more proficient at performing a movement, the amount of spurious tension (tension not directly contributing to the action) in antagonistic muscle groups decreases and the overall energy expenditure drops. Similarly, the ability to relax more quickly after contractions during cyclical activities allows for better regeneration of energy stores and therefore allows for intensity to be maintained for longer. This is where endurance and skill directly overlap with one another.

Mobility:

Mobility is usually defined as flexibility, or the range of motion through which the joints can travel voluntarily, but the author is going to throw relative muscle activation and posture into this category as well. Posture is based upon resting muscle length, which is based upon both flexibility and muscle activation, so it can be seen how they all fit together.

Flexibility, as just mentioned, can be thought of as the ability of the joints to move over a given range of motion. For the most part, flexibility is controlled by neurological phenomena. A number of proprioceptive organs within the muscles and tendons sense muscle length and tension and regulate range of motion accordingly in an effort to prevent injury. By gradually exposing the muscles to greater lengths and tensions (simultaneously is best), one can teach the body to allow for greater ranges of motion (Siff, 2003). The more freely the limbs are able to move, the easier one will be able to hold proper sporting positions and the less energy one will need to expend to move (this is where mobility and endurance cross). Having said that, it is possible to be excessively flexible (hypermobility), and being so will result in joint instability and increased injury potential.

In terms of relative muscle activation and posture, every sporting action has optimal body positions (relative to each athlete's limb lengths and tendon-insertion points). For instance, when running at top speed, the best sprinters display an upright posture, a neutral to slightly posteriorly rotated pelvis, depressed shoulders, sufficient hip extension ROM, and minimal external rotation of the femurs. To hit and hold these positions, they require not only strength in the right muscle groups, but proper range of motion and muscle activation as well.

Due to their posture, or their limb lengths, or their tendon attachment points, or their relative muscular development, or inflexibility, some people prefer to use certain muscle groups over others. For instance, in creating hip extension, some people primarily utilize their hamstrings and spinal erectors, while others utilize their glutes. In order to perform most movements in a proficient and efficient way, it's important that there is balance.

In addition to affecting performance, improper muscle recruitment patterns can result in injury. For instance, altered or diminished ability to activate and control the abdominal musculature can lead to lower back pain (Hides, Boughen, Stanton, Strudwick, & Wilson, 2010; Marshall & Murphy, 2009). Altered or diminished activation of other muscles around the body can result in similar decrements in performance, and it's essential that everything is working as it should be.

Skill:

Skill is by far the most task-specific of the the components of the athleticism. One can have all of the physical attributes necessary to excel in a given sport, but if they have no familiarity with the sport or its movements then their performance will be compromised. A good example for this is that someone may have fast hands and good hand-eye coordination, yet may be unable to juggle due entirely to a lack of practice. Naturally, with practice they'd do just fine, but until they build up their skill in that particular movement, their physical abilities will be nothing but untapped potential.

In sports, every movement requires the mind to coordinate different muscle groups, at different times, in different proportions, and for different durations. And while a kinesthetically competent athlete may be able to perform most movements with some degree of proficiency with little to no practice, mastering a given movement takes years of work. If one wants to get good at an action, they need to practice it.

In addition to being task-specific, skill is also largely intensity-specific as well. If one wants to get good at running as fast as possible, they need to practice running as fast as possible. Jogging will do nothing for sprint form, nor will mere running. The same goes for jumping, throwing, or any other skill as well. The only real exception is for brand new athletes or those just coming back from injury. For them, any skill work that's remotely close to the sporting task can be beneficial.

And finally, depending on the complexity of the task, the amount of skill necessary to perform it varies. Golfing requires significantly more skill than does putting a shot, and as such, the amount of time and energy devoted to skill training will vary between sports.

Wrap Up:

Once more, fitness or athleticism is comprised of five different components: **strength, speed, endurance, mobility, and skill**. Now that one has a basic understanding of said components, it's time to discuss how to go about building them. As has been mentioned, different athletes, in different positions, in different sports require different levels of development in order to perform at their best, but there are commonalities between all individuals. From this point on, the text will start focusing on prescription rather than description; starting with the development of basic strength and athleticism and working towards individual sporting mastery.

3

Exposure

Sporting development can be broken down into three separate stages, the first of which is known as **Exposure**. Exposure is the period of training in which the groundwork for all future improvement is laid. Regardless of sport, this is where athletes go through a number of progressions in order to build a healthy, mobile body and prepare themselves physically and mentally for the more intense exercises yet to come. Though it can be considered the most remedial of stages, it is also the most important. Just like one cannot perform calculus without having learned elementary math, one cannot become a great athlete without having established the basic qualities addressed during the Exposure stage.

The goals of Exposure include:

- Strengthening vital muscle groups**
- Strengthening connective tissues**
- Teaching correct muscle activation**
- Increasing flexibility**
- Building work capacity**
- Mental preparation**

Once these goals have been met, the athlete will be prepared to undertake more intense forms of training while maximizing their results and minimizing their injury risk. As for how this will be accomplished, the rest of the chapter will outline both the reasoning behind the above goals as well as a plan in order to reach them.

Strengthening Vital Muscle Groups:

The first, though not necessarily most important, goal of the Exposure phase of training is

strengthening a number of vital muscle groups. These muscle groupings have been deemed “vital” because their development is crucial not only to optimizing sports performance, but in preventing injury as well. Of course, all muscle groups will be strengthened during this phase, but the muscles of particular interest include the abdominal musculature, the dorsal muscles, the gluteals, and the hamstrings.

First and foremost, the abdominal and dorsal muscles are largely responsible for the stabilization of the pelvis and spine. The greatest forces encountered in sport are generated around the pelvis, and as such, strength and control over the muscles in the region are necessary for performance. Without proper abdominal support, the gluteals (the primary hip extensors) cannot function to their full capacity. In terms of sheer injury prevention, a lack of strength and endurance in the dorsal muscles has been linked with incidences of low back pain (and therefore spinal instability) (Johnson, Mbada, Akosile, & Agbeja, 2009; Kankaanpää, Taimela, Laaksonen, Hanninen, & Airaksinen, 1998). Deficits in abdominal muscle control, and presumably weakness as well, have also been linked to low back pain (Hides, Boughen, Stanton, Strudwick, & Wilson, 2010; Marshall & Murphy, 2009).

The glute muscles are the primary hip extensors (Bosch & Klomp, 2005) and their development is necessary for any athlete that wants to run fast or jump high. Strength in the hip extensors contributes heavily to jumping (Robertson & Fleming, 1987), sprinting (Delecluse, 1997), and stabilization of the hip and knee joints (Imwalle, Myer, Ford, & Hewett, 2009). If one has underdeveloped glutes, they're setting themselves up for both poor performance on the field and an increased risk of knee injury (Leetun, Ireland, Wilson, Ballantyne, & Davis, 2004).

The hamstrings are another key muscle group, in that their development is necessary for both sprinting speed (Delecluse, 1997; Bosch & Klomp, 2005) and the prevention of knee injuries. It is, however, not the absolute strength of the hamstrings, but the balance of strength between the hamstrings and the quadriceps that has been shown to have a significant link with knee injury (Lehance, Binet, Bury, & Croisier, 2009; Croisier, Ganteaume, Binet, Genty, & Ferret, 2008). If the quadriceps are significantly stronger than the hamstrings, knee stability is compromised and the likelihood of injury rises.

Other than the absolutely essential groups already mentioned, the focus during Exposure will be on the proximal muscle groups, as nearly all athletic training should be. The proximal muscle groups should be dominant in sportsmen, as they allow for the most economical manipulation of the limbs.

The more muscle one carries further out towards the distal end of the limb, the more difficult and costly it becomes for them to move that limb due to leverage issues. When looking at particularly fast animals in nature, this proximal distribution of muscle mass is apparent. Though some mass out at the distal end of the limbs is unavoidable, those muscle groups should not be the primary focus.

Strengthening Connective Tissues:

In life, and especially in sports, avoidable soft tissue injuries are all too common. Tendons do have some amount of give (which allows them to store energy and act like springs during certain types of movement), but ligaments don't. Either way, when connective tissue is loaded too heavily, it will deform beyond a safe range resulting in serious damage to its structure (Wang, 2006). In order to prevent such an overload, the best solution is to regulate training intensity and volume, make sure the muscles are strong enough to keep the joints out of vulnerable positions, and of course, to strengthen the tissues themselves.

Connective tissue responds to loading by laying down further collagen fibrils (Michna, 1984; Michna & Hartmann, 1989) and becoming more resistant to injury (Viidik, 1969; Woo et al, 1981). In this way, exposing the body to higher intensity forces than it's accustomed to dealing with will result in more robust connective tissues. Tendons and ligaments with more collagenous mass will not only serve to return more energy during reactive movements, but will require more force to deform beyond safe limits, and therefore reduce the risk of overload injury.

Unlike with the muscles, tendon-specific training isn't necessary, as tendon stiffness and mass respond to both traditional strength loading (Kubo et al, 2007) as well as plyometric (Burgess, Connick, Graham-Smith, & Pearson, 2007) and sprint work (Tipton, Schild, & Tomanek, 1967). Really, any kind of consistent loading works to strengthen the tendons and ligaments over time. Caution needs to be taken though, as blood flow and nutrient transport to the connective tissues is not as great as in muscle tissue, and so recovery between bouts of exercise takes longer.

Teaching Correct Muscle Activation:

Beyond just being strong, the muscles and tendons also need to coordinate in the correct manner in order to facilitate sports performance and reduce injury risk. If the right muscles aren't firing at the

right times, even under low force situations, then overuse injuries, soreness, or chronic pain can occur. Add in more force and the right muscle failing to contract properly can lead to surgery or a career ending tear. Regardless of whether one is looking for performance or just looking to stay healthy, making sure everything is firing correctly is a necessity.

As when developing strength, there are certain muscle groups that deserve more attention than others when it comes to muscle activation training. The two groupings that usually need the most attention are the abdominal muscles and the gluteal muscles. The gluteus maximi are the largest single muscles in the body and, as the primary hip extensors, are the driving force behind nearly all athletic movements. The glutes however, cannot function optimally if the pelvis isn't correctly positioned and stabilized, a task which falls largely to the abdominal muscles. Adequate abdominal strength and control will ensure that forces around the hip and lower spine are properly controlled (Bosch & Klomp, 2005) and will allow for the glutes to do their job.

Improper strength and control of the abdominal and trunk muscles can also lead to back (Hides, Boughen, Stanton, Strudwick, & Wilson, 2010) and knee (Zazulak, Hewett, Reeves, Goldberg, & Cholewicki, 2007) pain or injuries. Similarly, altered activation patterns of the gluteus maximi have been linked to low back and sacroiliac pain (Leinonen, Kankaanpää, Airaksinen, & Hanninen, 2000; Hungerford, Gilleard, & Hodges, 2003). As such, getting these muscle groups working is of prime importance for health reasons.

Similarly, improper strength and function of the muscles around the glenohumeral (shoulder) joint can, and often do, lead to instability and impingement issues. Factors contributing to the instability include dysfunction and/or weakness of the scapulothoracic muscles, excessive shoulder internal rotation strength compared to external rotation strength, limb strength asymmetries, laxity of the anterior capsuloligamentous structures, and a deficit in shoulder internal rotation range of motion (Olivier, Quintin, & Rogez, 2008; Rupp, Berninger, & Hopf, 1995; Wadsworth. Bullock-Saxton, 1997). By strengthening the scapular retractors and the external rotators of the humeri while increasing flexibility in a select few other muscle groups, these issues can be avoided.

Increasing Flexibility:

Modern life is a largely sedentary one for most people and all of the time spent sitting, whether in a desk, in front of a computer, or just in front of a TV, tends to limit mobility around certain joints.

Most sports and a lot of training methods require free movement over large ranges of motion from the hips and shoulders, and unfortunately, these joints are usually tightened the most from poor day-to-day posture.

In terms of sheer athletic performance, having antagonistic musculature which is too tight will impede the stroke of a limb, slowing its speed and increasing the amount of energy needed to move it. Increasing mobility will rectify the issue. Likewise, inflexibility in certain muscle groups will prevent athletes from reaching the right positions, thereby distorting form and overall efficiency. One example of this can be seen in running form. Inflexible hip flexors (rectus femori and iliopsoas) will force hip extension beyond neutral to come from pelvic movement (anterior rotation) which will reduce the ability to reutilize reactive energy gained during footstrike (Bosch & Klomp, 2005).

In terms of injury potential, lower hip and hamstring flexibility has been correlated with an increased chance of muscle strain (Bradley & Portas, 2007; Henderson, Barnes, & Portas, 2009), while for the upper body, altered scapular position (as caused by tight pectoralis majors, pectoralis minors, anterior deltoids, and latissimus dorsi) can be linked to shoulder pain and impingement (Kibler, 2006). Preventing such issues from arising is of prime importance.

Building Work Capacity:

The bodies of most beginning athletes aren't used to doing too much besides sitting around and playing video games, and as such, before they can really begin to train hard, they need to prepare themselves to weather and recover from physical activity. The Exposure stage of training is essentially a GPP (general physical preparedness) phase in which the general qualities of athleticism are trained at a relatively low level of intensity (Siff, 2003).

The work done in this phase prepares the muscles, tendons, endocrine system, and nervous system to stand up to the higher intensity work coming in later phases. It has been demonstrated by thousands of athletes in nearly every sport for decades that periods of higher volume and lower intensity best prepare the body for safe gains when the volume is slowly lowered and the intensity raised (Siff, 2003; Zatsiorsky 1995). This process is what the progression outlined here is meant to conform to.

Mental Preparation:

Though athleticism is largely dependent upon physical skills, the mental component to training and competing is undeniably vital. Training to compete at a high level is hard work and usually requires years of unwavering dedication. As such, if one intends to participate as an elite athlete, they will either need superior inborn skill or high levels of self-confidence and work ethic to keep them working towards their goals (Smith, 2003). The mental component is, in fact, largely what separates the successful from the unsuccessful, in athletics and business alike. Successful people tend to be mentally tough and relentlessly focused (Jones, 2008); skills that allow them to train through physical, mental, and emotional pain, while the unsuccessful lack such traits.

Though mental toughness and perseverance are something that one must cultivate rather than be taught, the Exposure stage looks to do its part to try and acclimate athletes to hard work. The intensity found in this phase won't be high, but a majority of the training methods used are uncomfortable and mentally taxing. If one manages to make it through the upcoming progression and out of the Exposure stage, they'll be able to handle the more intense (but easier) training in upcoming phases.

Training in Exposure:

Though training is a highly individualized process, with prescribed exercise depending on the needs of the sport, position, individual, and even the time of year, the Exposure phase revolves around a one-size-fits-all program. At this point in development, the goal isn't to construct a capable athlete, but a healthy and capable human being. Regardless of their sport, everyone needs proper mobility, everyone needs correct basic activation patterns, and everyone needs muscle and connective tissue strength. The Exposure program is specifically designed to meet these needs with minimal individual input or tinkering.

Whether one is an experienced athlete or an Xbox warrior, Exposure will tune up their body and make sure that it's ready to perform optimally in upcoming phases. The author would suggest that all trainees, regardless of experience level, start with this phase and keep with it for at least a month and preferably until their gains start to stall. There's always the temptation to look at the simple things and think they're too easy or too remedial, but by putting in this type of work early, one is ensuring that they're getting the most out of the work they put in later.

In terms of actual training methods, most of the work during Exposure will consist of combination strength and coordination exercises meant to teach balance and muscle activation and build strength and muscle in positions most relevant to general movement and athletics. Specifically, the program will be comprised largely of longer duration yielding isometrics.

Yielding isometrics involve holding a weight (or one's body) in a set position for a set amount of time rather than moving through a specified range of motion like most normal lifting. And despite their name, yielding isometrics are actually reliant on a combination of isometric and extremely slow eccentric muscle contractions. As each individual set goes on, fatigue will cause a slight and almost imperceptibly slow lengthening of the working muscles.

The program utilizes isometrics for a number of reasons. First and foremost, since isometrics involve minimal to no movement, it's easy to get into the right position and concentrate on contracting the right muscle groups. The fact that most of the movements will train the muscles while stretched will also ensure that strength is developed over the entire range of motion (Zatsiorsky, 1995) and will effectively increase flexibility (Siff, 2003). Beyond that, isometrics have also been shown to build strength, muscle, and connective tissue very effectively (Kubo, Kanehisa, Ito, Fukunaga, 2001) and the isometrics are all of longer duration because the greater volume allows for quicker motor learning, builds endurance and strength simultaneously, and there is evidence to suggest that longer duration isometrics result in greater increases in tendon stiffness as well (Kubo, Kanehisa, & Fukunaga, 2001).

The Exposure Program:

The following template is the Exposure program. It is meant to be followed in its entirety with minimal (preferably no) alteration. All exercises in the mobility section are to remain unloaded.

<u>Frequency:</u>	3 times per week
<u>Warm-Up:</u>	Mild activity (elliptical, rowing, etc) for 5-10 minutes or until a light sweat develops
<u>Mobility:</u>	Walking Lunges, 2 sets x 10 repetitions per leg Side Lunges, 2 sets x 10 repetitions per leg Shoulder Dislocations, 2 sets x 10 repetitions Toe-Touch Squats, 2 sets x 10 repetitions

	Scapular Slides, 2 sets x 10 repetitions
	Chair, 3 sets x 25 repetitions
<u>Workout:</u>	ISO Lunge, 4 sets x 30 seconds per leg
	ISO Inverted Row, 4 sets x 30 seconds
	ISO Squat, 4 sets x 30 seconds
	ISO Push-up, 4 sets x 30 seconds
	ISO Overhead Single-Leg RDL, 4 sets x 30 seconds per leg
	ISO Leg Lowering, 4 sets x 30 seconds
	ISO Single-Leg Calf Raise, 4 sets x 30 seconds per leg
<u>Conditioning:</u>	20-30 minutes of mild activity (elliptical, rower, etc.) while keeping the heart rate between 120-140 beats per minute
<u>Cool Down:</u>	Repeat the “Mobility” section

Notes: Rest periods in between sets and movements should be held to under 2 minutes. This will get tiring, but that is the intended effect. All movements listed in the “Workout” section should be done unloaded for the first workout, regardless of one's level of strength or qualification. From that point on, if one is able to perform all of the sets of a given exercise while maintaining perfect form, they may increase the load used a maximum of 5 lbs each session. Advanced or very strong athletes can increase 10 lbs at a time. This limitation on loading is in place because it forces one to focus on correct muscle activation rather than weight lifted.

Though each movement will be described in detail momentarily, the one cue to keep in mind while performing every movement is to focus on keeping the pelvis neutral through conscious manipulation of the abdominals (allow neither excessive posterior nor anterior pelvic tilt). It should be made clear now that the primary focus while performing this program is on maintaining correct form and using the right muscle groups. One should never sacrifice form for load.

Most people can expect to stay with this routine for at least a month before moving on to the next phase and many will need stick with it for three or more before continuing. It's possible to build strength on a routine like this for an extended period of time and one is advised not to move on too early just because the program is boring and hard.

Movements:

Since the correct performance of each movement is of such great importance, each of them will be described in detail and demonstrated. Once more, it needs to be reiterated that form and muscle activation are the focus, not the amount of weight lifted. It's far better to remain at a lighter weight and lift correctly than to add weight and disrupt proper recruitment patterns. If fatigue causes one to deviate from proper form, the set ends.



Chair:

Lie on your back and position your legs so that the hips and the knees are both at 90 degree angles. Using the abs, posteriorly rotate the pelvis and press the lower back flat on the ground. Maintaining the position of the pelvis, back, and legs, concentrate on keeping the knees close together while moving the feet as far apart as possible (medially rotating the femurs). Once you have reached the end of the ROM, hold momentarily before letting the feet come back together. That is one repetition.



ISO Inverted Row:

Using a bar set at roughly navel-height, grasp the bar with a supinated (underhand) grip with the hands spaced slightly wider than shoulder-width apart. Position yourself so that, when your arms are straight, your solar plexus is directly beneath the bar. Your feet should be significantly in front of the bar. Now, keeping your body and legs perfectly straight (it'll look like you're doing an upside down push up), retract and depress your scapulae and pull the bar towards your sternum, touching it to the bar if possible. Hold yourself in this position as close to the bar as possible for the designated time. To increase difficulty, one can elevate their feet.



ISO Leg Lowering:

Lie on your back and, keeping the knees locked, flex at the hips so the legs and torso form a roughly 90 degree angle. Using the abs, posteriorly rotate the pelvis and press the lower back flat on the ground. Keeping the lower back in contact with the floor, keep the legs straight and the feet pointing upwards and lower them slowly towards the ground. Get the legs as close to the ground as possible while maintaining contact between the ground and lower back. Hold this position for the designated time.

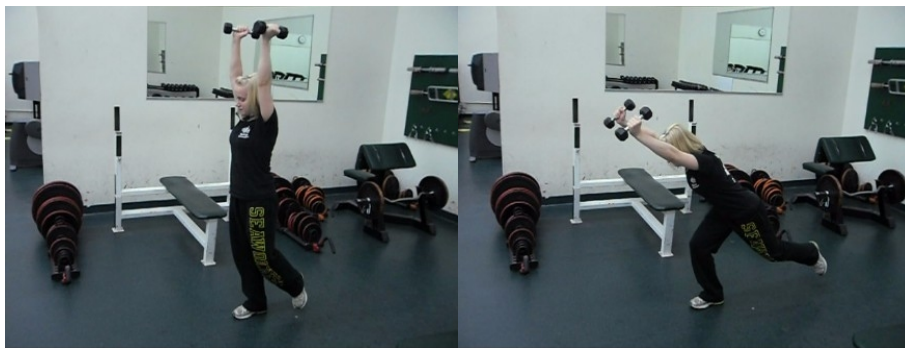
The Right Way



The Wrong Way

**ISO Lunge:**

Get into a deep lunge position with your weight distributed evenly between both legs. The shin of the front leg should be perpendicular to the ground and one's weight should be supported through the heel. The torso should be completely upright and one should use their abs to maintain a neutral pelvis (avoid anterior rotation). The legs should also be kept roughly in line (avoid external rotation at the hip). Get as low as you possibly can while following all cues and hold for the designated time. Both feet may need to be elevated for those with good flexibility.

**ISO Overhead Single-Leg RDL:**

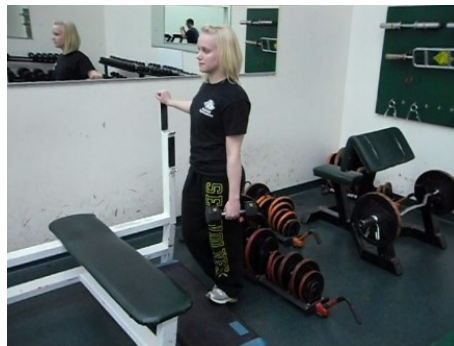
Stand upright and raise the arms up overhead so the torso and the arms are in line. Keep the palms facing one another. Stand on one foot, contract the abs to pull the pelvis into a neutral position, and push the butt back, keeping the supporting leg fairly straight. Push the butt as far back as you can while maintaining balance and a neutral spine. Nearly all of the movement should be at the hip, though the knee can come forward a bit. When at the end of the ROM, hold for the designated time. If weights are added, they are to be held in the hands.

Emphasis can be shifted between the glutes and hamstrings by manipulating knee flexion. Less knee flexion will shift stress on to the hamstrings while more will put it on to the glutes



ISO Push Up:

Get into a push up position with both the hands and the feet elevated for extra ROM. Tighten the abs and hold the pelvis and spine neutral. Now, lower yourself as far as you can while keeping the upper arms flared roughly 45 degrees from the torso. Hold the position for the designated time.

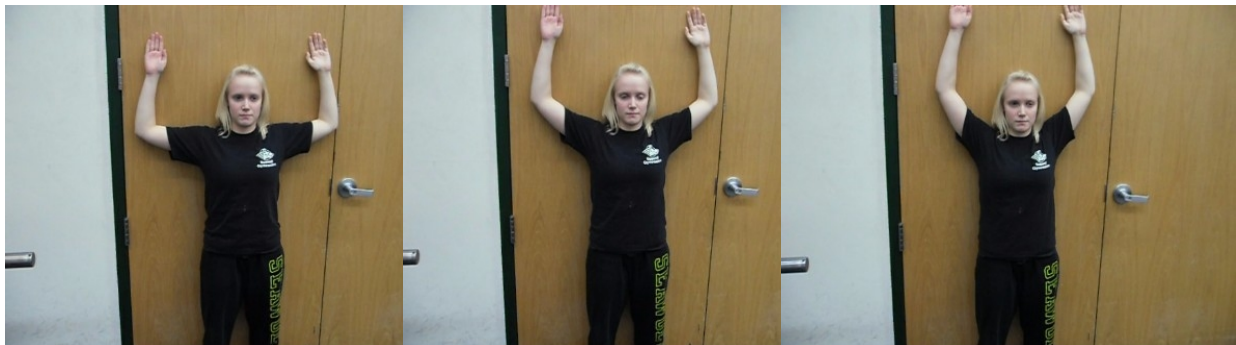


ISO Single-Leg Calf Raise:

Stand on the edge of a step with only the ball of the foot on the step and the heel and midfoot hanging down over the edge. Drop the heel as low as possible while keeping tension in the calf. Keep the weight distributed evenly between the inside and the outside of the foot. Hold the position for the designated time. You can use your hands to steady yourself.

**ISO Squat:**

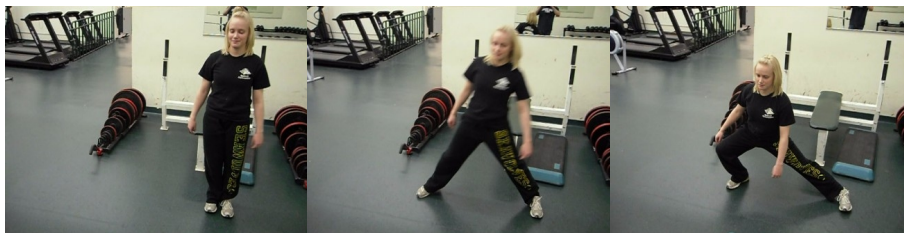
Standing with the feet roughly shoulder width apart and slightly externally rotated, use the abs to pull the pelvis into a neutral position and then squat down keeping your weight on your heels. Go as low as you can while maintaining a neutral pelvis and hold in this position for the designated time.

**Scapular Slides:**

Stand with your heels roughly 6-12" away from a wall. Lean back against the wall and raise your arms so they form 90 degree angles at the shoulders and elbows. Keeping the back, shoulders, elbows, and wrists in contact with the wall, reach up towards the ceiling. Raise your arms as high as you can while maintaining contact with the wall before lowering them back to the starting position. Repeat for the designated number of repetitions.

**Shoulder Dislocations:**

Hold a broomstick, belt, or rope in front of the body with straight arms. Keeping the arms straight, move the object up in front of the body, up over the head, and then back behind you where it will come to rest against your glutes or lower back. Still keeping the arms straight, return it to the starting position. Repeat for the designated number of repetitions. In order to correctly complete this exercise, some people will need to take very wide grips. You will be able to bring your hands in as flexibility improves though.

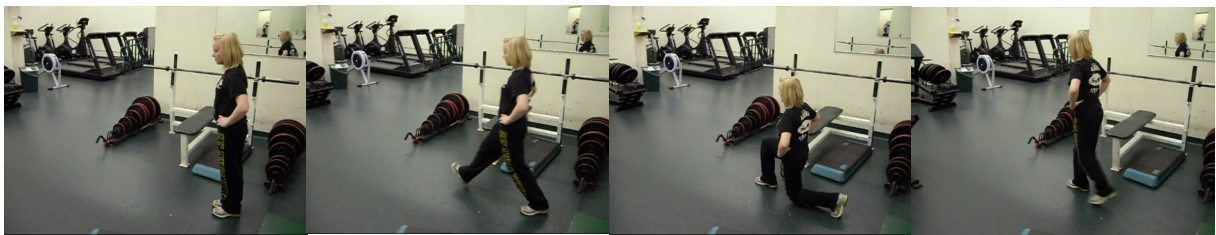
**Side Lunges:**

Standing up straight and keeping the pelvis held neutral via abdominal contraction, step out directly to the side and descend into a lunge position. Go as deep as possible while maintaining a neutral back. Driving through the heel, stand back up to the starting position and repeat for the designated number of repetitions.



Toe-Touch Squats:

Standing with the feet roughly shoulder width apart and slightly externally rotated, use the abs to pull the pelvis into a neutral position and then squat down keeping your weight on your heels. Descend until you are able to touch your feet with your hands and then stand back up. Repeat for the desired number of repetitions.



Walking Lunges:

Standing up straight and keeping the pelvis held neutral via abdominal contraction, step directly forward and descend into a lunge position. Driving through the heel, stand up on the foot that just stepped forward and repeat for the desired number of reps.

Wrap Up:

After finishing up with the Exposure phase, one should have ingrained proper muscle recruitment patterns, enlarged most major muscle groups, strengthened their tendons and ligaments, increased their flexibility, and prepared themselves for the more intense work yet to come. If one questions whether or not they're ready to move on to the next phase, then they should stick with Exposure work until they're sure they are. If one feels they're ready, they can move on to the Integration phase.

4

Integration

Integration is the second of the three phases of training. By the time they've reached this point, a trainee has developed a base of muscular and connective tissue strength, ingrained proper movement patterns, and has started to acclimate their body to the rigors of training. What they've yet to do is integrate those skills into dynamic sporting movements.

Though yielding isometrics (the primary tool of the Exposure phase) are useful for teaching initial coordination and conditioning the musculotendon system, they do have their limits. Whereas the isometrics, by nature, involve minimal movement, most sporting actions occur at high speeds and involve not only one mode of contraction, but all three, oftentimes simultaneously across different muscle groups with tensions far exceeding what one is able to create voluntarily. So while the gains from the previous phase do prepare the body for upcoming work, there's still a lot more to be learned before one can truly perform at their best out on the field.

Specifically, the goals of the Integration phase include:

- Teaching correct muscle activation while moving
- Exposing the muscles and tendons to high forces
- Mastering general high speed eccentric athletic movements

By the time an athlete has met the above goals, they will finally be ready to get down to training for their specific sport, but that's a ways off at this point. As with the last phase, taking one's time and progressing only as they're able is the key. Rushing to get ahead will do nothing but impair future results.

Teaching Correct Muscle Activation While Moving:

As mentioned, isometrics, by definition, don't involve much movement. Sporting actions, on the other hand, are all about speed. Coordination is specific to not only the position of the limbs and the

muscle groups being activated, but to contraction speed and timing as well (Siff, 2003). Learning to activate the right muscle groups while sitting still is one thing, but doing the same while moving as fast as possible and dealing with the distraction of a opponents, expectations, and a roaring crowd is another thing entirely. In fact, research has shown that fast and slow movements result in differing levels of brain activity in different parts of the brain (Siff, 2003).

The jump from isometrics to full speed sporting movement is a bit too much for most, so the journey has to be made in steps. The speed and complexity of movement needs to be gradually increased in order to allow for the development of optimal coordination at all speeds. Some naturally gifted athletes exhibit near perfect coordination from the beginning, but for those who are less talented it takes time and lots of practice. And though it might be cliché, it needs to be said that practice doesn't make perfect, only permanent. Just performing high speed movements (or movements of any speed, for that matter) with poor form won't get one anywhere. They need to strive to perform each movement perfectly each time. Doing so ensures that they're teaching themselves to do it right, not just hammering home sloppy and counterproductive repetitions.

Exposing the Muscles and Tendons to High Forces:

The forces encountered in sporting movements far exceed those found in normal life or even weight training (regardless of how heavy one lifts). In both sprinting (Kyrolainen, Avela, & Komi, 2005) and plyometrics (Dursenev & Raevsky, 1978), muscle tension and activation exceeds 100% of voluntary concentric capacity. This is possible because the strength of a muscle group is partially dependent upon the mode of contraction.

Muscles are capable of generating 30-40% greater tension during an eccentric contraction and around 10% greater in an isometric contraction than in a concentric contraction (Siff, 2003). This is believed to be due to the properties of the bonds between intramuscular contractile proteins, but the exact reason is still unknown. Irrelevant minutia aside, these properties make for some useful and interesting differences between contraction types. For instance, as the speed of concentric contraction increases, the amount of force the muscle is able to produce decreases. For eccentric contractions however, the amount of force the muscles are able to produce increases with speed. In fact, depth drops from over 2 meters have been shown to result in instantaneous forces exceeding 3500 kilograms, or

more than 20 times bodyweight (Dursenev & Raevsky, 1978).

Though one would be ill advised to use 2 meter depth drops as a training tool, at least without years of extensive preparation, eccentric training is arguably the best mode of training with which to expose the muscles and tendons to high levels of force. Potential benefits of eccentric-dominant training include sarcomereogenesis (Butterfield, Leonard, & Herzog, 2005), increased tendon stiffness (Rabita, Couturier, Lambertz, 2008), a shift towards fast twitch fiber expression (Hortobagyi, Dempsey, Fraser, Zheng, Hamilton, Lambert, & Dohm, 2000; Paddon-Jones, Leveritt, Longergan, & Abernethy, 2001), increased intramuscular structural protein levels (Lehti, Kivela, Komi, Komulainen, Kainulainen, & Kyrolainen, 2009), and possibly even hyperplasia (or the formation of new muscle fibers (Kelley, 1996).

Mastering General High Speed Eccentric Movements:

Unlike lifting weights, in which the primary focus is generally on the concentric portion of the movement, most sporting actions rely primarily on eccentric contractions. During a high speed movement, such as a sprint stride or the countermovement prior to a jumping takeoff, the working muscles contract eccentrically to dampen the force of the body descending. As they contract, they transfer that force to the tendons, which stretch under the load. And then, once downward movement has been terminated, the tendons snap back to their original length and the muscles contract concentrically to add to the tendon-generated force. In this way, the tendons provide a great deal of the propulsion while the muscles they're attached to serve to correctly regulate tension and stretch the aforementioned connective tissue (Bosch & Klomp, 2005; Kurokawa, Fukunaga, Nagano, & Fukashiro, 2003).

Performing high-speed eccentric movements (a category which includes nearly all sporting movements) requires not only a great deal of muscular strength and tendon stiffness, but also a significant amount of coordination. The brain needs to learn when and how to contract the muscles during these movements, and it also needs to learn that it isn't in danger from the rapid stretching forces, lest it inhibit muscle contractions to prevent a potential tear or rupture.

As with all training goals, there needs to be a gradual build-up here. Having someone go out and try to perform sprints at 100% their first time on the track is a recipe for disaster. Speed and force need to be closely regulated.

Training in Integration:

Just as in the Exposure phase, training in the Integration phase is in a simple one-size-fits-all format. Whereas the point of Exposure was primarily to make the body healthy enough for real exercise, the point of the Integration phase is to prepare the body and mind specifically for performing sporting actions. This goal will be accomplished by first teaching the athletes to perform basic dynamic movements while holding the correct postures and activating the right muscles. To do this, the phase will use a progression designed specifically to ease them into maximal ballistic movement. The progressions will ultimately lead to the athlete, regardless of sport, being able to perform both depth jumps and sprints at full intensity. Once they're able to do that, they will be able to move on to the Refinement phase.

Sprints and depth jumps have been chosen as the ultimate goal movements for a couple of reasons. For one, top speed sprinting and depth jumps involve higher intensities than are found in nearly any sporting movement. Team sport athletes never get the chance to actually reach top speed in a game, so the forces of top speed sprinting are higher than anything they'd typically encounter (Weyand, Sternlight, Bellizzi, & Wright, 2000), and the eccentric loading found in depth jumps is higher than anything seen outside of track and field. And two, sprints and depth jumps are very general movements that transfer well to nearly all sports and provide great overall benefits (Markovic, Jukic, Milanovic, & Metikos, 2007; Young, McLean, & Ardagna, 1995).

In addition to working towards maximal sprinting and plyos, regular weight training with moderate loads (around 70-80% of one rep max) will also be employed in this phase. Not only does combining resistance training with plyometrics produce results superior to plyometrics or weights alone (Adams, O'Shea, O'Shea, & Climstein, 1992), but plyometrics performed prior to weight training effectively enhance strength (Masamoto, Larsen, Gates, & Faigenbaum, 2003), further increasing the training effect of the session.

Keeping in mind the interactions between each type of training, each session will be structured for maximal results. Similarly, the progressions will allow one to safely increase the force and complexity of the employed movements in a safe and methodical manner. As with last phase, this phase will focus on a few select movements and will drill them with regularity. And again, as with last time, the focus will be on performing each movement with the best posture and muscle activation as possible, with intensity coming afterwards.

The Integration Program:

The following program is meant to be followed as closely as possible. Unlike in the last phase, training will be split into upper and lower body sessions. There will also be a little more variability because it will be up to the individual to determine the volume and intensity of their training sessions as well as the rate at which they move through the outlined progressions.

Lower Body Session:

<u>Frequency:</u>	2 times per week
<u>Warm-Up:</u>	Mild activity (elliptical, rowing, etc) for 5-10 minutes or until a light sweat develops
<u>Mobility:</u>	Walking Lunges, 2 sets x 10 repetitions per leg Side Lunges, 2 sets x 10 repetitions per leg Shoulder Dislocations, 2 sets x 10 repetitions Toe-Touch Squats, 2 sets x 10 repetitions Scapular Slides, 2 sets x 10 repetitions Chair, 3 sets x 25 repetitions
<u>Progressions:</u>	2-4 Exercises from the “Ballistic Progression”, 8-12 total sets
<u>Workout:</u>	Back Squat, 20-40 total repetitions Single-Leg Romanian Deadlift, 20-40 total repetitions per leg ISO Leg Lowering, 4 sets x 30 seconds ISO Single-Leg Calf Raise, 4 sets x 30 seconds per leg
<u>Conditioning:</u>	20-30 minutes of mild activity (elliptical, rower, etc.) while keeping the heart rate between 120-140 beats per minute
<u>Cool Down:</u>	Repeat the “Mobility” section

Upper Body Session:

<u>Frequency:</u>	2 times per week
<u>Warm-Up:</u>	Mild activity (elliptical, rowing, etc) for 5-10 minutes or until a light sweat develops
<u>Mobility:</u>	Walking Lunges, 2 sets x 10 repetitions per leg

Side Lunges, 2 sets x 10 repetitions per leg
 Shoulder Dislocations, 2 sets x 10 repetitions
 Toe-Touch Squats, 2 sets x 10 repetitions
 Scapular Slides, 2 sets x 10 repetitions
 Chair, 3 sets x 25 repetitions

Workout:

Bench Press (shoulder-width grip), 20-40 total repetitions
 Chest-Supported Rows, 20-40 total repetitions
 DB External Rotations, 2 sets x 10-12 repetitions

Conditioning:

20-30 minutes of mild activity (elliptical, rower, etc.) while keeping the heart rate between 120-140 beats per minute

Cool Down:

Repeat the “Mobility” section

Notes: As one may notice, while there are some concrete guidelines in the routine above, there is a lot of room for play. For instance, when one is given the directive “20-40 total repetitions” that means that they get to choose how much volume they do. They can choose 5 sets of 5 repetitions, 3 sets of 10 repetitions, 10 sets of 2 repetitions, or maybe sets of 8, 7, 6, and 5 repetitions. What they do does not matter. The only guidelines are that the total number of working reps is between 20 and 40 and the trainee challenges themselves. Going to failure on any given set is strongly discouraged, but working hard is the name of the game. One should be neither fresh as a daisy nor fall-down tired after a given session. As long as one challenges themselves and tries to increase the weights, repetitions, or exercise density between sessions, they're doing fine. Again though, never increase the weight or number of repetitions at the expense of form (tilted pelvis, jerky motions, etc.).

This variability in total volume also allows one to assign work depending on how they're feeling on a particular day. If one feels rundown or tired, they might do less work at a lighter weight. If one feels strong and is itching to train, they may do more work. It's all up to the individual to decide what they're doing. Regardless of the number of repetitions however, the author suggests that trainees limit rest times to 2-3 minutes between sets. This provides both a cap to the intensity and helps build conditioning.

In the “Progressions” section of lower body days, a similar amount of variability is seen. Again, depending on how the trainee feels on a given day and how they want to focus on things, they can

choose to vary the number of ballistic exercises they perform as well as the total volume. If the trainee really wants to work on mastering a couple of particular exercises, then they should only employ two different movements per session. If they want to slowly get acquainted with more movements, or perhaps maintain proficiency in some movements while building it in others, they can distribute their volume between more exercises. For more information on the ballistic progressions, see the “Ballistic Progression” section below.

As a final note, it should be said again that during all movements, **one should attempt to keep their pelvic tilt neutral through active abdominal control.**

Ballistic Progression:

The Ballistic Progression is a series of exercises meant to gradually and safely expose trainees to high-speed, high-force activities such as sprinting and depth jumps. One should start with the exercises at the beginning of the progression and only move on to more difficult exercises as their abilities allow. One can move on from an exercise when they are able to perform it quickly, easily, and while keeping their pelvis in the right position. Having said this though, knowing when to progress can be difficult.

“Quickly” and “easily” are rather subjective, but when one can perform a movement confidently, smoothly, and with perceived ease, they're usually ready to go on. If one feels like there's a chance they might not be ready to move on, then they are not. Pelvic tilt is a little easier to quantify with the use of a video camera. By filming one's self performing the exercise, one can see what their posture is like at any given time. When it remains perfect throughout the movement, they're ready to move on. Keys to look for are excessive posterior or anterior tilt, which will be indicated by an overly flexed or overly extended lumbar spine.

The progression includes not only a list of exercises, but a preferred range of set durations and rest periods for each movement as well. The reason for this is that each movement works best when applied for certain volumes per set. There's also variability between the optimal rest periods for many of the movements.

And just as a note, though one might be proficient in a given exercise right away, it's usually a good idea to drill each exercise for at least 2-4 sessions before leaving it behind. Also, for single-legged exercise, the set for the right leg and the set for the left leg count as a single work set.

Movement	Set Duration	Rest Between Sets
RFI Line Hops	25-40 seconds	120-180 seconds
Squat Jumps	5 repetitions	120-180 seconds
RFI Step Hops	10-25 seconds	120-180 seconds
Countermovement Jumps	5 repetitions	120-180 seconds
Altitude Landings	5 repetitions	180-240 seconds
Single-Leg RFI Line Hops	10-25 seconds	120-180 seconds
Depth Jumps	3-5 repetitions	240-360 seconds
Single-Leg RFI Step Hops	10-25 seconds	120-180 seconds
Sprints (long)	>200M	30-60 seconds per 10M ran
Sprints (short)	<200M	30-60 seconds per 10M ran

Movements:

Some of the movements utilized in this phase might not be familiar to a number of trainees. Some might also require special cues or instructions for their performance. This section will address both issues.

As has been said continually throughout the last two chapters, form is the first priority in performing any given movement or exercise, followed by intensity and volume. It's better to move more slowly, lift less weight, or drop from a lower height with good form than it is to go faster, lift more, or drop from higher if one's form is considerably off.

Since the movements listed in the “Workout” section of the Integration Program are largely self explanatory, only the movements from the Ballistic Progression will be covered. As always, each movement is to be performed with a neutral pelvic position.

Altitude Landings:

Altitude landings involve stepping off of a box or other raised surface and sticking the landing like a gymnast (overhead arm flourishes are optional and not recommended). Upon ground contact, the joints should give as little as possible, but the landing should not be harsh or jarring.

Though one can land in a number of different positions to emphasize different muscle groups, altitude landings in the Ballistic Progression should be performed by landing in a quarter squat. One

should also land with a majority of their weight on their mid-foot. The heels can and will touch the ground, but they should be absorbing very little landing energy.

Drop height is determined by strength and specific preparedness, but most people can start with a box anywhere from 100-110% of their countermovement jump height. When one can correctly land from a drop 120-130% of their maximal countermovement jump height, they are proficient in the exercise. Heights of up to 3.2M have been used during research, but the injury potential during such drops is too high to be considered safe (Dursenev & Raevsky, 1978).

Countermovement Jumps:

A countermovement jump is otherwise known as a standing vertical leap. One stands still, quickly dips down, and then jumps as high as they can. The depth to which one dips and the speed with which they alternate from eccentric to concentric contraction is likely to be largely determined by the dominant muscle fiber type in their drive muscles (glutes and quadriceps). People with a higher proportion of fast twitch fibers benefit from shallower dips and faster transitions, while people with a higher proportion of slow twitch fibers are the opposite (Bosco, Tihanyi, Komi, Fekete, & Apor, 1982).

When one is able to jump and land under control and in balance, they are proficient in this movement.

Depth Jumps:

Depth jumps are similar to altitude landings. One steps off of a box or other raised surface, absorbs the landing energy, and springs back into the air as high as they can. The whole movement should be smooth and fluid. If it's noticeably separated into a landing and a takeoff phase, then one is not performing the movement correctly, likely due to too high of intensity (drop height).

As with altitude landings, one should land in a quarter squat position with their weight on their mid-foot. One should focus on both getting off of the ground as quickly as possible and jumping as high as possible. By focusing on fast absorption and reversal, one will see better results than by focusing on rebound height alone (Bobert, Huijing, & van Ingen Schenau, 1987). Drop height is determined by finding the box height from which one rebounds the highest.

When one is able to rebound higher than their countermovement jump from a drop of any height, they're proficient in performing depth jumps.

RFI Line Hops:

RFI line hops involve simply hopping back and forth over a line on the ground as quickly as possible. They can be done both linearly (forward and back) or laterally (side to side). Foot contacts should be fast (well under .2 seconds each) and movement should be fast and coordinated.

There are no strict proficiency guidelines, so one will have to judge for themselves when they're ready to move on from here.

RFI Step Hops:

RFI step hops involve hopping onto and off of a step (usually 6-8" in height) as quickly as possible. During these hops, the body's center of gravity does not rise and fall by the full height of the step, but rather there is movement at the hips to allow the feet to travel upwards and downwards while the center of mass stays relatively stable in height. Foot contacts should be fast (well under .2 seconds each) and movement should be fast and coordinated.

There are no strict proficiency guidelines, so one will have to judge for themselves when they're ready to move on from here.

Single-Leg RFI Line Hops:

These are performed the same as RFI Line Hops, but on one foot at a time.

Single-Leg RFI Step Hops:

These are performed the same as RFI Step Hops, but on one foot at a time.

Sprints:

Describing proper sprint form in a single chapter, let alone a single set of paragraphs, is beyond the author's capabilities. Still, as long as one remembers to keep their pelvis neutral and relax out on the track, things will tend to turn out fine. If one pushes too hard or puts too much effort into a run, they'll tie up and destroy both their form and their speed.

Form aside, the progression has sprint work moving from longer runs to shorter runs because longer runs will necessitate a slower speed than shorter runs, and therefore less pounding on the body.

To replicate this effect in another way, one can start sprinting on surfaces like flat grass and move to a synthetic track after a while. Regardless of the surface, it is suggested that athletes purchase a cheap pair of sprint spikes or cross country waffles in which to run. Not only will the minimalistic shoe design allow their feet and lower legs to work properly, but the spikes will provide grip on any surface.

Squat Jumps:

A squat jump is essentially a countermovement jump with no countermovement. One squats down into a quarter squat position, pauses at the bottom for 2-4 seconds, and then explodes upwards as high as they can.

When one is able to leap upwards and land in a coordinated and balanced manner, they can move on to the next movement in the progression.

Wrap Up:

With the Exposure phase having developed the requisite physical attributes for proper training, and the Integration phase having taught the athlete how to put those attributes to good use in high speed, high intensity athletic movements, it's now time to move on to the third and final phase of training: Refinement. Once one has become proficient in sprinting and depth jumps, they've been exposed to two training methods with higher intensities than nearly any sporting movement and from that moment on, they should be able to handle anything their sports throw at them.

5

Refinement

Refinement is the third and final stage of training in which the focus shifts from general training to sport specific training, more specifically, the perfection of an athlete's sporting movements and the precise physical qualities they depends on. As such, the generalized format of the previous two phases is gone. Training in Refinement needs to be tailored to the individual and their sport. Though this does make specific prescription impossible, the author will still cover general programming strategies.

Playing the Game:

No matter how big, fast, and strong an athlete is, in order to perform optimally at a given task they will need to spend significant amounts of time practicing it. In some sports, it's perfectly possible, and in fact common, for more physically capable athletes to be outplayed by opponents who are simply more skilled. In order to be at one's best, they need to hone both their physical abilities and their sporting skill, and this is what the Refinement phase seeks to do.

Whereas the previous two phases focused solely on increasing one's raw physical abilities, the Refinement phase centers around making each athlete as proficient at their sporting skills as possible while targeting specific physical abilities necessary to perform said skills. Since this book deals mainly with running and jumping athletes (which a majority of American athletes are), that's mainly what this section will cater towards.

In any sporting activity, proficient athletes will contract only the muscles they need to perform the movement, while less skilled athletes will contract antagonistic muscle groups, creating spurious tension which reduces the output and efficiency of the movement (Siff, 2003). By repeatedly practicing a movement, the body will become more efficient, will stop contracting extraneous muscles, and will boost the overall level of performance. In fact, in some sports, skilled athletes expend less energy to perform given movements than their less skilled counterparts, even though their work is significantly

more intense (Vorobyev, 1978).

At this point in training, the question isn't whether or not one needs to train their sport, but how often they need to do it. Some sports will require significantly more practice than others; for example, golf versus shot put. Needless to say, a golfer will spend far more of his energy playing golf than he will in the weight room, whereas a shot putter will spend a great deal of his energy in the weight room and a bit less in the ring. For athletes in more common (for the US) sports, basketball players will need to spend more time on the court than football offensive linemen will on the field. Individual plans need to reflect this.

Moving away from sports themselves, which usually require a rather large mental component, sporting actions are what this phase is really about. Sporting actions include sprinting, jumping (off of one foot or two, depending on one's sport), throwing, and any other basic movement one's sport relies heavily upon (or entirely upon in the case of track and field athletes). This text won't cover how to read defenses, anticipate opponents' motions, dribble better, or properly run pass routes. Those things are best learned on the field.

Like the sports themselves however, sporting action are also best learned through performance. Many athletes want to run fast and jump high and they look for special exercises to help them reach their goals, but what they should be doing is practicing running fast and jumping high. Just like if one wanted to get good at the piano, they'd sit down and play, if one wants to get good at a sporting action, they need to do it.

The Plan:

Training sessions in Refinement will usually contain three elements: specific work, supplementary work, and general work. Specific work includes the sporting actions themselves. Supplementary work includes anything meant to train the specific physical and/or neural qualities upon which sporting actions rely and/or potentiate sporting movement performance. And general work includes anything meant to fulfill general goals like increasing muscle mass, maintaining or increasing flexibility, reinforcing proper general recruitment patterns, or anything else that isn't directly related to sporting movement performance.

The importance of each type of work can generally be ascertained by looking at its name. Specific work is most important, followed by supplementary work, and trailed by general work. The

order and construction of training sessions will reflect such.

A sample training session may look something like this:

- Warm Up
- Mobility
- Specific Work
- Supplementary Work
- General Work
- Conditioning (*if necessary*)
- Cool Down

It won't always be this way though, as a careful mixing and matching of certain methods (specific, supplementary, and general) can create potentiating effects if employed properly. Instructions for implementing this type of training will be covered later.

Specific Work:

As already mentioned, specific work is classified as performing one's sporting actions at a relatively high intensity. If you're a sprinter, you sprint, if you're a basketball player, you jump and focus on change of direction, if you're a thrower, you throw. Pretty simple. Specific work should be the primary focus of an athlete's training plan for most of the year, with the exception of the early off season.

Despite the fact that specific work is limited to a few sport-specific movements, there is still great variability in the way it can be applied. One can manipulate volume, rest periods, set duration, and intensity to create the desired training effect. How and why one should manipulate each of the aforementioned variables requires a little explanation.

Starting at the end of the list and working back, the intensity of the specific work can thought of as its quality relative to a maximal performance. Intensity is the speed ran, the height jumped, and the distance thrown. The better the performance relative to one's ability, the higher the intensity.

In competition, the objective is usually to perform at the highest level possible (ie. maximally). As covered in the "Skill" section of the second chapter, each and every movement is a skill unto itself. However, what wasn't covered was that speed/intensity of movement is specific as well. The only movement that matches the skill of performing maximally is performing maximally. In other words, running at 95% is not the same as running at 100%. They're both very similar, but there are distinct differences.

The further from maximal intensity a movement is performed at, the less transferability there is. In other words, when looking to train the skill necessary for sprinting at 100%, running at 95% is more transferable than running at 90%, which is more transferable than running at 85%, and so on. If one wants their skill training to be effective, it needs to try to replicate game speed. A focus on high intensity sports practice becomes even more important once one understands that very few people are able to perform at a true 100% outside of competition (Zatsiorsky, 1995). Overall excitation levels are much higher in competition than in practice, and one's 100% in practice may be 95% or less of their true max while competing.

Set duration (how long a given set lasts) is another important factor in specific training. Set duration directly affects potential movement intensity, overall work volume, and which energy system is taxed/trained.

Movement intensity is affected because the longer duration a movement is performed for, the less average intensity it must have. Explosive movements are dependent upon type II muscle fibers, and type II fibers are relatively quick to fatigue. Type IIa muscle fibers can provide tension for roughly 50 seconds, but type IIb fibers, which are the most powerful, fatigue in well under 10 seconds, usually after only around 3 seconds or less. If any type of fibers are exhausted and unable to contribute, the body will not be able to produce maximal tension and sporting ability will decline. For this reason, if one is going for absolutely maximal quality, set duration should be limited to ~3 seconds (about twice that in cyclical activities with intra-movement “rests,” like sprinting).

Set duration affects overall work volume because longer sets necessitate lower intensities, and lower intensities allow for greater volume before performance deteriorates. Again though, as intensity decreases, so does the movement's transferability over to maximal performance.

Which energy system is primarily trained relies on set duration as well. As covered in the “Endurance” section of the second chapter, each of the three energy pathways is dominant over a certain span of time. By training in the correct span of time one can effectively target a given energy pathway. Doing away with unnecessary science, what one really needs to do is observe patterns of energy expenditure in their sport and train accordingly while not really worrying about which pathway is providing the fuel.

Much like set duration, rest periods also play a big part in determining both the quality of work and the energy system(s) trained. Longer rest periods allow for higher quality work and less of a

performance drop off between sets. High intensity work for greater volumes isn't always desirable though, as this will involve longer recovery times between sessions and motor learning happens fastest with more frequent exposures.

On the other side of the spectrum, limited rests can be used as an intensity and/or volume governor. If forced to operate on limited rests, an athlete will not be able to train at full intensity nor will he be able to maintain performance levels for too long before they begin to deteriorate. This will allow for more frequent exposure to one's sporting movements and if intensities and rest periods are kept the same, it's also a good way to monitor work capacity.

In general, when focusing on the quality of work, rest periods in between bouts of explosive exercise should be at least 3 minutes in length (Willardson, 2006). For more metabolically taxing movements like sprinting, a good rule of thumb laid down by legendary sprint coach Charlie Francis is 1 minute of rest for every 10M ran. This means, if one ran 200M at 95-100% intensity, they would need to rest 20 minutes before trying to repeat the feat. When using rest periods as an intensity/volume governor (which usually works best with sprint work) rest periods of 90-120 seconds between sets of most explosive movements works well, while 1 minute of rest for every 20-40M ran works well for sprints. Intensity during sets with such limited rest periods will necessarily need to be around 80-90%.

Finally, the last variable that needs to be taken into consideration when performing specific work in a given session is overall stimulus volume. Greater volumes allow for a greater training stimulus, but they also require more post session recovery time. More post session recovery time means less training frequency. In a sense, it's a scale one has to balance, with single session volume at one end and training frequency at the other. In addition, one also needs to take training intensity into consideration as well.

The intensity a sporting movement is performed at will determine the maximal volume one can apply and will also influence the training effect. For beginners, who have not yet mastered their sporting skill, lower intensity work can be very effective in teaching them to perform their movements. As their proficiency in the skill increases however, any work meant to train skill must increase in intensity if one wants it to apply. In other words, a beginning sprinter can train at 85% and make gains in their 100% sprint form, but as their skill increases, so too must the intensity at which they're training if they hope to see gains in sprint proficiency. The training intensities discussed above also affect work volume. Lower intensity work allows beginning athletes to get more overall exposure to their skill,

while higher intensity work for the proficient necessarily limits their training volume.

Pure skill development aside, specific physical development through specific work seems to occur best when one keeps intensity between 85-95%. Work in this intensity range allows for great enough volume to create physical changes, regardless of one's level of proficiency in the skill.

So in short, when training for pure skill, beginners can afford to work in the range of 85% or so, but as their proficiency increases, they need to gradually work their way towards 100%. When training for specific physical adaptations, the best range of intensity to work in is 85-95%, regardless of skill level. Volumes will be determined by recovery ability, desired training frequency, and exercise intensity.

Supplementary Work:

Supplementary work is any work that is meant to train the specific physical and neural qualities upon which an athlete's sporting movements are based. Similarly, supplementary work can also be used to potentiate sporting skill performance. It tends to mimic an athlete's sporting movement in muscles targeted, range of motion, speed of movement, contraction type, and/or muscle-tendon dominance.

What makes supplementary work useful is that it can be used as a form of specific overload for pertinent musculotendon groups and/or neural processes. The ability to target and strengthen specific muscles or processes that might be lagging in sporting movements is very useful, because if one tried to address them with the sporting movement itself, the body would likely compensate (through either altering form or decreasing overall output) and just try to work around the deficit. Supplementary work allows one to target their problems without worrying about negatively affecting sporting form.

As mentioned, supplementary work tends to mimic sporting actions in muscles targeted, range of motion, speed of movement, contraction type, and/or muscle-tendon dominance. However, since running, jumping, and cutting (the foundation of most popular sports) are so similar, there's a lot of crossover between supplementary movements and sporting movements. Depth jumps, for instance, can be used to effectively supplement nearly any sporting movement, but one can tweak form to create specific adaptations and/or make them more specific. A lot of other movements are similar in that they can be applied for a wide spectrum of goals, but further tweaking allows for greater specificity.

In order to simplify things somewhat, the author is going to give a list of common and effective supplementary movements for a few common sporting skills.

Sprinting (Acceleration)

- Altitude Landings (split squat variation especially)
- Depth Jumps (split squat variation especially)
- Bounds (from standing)
- Resisted Sprints (w/sled or tow cord)
- Hill Sprints (slight grade)

Sprinting (Top Speed)

- Altitude Landings (reverse and stiff-legged variations)
- Depth Jumps ($\frac{1}{4}$ squat and stiff-legged variations)
- Hurdle Hops (focus on low GCT)
- Speed Bounds (from an approach)
- Downhill Sprints (very slight grade)

2-Foot Jumping (From an Approach)

- Altitude Landings ($\frac{1}{4}$ squat variation)
- Depth Jumps ($\frac{1}{4}$ squat variation)
- Short Sprints (<40M)

1-Foot Jumping (From an Approach)

- Altitude Landings (nearly all variations)
- Depth Jumps (nearly all variations)
- Bounds (from an approach)
- Top Speed Sprints

Changing Direction

- Altitude Landings (split and deep squat variations)
- HARTT Progression
- Short Sprints (<40M)

Altitude Landings:

Altitude landings are an effective way to expose the body to high levels of force in very specific positions. This force overload can be used to either condition the muscles, tendons, ligaments, and bones to withstand higher forces, or can be incorporated with specific work in order to cause potentiation.

Altitude landings are useful because they allow for higher intensities than depth jumps (Dursenev & Raevsky, 1978) and are easier to perform as there is no rebound. The lack of a rebound

allows the athlete to concentrate solely upon landing in the right position and absorbing the kinetic energy properly. As covered extensively (some might say: excessively) earlier, proper position and activation are even more important than exercise volume and intensity.

Depending on one's goals, landing position can be altered to target certain movement patterns and muscle groups. The following table outlines common variations and the muscle groups they target. Single-leg and reverse variations can be combined with all other variations with the exception of single-leg split squat landings (ie. reverse single-leg $\frac{1}{4}$ squats).

Variation	Targets
$\frac{1}{4}$ Squat	Plantarflexors (gastrocnemii), Knee Extensors
Deep Squat	Plantarflexors (solei), Hip Extensors, Knee Extensors
Stiff-Legged	Plantarflexors
Split Squat	Hip Extensors, Knee Extensors, Plantarflexors (solei)
Reverse	Shifts Stress to Hip Extensors
Single-Leg	Shifts Stress to Femoral Rotators

Sets of altitude landings should consist of 5 or less reps and rest times in between sets should be greater than 3 minutes. When one is using single-leg or split squat variations, it's best to alternate between the left and right leg with each rep (ie. left, right, left, right, set finished).

Bounds:

Whereas depth jumps and altitude landings are typically knee extensor dominant, bounds provide a means of supplementary training focused far more on the hip extensors. Performing bounds also trains a number of reflexes whose development is crucial to running fast (Bosch & Klomp, 2005) while the fact that its unilateral in nature only makes it more specific to sprinting (Siff, 2003). In essence, where traditional plyometrics are meant to mimic jumping movements, bounding is meant to mimic sprinting movements. Some high level sprint coaches even use bounds as a tool to measure specific strength for their athletes (Dick), as bounds involve even higher levels of ground forces than sprints (Weyand, Sandell, Prime, & Bundle, 2010).

Though bounding form isn't as variable as that found in depth jumps and altitude landings, it can be tweaked for different purposes. The movement has only 3 real variations: bounding from a

stand, bounding from an approach, and speed bounding from an approach.

Bounding from a stand is commonly done in continuous sets of 3 to 10 (RLRLR...and so on) and due to the standing start ground contact times are longer. Bounding from a stand requires the most strength and the least reactivity of all bounding variations.

Bounding from an approach involves approaching a designated area at a jogging pace and then using that momentum to bound for either height or distance. Bounding for height puts more stress on the quadriceps and plantarflexors and bounding for distance puts more stress on the glutes and hamstrings. Sets typically involve covering a distance of 20-30M. Bounding from an approach requires a moderate level of strength and moderate level of reactivity compared to the other two variations.

Speed bounding from an approach involves running at a high speed and then transitioning into a bounding sprint in which one tries to replicate traditional sprinting form but with more vertical and horizontal amplitude. The faster one is able to go while maintaining form, the better. Speed bounding requires the highest levels of reactivity of any bounding variation and sets typically involve covering distances of 20-30M. Most of the stress from this variation falls to the glutes and hamstrings.

Depth Jumps:

Depth jumps are similar to altitude landings, but involve a landing and then an explosive rebound. All of the guidelines and variations that apply to altitude landings also apply to depth jumps. Depth jumps and altitude landings really both accomplish the same thing, but depth jumps are easier to measure fatigue with (decrease in jump height) and they're more fun too. In truth though, one could very easily exclude depth jumps from their supplementary work and only use altitude landings with no problems whatsoever.

HARTT Progression:

HARTT, which stands for Horizontally-loaded Absorptive and Reactive Torsion Training, is a progression the author created to help build change of direction ability in athletes. The basic premise behind HARTT is that when cutting and changing direction, the force on the limbs is largely horizontal, while the force from traditional plyometric drills is vertical. The progression circumvents this issue by using athlete-generated horizontal (and vertical) energy as loading rather than the always-vertical force of gravity. The progression also has the benefit of needing no equipment to apply, only a fair-sized

patch of clear ground. And before going any further, yes, the name is meant to be overly complex and totally tongue-in-cheek. It was a joke, but the title works and so it stuck.

Moving on, as already mentioned, HARTT involves taking the horizontal and vertical energy generated by performing a broad jump and uses that to teach force absorption. Each movement in the HARTT progression consists of 2 or 3 components. The first component is a plain 2-footed broad jump. This is where the intensity of the movement is controlled. The higher and further one jumps, the more energy they'll be absorbing upon landing. The second component is the landing from the broad jump, and it's here where the training effect is sought. Landings can be 2-footed or 1-footed and can involve any amount of rotation. 1-footed landings will obviously be more intense than 2-footed landings and the rotational component will put stress on the same structures needed for fast cutting. The third component isn't present in all movements. Some HARTT movements are like altitude landings, they only involve a drop and then absorption. Others are like depth jumps; they involve a drop, an absorption phase, and then a rebound. The rebound just involves immediately (no resetting or stutter stepping) bouncing back to the exact position one broad jumped from, reversing rotation as necessary.

When performing HARTT movements, it's important to pick a broad jump distance that allows for the proper intensity. Much like depth jumps and altitude landings, finding the right intensity (drop height in those cases) is critical. It's always better to start off with too little rather than too much and risk injury.

HARTT Progression

- Jump forward with no rotation
- Jump forward with 90 degrees rotation
- Jump forward with 180 degrees rotation

- Jump forward with no rotation, rebound back
- Jump forward with 90 degrees rotation, rebound back
- Jump forward with 180 degrees rotation, rebound back

- Jump forward with no rotation, land on one foot
- Jump forward with 90 degrees rotation, land on one foot
- Jump forward with 180 degrees rotation, land on one foot

- Jump forward with no rotation, land on one foot, rebound back
- Jump forward with 90 degrees rotation, land on one foot, rebound back
- Jump forward with 180 degrees rotation, land on one foot, rebound back

When going through the progression, it's best to start with 2-3 different movements per session and only move on once one becomes truly proficient in performing them. Proficiency can be judged by viewing the control with which one manipulates their body during the landing and, if applicable, the rebound. If the movements are fast, powerful, and graceful, one is ready to move on and/or increase the intensity. Any stutter stepping, hesitation, or wild movement means the trainee needs to go back to earlier steps in the progression and/or decrease the length of their initial broad jumps.

Landing cues are simple. All one needs to do is focus on landing in a balanced position in which they could easily explode out in any direction at a moment's notice.

And as a final note, one needs to make sure to rotate both directions in equal volumes (unless trying to bring up the performance of a weaker leg).

Sprints:

There is perhaps no better single movement pattern for improving general athletic abilities than sprinting. Sprinting heavily involves every muscle in the trunk and legs, is very metabolically demanding, requires minimal to no special equipment, and even produces better results (in terms of strength, power, and agility) than traditional plyometric training (Markovic, Jukic, Milanovic, & Metikos, 2007). If the author could only choose one supplementary movement to include for all athletes, it would be sprinting.

Sprinting can be broken down into two general phases: acceleration and top speed. Even though the world's best sprinters don't hit their top speed until roughly 60M, most of them are at 90% of their top speed within 30M (Ferro, Rivera, & Pagola, 2001). For those who aren't gifted enough to run <10 seconds in the 100M dash, top speed is reached even earlier. As such, the author is going to draw the divide between acceleration and top speed sprinting work at roughly 30M. Anything below 30M is acceleration, anything above is top speed. This only applies to sprints from a standing or jogging start, of course. Even 10M flying sprints are over 40M if the build up is included.

As said earlier, describing proper sprint form in detail is beyond the scope of this text, as the biomechanical analysis could fill a book on its own. With this in mind though, deficits in sporting form are nearly always due to recruitment issues or strength imbalances and sprinting is no different. Since any athlete looking to sprint has already spent months building a balanced and coordinated physique (when going through the Exposure and Integration phases), sprint form should not be an issue. Still, it's

a good idea to try and relax when sprinting. Trying too hard usually makes one tighten up (create spurious tension) or causes them to lose proper pelvic position and fall into excessive backside mechanics. Other common problems, as well as their causes and solutions, will be given in the “Standard and Testing” chapter.

Standard sprints aside, the movement has a number of different variations that can be used to great effect. When training for acceleration, resisted sprints (either with a pulley system or a tow sled) (Harrison & Bourke, 2009) and incline sprints both work well. When training for top speed, downhill or decline sprints are very effective.

When performing resisted sprints one can either use a tow cord or a sled, with sled work being the most common. Resistance is determined on an athlete by athlete basis, but a number of world class sprint coaches recommend that times increase by no more than 10% (when compared to an unloaded sprint) when doing tow work. The reason for this is that the greater load found in towing work, the greater the change in sprinting form (Lockie, Murphy, & Spinks, 2003). Similarly, incline sprint work also impacts sprint form, so it's wise to keep the grade manageable (Slawinski et al, 2008). Towing and hill work is best kept to under 30M, as is all other acceleration-focused work.

Downhill sprinting is done from a fly (submaximal approach used to build up to top speed) and typically takes place over 20-30M while actually at top speed (not including the run-in). Both the top speed and the eccentric loading found in downhill sprinting are higher than in sprinting on flat ground (Paradisis & Cooke, 2001), and this loading has been shown to lead to sarcomerogenesis, or the formation of new sarcomeres in series within a muscle (Butterfield, Leonard, & Herzog, 2005). This adaptation is not only useful for top speed, but for all speed-related performances as well as injury prevention. The optimal grade on which to perform downhill sprint work is difficult to pick out. Excessive grades lead to significant changes in form. Though the highest speeds are found with declines of 5-6% (Ebben, 2008), the form breakdown at this speed is probably too great for optimal carryover. As such, the author suggests a grade of around 3%, though even the slightest grade will provide enough overload when training specifically for top speed.

Potentiation:

Potentiation is an increase in performance in one movement caused by the aftereffects of another movement performed prior (anywhere from minutes to days). By properly arranging training

means within a given session, or arranging means from one session to the next, it's possible to raise the maximal intensity of subsequent work. This increase in performance comes through either neural excitation or, in some cases, biochemical priming.

When dealing with methods of neural potentiation, the result is referred to as post-activation potentiation (PAP). After a short period of maximal activation (usually less than 10 seconds), a given muscle group will display an increase in maximal torque production, a decrease in half-relaxation times, and an increase in rate of force development (O'Leary, Hope, & Sale, 1997). The muscle activation can be achieved through isometrics, traditional weight training, or plyometric drills and its effects typically last from 5-20 minutes, depending on the individual. Also, those with higher percentages of fast twitch muscle fiber will likely gain more benefit from PAP than those with lower percentages (Hamada, Sale, MacDougall, & Tarnopolsky, 2000).

Put it into practice, athletes can use their supplementary training movements to potentiate performance in their specific sport skills. Rather than performing the supplementary work after the specific work, the athlete may have a few sets of supplementary work precede the specific work. The trick, however, is creating a high enough level of stimulation without causing an undue level of fatigue in the process (Siff, 2003). To get the benefits of PAP, all that's required is 1-2 sets of intense supplementary work, after which point additional volume tends to become counterproductive. Rest periods in between sets of supplementary work, and between supplementary work and specific work should be kept between 4-8 minutes. This allows enough time for recovery yet is still short enough to take advantage of the PAP.

Here are some combinations the author has found particularly effective:

Sporting Movement	Supplementary Movement
Sprints (Acceleration)	-Altitude Landings (split squat variation especially) -Hill Sprints (slight grade)
Sprints (Top Speed)	-Downhill Sprints (very slight grade) -Hurdle Hops (focus on low GCT)
2-Foot Jumping (from an approach)	-Altitude Landings ($\frac{1}{4}$ squat variation) -Short Sprints (<40M)
1-Foot Jumping (from an approach)	-Altitude Landings (nearly all variations) -Bounds (from an approach)
Changing Direction	-Altitude Landings (split and deep squat variations)

It should be mentioned now that though this type of training is effective, it significantly increases the intensity of sporting work. This increase in intensity will either require a reduction in overall session volume or a longer recovery time after the session. Because using potentiation work has these effects, it's wise to use it sparingly or only in periods of time when absolute quality is demanded at the expense of frequency and volume. Also, it is advised that this type of training only be used when athletes are entirely fresh. An increase in intensity goes hand in hand with an increased risk of injury, and as such, it's not something one should be doing if they're not 100%.

Beyond immediate potentiation, training means can also have an effect on work performed days later. A moderate volume of weight training increases general performance 1-2 days after training, while a moderate volume of plyometrics does the same 5-6 days after performance. These increases are due to a general tonic effect on the CNS (Siff, 2003) and are not muscle-group specific. Some coaches even go as far as to use upper body lifts like the bench press to prime the CNS for sprint performance while sparing the legs (Francis, 2003). When building potentiation through unrelated muscle groups, the volume and intensity of the potentiating work can be higher than when seeking it in specific muscle groups.

As far as biochemical potentiation goes, the only place the author has seen it in practice is prior to long sprint races. Some athletes like to perform a 300M sprint at 90-95% about an hour before

competing in a 400M race. This is obviously very physically and mentally taxing however, and should only be attempted by athletes with high levels of work capacity and mental toughness. The author has not personally put such a protocol into action and would advise anyone who wants to do so to be careful.

General Work:

General work is anything meant to increase desirable physical qualities that does not attempt to approximate one's sporting movements. Examples include resistance training, stretching, and general conditioning work. The main purpose of general work is continuing on with the goals first outlined in the Exposure phase: strengthening vital muscle groups, strengthening connective tissues, teaching correct muscle activation, increasing flexibility, and building work capacity. Though the trainee has already laid a baseline of said qualities, general training will allow their development to continue.

Conditioning:

Conditioning, as it's considered here, is not sport specific and can be thought of as general health training. Consistent conditioning work allows for faster recovery in between sets, faster recovery in between training sessions, and helps to promote leanness. As in the previous two phases of training, conditioning work doesn't need to be anything fancy. All one needs is 20-30 minutes of mild activity while keeping their heart beat between 120-140 beats per minute, done 3-6 days per week. In a given training session, conditioning should be dead last, with the exception of a cool down. This will prevent any fatigue, however mild, from interfering with the rest of the session's workload.

The presence or lack of conditioning work won't make or break an athlete, but it is beneficial, and despite being simple, easy, and seemingly unimportant, it does help to include in a training plan.

Resistance Training:

Though nearly all forms of training can loosely be considered resistance training (whether that resistance come from bodyweight, bands, iron, or kinetic energy), in this section, the author is referring to weight training. Resistance training can build muscle, strengthen tendons, build or maintain muscle activation patterns, increase mobility, build work capacity, and generally lay or reinforce the ground work for athleticism.

Unlike powerlifters and Olympic lifters whose sports are about hoisting as much weight as possible in their competition lifts, most athletes don't need a very high volume of weight lifting in their routines. The majority of an athlete's training volume should come from their specific and supplementary work, while general work (such as resistance training) is added on top of everything else.

Since the point for athletes is to get the biggest bang for their buck from their resistance training, the question is not how much they can do and see results, but how little. When it comes to strength training, economy is the name of the game and one's program should reflect such.

Whereas all resistance training so far has contained no individualization, coaches and athletes at this point need to assess the muscular needs of their sport as well as individuals' own relative muscular development. Generally speaking, balance is necessary for optimal performance, but athletes in some sports can afford to carry more muscle mass in certain places than others.

In terms of lower body and trunk development, all athletes benefit from highly developed glutes, spinal erectors, abdominals, obliques, hip flexors, and hamstrings, but the odd muscle out is the quadriceps. Athletes whose sports requires a high degree of top speed (as opposed to acceleration) may find that excessive quadriceps development is a hindrance to their performance, as the extra weight can impede leg swing and disrupt sprint mechanics (Bosch & Klomp, 2005). For athletes whose sports are acceleration and/or change of direction reliant, quadriceps strength and mass is necessary, but balance is still important. As has been mentioned, quadriceps that are too strong relative to the hamstrings can lead to knee instability and higher incidences of knee injury (Lehance, Binet, Bury, & Croisier, 2009; Croisier, Ganteaume, Binet, Genty, & Ferret, 2008).

Regarding upper body development, balance, especially around the shoulder girdle, is the key, regardless of sport. The most common balance issue is scapular protractors which are relatively stronger than the scapular retractors. Such an imbalance can lead to subacromial impingement (inflammation of the supraspinatus). This issue is extremely common amongst swimmers (Bak, 1996) and can also be caused by excessive internal rotation strength of the humeri relative to external rotation strength and deficits in internal humeral rotation range of motion (Olivier, Quintin, & Rogez, 2008; Rupp, Berninger, & Hopf, 1995; Wadsworth. Bullock-Saxton, 1997). It usually arises because of a high volume of horizontal pressing relative to horizontal pulling movements. In other words, too much bench pressing or too many push ups.

Balance issues aside, the level of relative upper body mass an athlete should carry depends on their sport. Athletes whose sports depend on high levels of top speed or have significant endurance requirements (sprinters, basketball players, etc.) should carry less mass than athletes whose sports are of shorter duration or are acceleration dependent. For sprinters and basketball players, large upper bodies are just excess mass that needs to be dragged along for the ride.

Regardless of sport, proximal muscles should be given the most attention as their development is the most crucial to sporting performance.

Though the relevant muscle groups can be trained through nearly any number of movements (including those necessitating machines), economy is the name of the game. Doing a set of back squats is far more economical than doing leg curls, leg extensions, and back extensions and will probably provide better results too. As such, one should look for the most economical movements when designing the resistance training portion of their routines. Though some people's muscle attachment points, muscle activation patterns, and limb lengths will make some movements easier or more difficult than others (and might change the distribution of training effect), almost everyone can benefit from a core group of training movements. These are some of the ones the author finds most effective:

Movement	Muscle Groups Trained (in order of magnitude)
Back Squat	Glutes, quadriceps, spinal erectors, hamstrings
Snatch-Grip Deadlift	Glutes, spinal erectors/hamstrings, quadriceps, trapezius, rhomboids
Romanian Deadlift	Glutes, hamstrings, spinal erectors
Stiff-legged Deadlift	Hamstrings, glutes, spinal erectors
Front Squat	Quadriceps, glutes, spinal erectors, hamstrings
Lunges (walking)	Glutes, hamstrings/quads (depending on step length)
Split Squats	Glutes, hamstrings/quads (depending on stance width)
Power Snatch/Clean	Glutes, spinal erectors, hamstrings, quadriceps, trapezius, rhomboids
Planks	Abdominals, iliopsoas
Leg Lowerings	Abdominals, iliopsoas
Decline Situps	Abdominals, iliopsoas
Bench Press (close grip)	Anterior and medial deltoids, pectoralis major/triceps
Bench Press (wide grip)	Pectoralis major, anterior and medial deltoids/triceps
Chest-Supported Rows	Latissimus dorsi, biceps, posterior deltoids, trapezius, rhomboids
Dumbbell Rows	Latissimus dorsi, biceps, posterior deltoids, trapezius, rhomboids
Overhead Presses	Anterior and medial deltoids, triceps
Chin Ups (scapulae retracted and depressed)	Latissimus dorsi, biceps, posterior deltoids, trapezius, rhomboids
External Rotations (humeri)	Infraspinatus, teres minor

Though this list is far from exhaustive, if one trained exclusively with the movements contained within they'd never have to worry about missing out on results. If one wanted to however, they could throw in a few sets of bicep curls, tricep extensions, or other bodybuilding work at the end of their sessions. Most athletes are young men and young men tend to worry about their appearance, and if having bigger arms will give them a psychological boost in competition (or just in life) then a little *pointless* mass might be worthwhile.

For athletes with certain joint or muscle issues, assigning some of the above movements may be contraindicated. If so, it is advised that one choose movements to work around the issues at hand, even

if that means using machines. Eventually, of course, it's recommended that the focus be put on resolving the problems, but that isn't always possible.

In terms of movement selection, athletes can also shift stress from the core muscles (abdominals, spinal erectors, etc.) and onto the limbs by performing lifts unilaterally. If an athlete starts their training session with back squats and intends to do Romanian deadlifts second, but finds their spinal erectors are tired, they can perform the RDLs unilaterally to save their backs. Unilateral movements also more strongly activate stabilizing muscles, including the internal and external hip rotators for the lower body (Siff, 2003).

Though each athlete is different, most trainees will only need 1-2 lower body, 2 upper body, and 1 abdominal exercise per session. The volume of each will be dependent on a number of factors.

In terms of set and rep numbers, a lot of coaches throw out guidelines for pure strength, myofibrillar hypertrophy, sarcoplasmic hypertrophy, and power applications, but in the author's viewpoint, they're just muddying the water. Though variable repetition ranges have been shown to create different training effects (Campos et al, 2002), a great number of athletes seem to respond best when following a set of very general, and simple, guidelines.

At the developmental, college, and even professional level, a great many athletes have seen their best results when using the abbreviated Olympic lifts for submaximal doubles or triples and traditional lifts for submaximal sets of 6-10 repetitions (Scott, 2010; White, 2009). For the abbreviated Olympic lifts (power snatch and power clean), 8-12 sets of 2-3 repetitions using 70-80% 1RM while focusing on bar speed and with 90-120 second rest periods works very well. For traditional lifts, 3-4 sets of 6-10 repetitions, all far short of failure, with ~180 second rest periods is very effective.

Training within the above set, rep, and intensity ranges allows for the best of all worlds. Intensity and volume are high enough to create neural and muscular adaptations, but low enough to prevent burnout and minimally interfere with specific and supplementary work. This range of work is a sort of “sweet spot” in which a vast majority of athletes will find their best gains (in concert with training for their sport, that is). One could further increase volume, intensity, or both, but it would be at the expense of other training means. During the off season, this wouldn't necessarily be a bad thing, but that's an issue to be covered later.

In terms of form and progression, it is strongly suggested that proper form be given priority over the amount of weight lifted. Athletes should seek to maintain a neutral spine on nearly every

movement and are also encouraged to move through a full range of motion (within the limits of their mobility) on every exercise. Making sure to keep form tight will help prevent injuries, and moving through a full range of motion has a number of benefits. For one, strength is largely specific to the length of the muscles when it's developed. Strength gained when a muscle is in a shortened state will not transfer over when it's in a longer state, but the opposite is not true (Zatsiorsky, 1995). Strength gained when a muscle is lengthened will transfer over to the rest of the ROM. Training a muscle while it's lengthened also has the effect of increasing flexibility, and possibly producing sarcomereogenesis (Siff, 2003).

When one is capable of increasing the weight, sets, or reps while maintaining correct form and staying away from failure, they should do so. Progression over time is necessary. No benefit comes from doing the exact same thing over long periods of time.

Stretching:

Though how is beyond the author, stretching (static stretching especially) has become all but synonymous with fitness, injury prevention, and health in general. Contrary to the claims many make about it however, stretching does not decrease injury risk (Witvrouw, Mahieu, Danneels, & McNair, 2004), does not decrease or prevent soreness (Herbert & de Noronha, 2007), and (in the case of static stretching) can actually impair power generation in the short term (Robbins & Scheuermann, 2008; Samuel, Holcomb, Guadagnoli, Rubley, & Wallmann, 2008). One may be lead to ask then, what is stretching good for?

It may seem that stretching is completely pointless, but it really all depends on what type of stretching is performed and how it's done. While static stretching has been shown to decrease power output (Yamaguchi, Ichii, Yamanaka, & Yasuda, 2006) and musculotendinous stiffness (Ryan et al, 2008), it is only one form of stretching. Ballistic and dynamic stretching serve to increase flexibility just as well as their static counterpart, but actually increase power output in the short term rather than reduce it (Yamaguchi, Ichii, Yamanaka, & Yasuda, 2007; Jagers, Swank, Frost, & Lee, 2008). As such, it's suggested that any stretching that takes place before a training session be dynamic in nature. Post session, static stretching is fine as power output is no longer a concern. In either case, it's recommended the muscles being stretched are warm to help prevent possible injuries.

While proper range of motion around the joints is a good thing, it is important to note that there

is an inverse correlation between running economy and ankle and hip flexibility (Craib, Mitchell, Fields, Cooper, Hopewell, & Morgan, 1996). This may be due to better functioning of the elastic components of the glutes and hamstrings. However, chronic stretching routines have been shown to not affect running economy (Nelson, Kokkonen, Eldredge, Cornwell, & Glickman-Weiss, 2001), making the link between flexibility and running economy somewhat unclear. The author interprets this situation by thinking that those who are naturally less flexible may display greater running economy, and increases in their flexibility will not diminish it. As such, if one naturally has poor flexibility, don't worry too much about it. Fix the issue as the situation allows, but know that it has its positives.

Programming:

Now that the components of the Refinement phase have been set out, it's time to put them all together. Contrary to popular statement, designing a good training program is not that difficult if one knows the basics. Will it be perfect? No, but that's okay. Perfection is oftentimes the enemy of good, and seeing as it's unattainable it should not be the end goal.

Classically speaking, training plans are laid out weeks, if not months in advance. Exercises, sets, reps, rest periods, and sometimes even training loads are all specified. Despite its popularity however, the author does not believe in doing things this way. The body is dynamic and its tolerances and abilities are in a constant state of flux. Readiness at any given moment is affected by time of day, recent diet, sleep schedule, stress levels, psychological readiness, and any number of other factors that have yet to be named. Expecting an athlete's work capacity and abilities to perfectly sync up with what's written on a piece of paper week in and week out is foolish.

Rather than prepare each training session down to the tiniest detail, the author prefers to outline general frameworks and allows the athletes to decide on the specifics. If they're feeling energetic and motivated, one session might involve higher volumes and intensities. If they're rundown and dragging psychologically, they may end up doing very little, if anything at all. It all depends on the state of the athlete at the time of training.

Generally speaking, training plans are divided into three time frames: nanocycles, microcycles, and macrocycles, with nanocycles being the shortest, followed by microcycles, and trailed by macrocycles.

Nanocycle:

The nanocycle is the shortest period of training organization and is essentially nothing more than a single session. Yet even within this single session there are still a number of subsections, all of which the reader has already encountered thus far in the text. These subsections, of which there are 5, include: **Warm Up, Mobility, Workout, Conditioning, and Cool Down.**

Warm Up: The warm up is usually 5-10 minutes in length and its sole goal is to raise the body's temperature to prepare it for the more intense physical activity to come. Elevated muscle temperatures result in increased fiber conduction velocity, power output (Gray, De Vito, Nimmo, Farina, & Ferguson, 2006), flexibility (Funk, Swank, Adams, & Treolo, 2001), and strength. Work undertaken in the warm up should be strenuous enough to cause the athlete to build a light sweat, but not strenuous enough to develop any fatigue that might hinder their later training efforts. Popular options include jogging, rowing, using a stair stepper, jumping rope, and doing medicine ball circuits.

Mobility: The mobility section of the nanocycle is all about opening up the range of motion around the joints so upcoming work can be done safely and through the proper range of motion. All types of stretching can be used, but as covered earlier, dynamic and ballistic stretching work best at this point in the session as static stretching has the potential to decrease power production and tendon stiffness (Yamaguchi, Ichii, Yamanaka, & Yasuda, 2006; Ryan et al, 2008). Some people take more work than others to loosen up, but this section of the workout shouldn't take longer than 10-15 minutes.

Workout: The workout is the meat and potatoes of the training session. It's where skills are learned and adaptations are signaled. This is where specific, supplementary, and general work takes place, usually in that order (unless one is aiming to use supplementary work for potentiation).

Since the body has a finite (and constantly shifting) supply of adaptive resources, it's important to make sure they're allocated properly within a nanocycle. For most of the year (with the exception of the off season, but that will be covered shortly), most adaptive resources should go towards specific work and the left overs should be distributed between supplementary and general work, in that order.

Rather than provide set volumes and intensities for specific work, the author would advise one to instead choose a goal, maybe an intensity, and then let the athlete go to work. For instance, if one wanted to train for sprint acceleration, the coach might tell the athlete they're doing 30M accelerations and that he wants them to be fast. The athlete would then decide the exact intensity (depending on how they felt), the length of rest periods (as long as they needed before they were ready to repeat their

previous performance), and how much overall work is to be done. Work should be stopped when the athlete's performance noticeably declines or if the athlete expresses a strong desire to stop (some activities require more mental toughness than others, eg. 400M repeats).

After the specific work has been applied, if the trainee has any energy left, they would move on to supplementary work. Again, the coach should assign the athlete their movement(s) and tell them the goal and then let the athlete go to work. Once that's finished, one would move on to general training and repeat the process.

In terms of frequency, the author finds the best results typically come from training the same muscle groupings 2-3 times per week. It will take some trial and error, but volume for a particular session should be limited so that the trainee is recovered and fully ready to train again within 48 hours. The author also likes to split upper and lower body training into separate sessions. There is plenty of research demonstrating a drop in hormone levels after 45-60 minutes of exercise (Zatsiorsky, 1995; Siff, 2003), but that's not why the author suggests the split. Rather than worrying about insignificant changes in hormone levels, the author finds mental focus, or the lack thereof, is more important. As the length of a session draws out, athletes tend to get worn down and put less and less effort into their session (yet another reason for putting specific work at the forefront). Splitting upper and lower body work into separate sessions helps insure higher quality of both.

Conditioning: Conditioning is optional within any given session. If an athlete is having problems with their leanness or general stamina then including something here would be beneficial. If an athlete is lean and in good shape, this probably isn't necessary.

If one does decide to employ conditioning work, any activity can be used as long as the heart rate is kept within the appropriate range. Easy conditioning involves keeping the heart rate between 100-120 beats per minute for 20-30 minutes. Intermediate conditioning involves keeping the heart rate between 120-140 beats per minute for 20-30 minutes. Easy conditioning can be done every day, while intermediate conditioning should probably only be done 3-4 days per week unless the athlete is in very good shape.

Just like in the warm up, popular movement options include jogging, rowing, using a stair stepper, jumping rope, and doing medicine ball circuits.

Cool Down: The cool down is a repeat of the mobility section, but with an emphasis on easier and more subdued activity. This is where static stretching, deep breathing exercises, and even

meditation can come in. Anything that returns the body to a resting state or helps with physical or mental recovery fits here.

Organization: Within a given nanocycle, the balance between training means should vary depending on the goal(s) of the session. Late off season, pre season, and in season, most sessions should be comprised mostly of specific work volume, followed by supplementary work volume, and trailed by general work volume. However, there are circumstances in which this arrangement will change.

If facilities don't allow for performing specific work, supplementary work should take precedence, followed by general work. In the early off season, it's also not unusual to drastically reduce the volume of specific and supplementary work to focus on general work. The prime reason to do this is for putting together a strength and/or hypertrophy block. Since strength is ultimately dependent on cross sectional area of a muscle, setting aside a good portion of the off season to increase muscular size in important muscle groups, even at the expense of short term sporting form, is a good idea. During these periods sport specific work is put on maintenance while the volume of weight training is ramped up. Sports performance may, and probably will decrease during this period of time, but when specific and supplementary work are reintroduced in higher volumes performance will exceed baseline levels.

Another reason for decreasing the percentage of specific and supplementary work is to work around injuries. Sometimes athletes suffer injuries which prevent them from doing high impact work (foot and ankle injuries mostly), but leave them able to lift weights, especially if the movements are carefully chosen. These athletes should not stubbornly keep trying to push specific and supplementary work, but should only do those things they can do pain-free. Just as in a strength/hypertrophy block, athletes' performance may drop when dealing with their injury, but if they apply their general work right, their abilities will improve past baseline once they're healthy and able to play their sport again.

No matter why or how one allocates work volume within a given nanocycle, the body has finite adaptive capabilities and the more concentrated the volume is on one work type, the more concentrated the training results will be. On the other side of the coin, the more evenly volume is distributed between the types of work, the more diffused the results will be.

Microcycle:

Microcycles are small groups of nanocycles, usually one week in length. Whereas one needs to

focus on the content of each nanocycle, microcycles are more of a monitoring tool than an organizational one. By taking note of the total volume of work done within each microcycle, coaches can track their athletes' work capacity progressions over time. If everything is going well, athletes should see both their absolute abilities and their work capacity increase over time (Siff, 2003).

Volume within each microcycle is also important to take note of if one intends to change the frequency with which they train. If one usually trains their lower body twice during a given microcycle, but wants to start training it 4 times per microcycle (to see faster gains in motor learning), they can go back and calculate the total volume of specific, supplementary, and general work they performed in previous microcycles and spread it out over 4 sessions rather than 2. This will provide them a guideline to follow when it comes to work volume.

Microcycles are also useful for allocating volume so as to help prevent athlete burnout. Many coaches advocate training hard for 2-3 consecutive microcycles and then following those up with one macrocycle at severely reduced volume. The 2-3 hard microcycles deliver the bulk of the training effect while the one microcycle that follows allows for recovery. Typically, it's recommended that the intensity of the rest macrocycle be left alone, but volume should be dropped to ~50% of the others preceding it.

Macrocycle:

The macrocycle is the largest unit of training organization and it usually consists of 4-12 microcycles. As with microcycles, macrocycles are useful for tracking training volumes over time. Macrocycles are also used to outline and categorize long stretches of training by their goal(s).

For a sprinter, a macrocycle focused on bringing up their speed endurance would consist largely of specific work. More specifically, the volume of overdistance (compared to their competitive distance) sprinting would be disproportionately high when compared to the volume of supplementary and general work. Similarly, if an athlete needs to bring up their strength and size, they might devote one macrocycle to said goals. This macrocycle would contain a very large volume of weight training (general work) in comparison to specific and supplementary work.

As stated before, the more varied ones goals (and hence the work they're doing to achieve them), the more diffused results they will see. As such, if one wants to see great increases within a given macrocycle, it's best that they choose one or two compatible goals and focus their overall

workload on achieving them. Like the old saying goes, trying to chase two rabbits often results in catching neither.

The organization of macrocycles relative to one another also has an effect on training. After long periods of focusing on specific and supplementary work, some athletes find that their performance stops increasing. When this happens, it usually helps to implement a macrocycle focused on strength and hypertrophy. The author advises that one stick with the strength/hypertrophy macrocycle until gains start to slow down, at which point they can shift back towards training specifically for their sporting goals.

Regardless of the focus of a given macrocycle, a good rule to keep in mind is the rule of thirds. It states that to maintain a skill or quality takes $\frac{1}{3}$ the volume necessary to improve the skill or quality. Allocating volume according to this rule will help prevent one from taking too many steps back when shifting focus.

Macrocycles can also be applied in such a way as to create something known as long-term delayed training effect (LTDTE). During long periods of intense training (high levels of intensity and volume) in which the athlete is not allowed to fully recuperate between sessions, they will see a decrease in speed and power. If this decrease in speed and power is maintained over a period of 1-2 months before volume is dropped substantially and recovery is allowed, athletes will see a huge rebound in their physical abilities (Siff & Verkhoshansky, 1999). This increase is known as LTDTE.

The process of setting up a macrocycle in which the volume is too high to recover from is known as concentrated loading. Employing a block of concentrated loading is only for advanced athletes, but it's a good way to break up a plateau. If one is going to try to employ concentrated loading, a reasonable guideline is to increase the volume of the loading block by 50% over the volume of a typical block. Coaches will need to adjust from there, but maximal performance should dip well below its peak after a week or two and remain there for the duration of the block. The unloading block that follows should have a volume roughly 50% of a usual macrocycle to allow for adequate recovery. Again, all volume guidelines are merely suggestions. Each athlete will need to adjust the numbers to fit themselves.

Wrap Up:

Though the information covered in the Refinement chapter is far from comprehensive, it does

outline the basics of what one will need to devise a successful training plan. By following the guidelines put forth, employing a little critical thinking, and keeping tabs on individual characteristics over time, one will learn to assign training so easily that it will become second nature.

6

Nutrition and Recovery

Proper training isn't the only factor in the becoming a better athlete, diet and rest are important as well. While training applies the stress that causes the body to try and adapt, diet and recovery allow it to recover from said stress and actually adapt. Even if one's training is perfect, insufficient rest and nutrition can wipe out any prospective gains one might incur. As such, making sure one's diet and off-day schedules are in order is imperative.

Having said that, this is primarily a book on training. The most basic and most important facets of nutrition and recovery will be covered, but comprehensive biochemistry will be left to other texts. Rest assured however, that if it's important, it will be covered here.

General Nutrition:

In terms of total caloric intake and macronutrient distribution, there are no hard and fast rules that apply across the board. Tackling caloric intake first, the needs of athletes vary widely depending on their muscle mass, activity levels, and other metabolic factors. In order to determine one's baseline caloric needs, a little bit of observation is necessary.

To get an idea of how much one needs to eat to maintain their weight, they'll need to weigh themselves every morning and keep careful track of exactly how many calories they take in. By monitoring their daily food intake and seeing how their weight changes, one can determine their baseline metabolic rate.

Once one has established their baseline caloric expenditure (which will change if their weight and/or activity levels change), they can alter their intake based on their goals. If one is looking to lose body fat, then eating anywhere from 500-1000 calories less than necessary to maintain weight is a good range. Cutting more calories would result in too fast of weight loss and would most likely result in increased levels of lost muscle, as opposed to fat. If looking to gain muscle, one would take in roughly

500 calories more than is necessary to maintain their weight. Any greater increase would lead to increased muscle synthesis (to a point), but would cause an increase in the rate of body fat accumulation as well, something most athletes would want to avoid.

Macronutrient breakdown also varies on an individual basis, but not by nearly as much as caloric intake. The first thing an athlete needs to concern themselves with is protein intake. Protein is the building block with which the body rebuilds tissues after they're torn down. Athletes need to make sure they remain in a positive nitrogen balance, meaning their nitrogen intake exceeds the amount of nitrogen they excrete (Brooks, Fahey, and White, 1996). Studies on endurance trained athletes have resulted in recommended protein intakes of 1.2-1.3 g/kg of bodyweight to maintain positive nitrogen balance (Meredith, Zackin, Frontera, & Evans, 1989), and studies on strength trained athletes suggest intakes of 1.7-1.8 g/kg of bodyweight (Lemon, 1996). In the author's personal opinion, both of these figures are on the low side. The author would suggest a protein intake somewhere in the region of 3.3-4.4 g/kg of bodyweight, meaning 1.5-2 g/lb. While the upper end of this recommendation is over twice the clinically recommended limit, people who get too many of their calories from fats and carbohydrates tend to have “softer” physiques than those who eat large amounts of protein. If one's intent is to gain muscle mass, then following the author's elevated intake suggestions is even more strongly advised.

Fat is used as an energy source during aerobic exercise, allows for the absorption of fat-soluble vitamins, is vital in the production of testosterone, and has other function too numerous to list. Despite the bad rap it has gotten, eating fats will not make one fat, eating too much will; whether that excess comes from fat, proteins, or carbohydrates is irrelevant. It is suggested that one get 20-30% of their daily calories from fats. And for those still interested in low fat diets, diets in which 15% or less of the total calories from fats have no athletic or health benefits (American College of Sports Medicine, American Dietetic Association, & Dietitians of Canada, 2000).

Carbohydrates, which are converted to glucose to be used as energy in anaerobic exercise, fill in the gap left after covering protein and fat. After calculating the numbers for protein and fat intake, the rest of one's daily calories should come from carbohydrates.

Food Choices:

The sheer variety of foods available to one on a daily basis is mind boggling, but as far as

athletes (or people in general, really) are concerned, simple is better. Though food types won't really do that much to affect athletic performance in the short term, as the human body is an amazing machine that can run on nearly anything, over the long term, ingestion of the wrong foods can have health consequences.

Good food choices for each of the three macronutrient groups as well foods for particularly important vitamins and minerals are listed below.

<u>Macronutrient/Vitamin/Mineral</u>	<u>Foods</u>	
Protein	Chicken (not deep fried) Beef (preferably lean) Pork Eggs	Turkey Fish Lamb Various Beans and Nuts
Carbohydrates	Whole Grains Vegetables Flax	Legumes Yams Sweet Potatoes
Fats	Fatty Fish Eggs Nuts	Avocados Olives Olive Oil
Calcium	Milk Cheese Yogurt	Okra Collards Spinach
Iron	Beef Dried Beans	Dried Lentils Liver
Vitamin C	Citrus Fruits Peppers Leafy Green Vegetables	Sweet Potatoes Fruit (in general)
Vitamin D	Fish Oils Herring	Salmon Other Fatty Fish

The list of foods one should eat is short, but the list of foods they shouldn't eat is considerably longer. When it comes to what one shouldn't eat, common sense usually prevails. Anything sugary, refined, or deep fried should be out of the question. In fact, if it looks like something that one couldn't have eaten 1000 years ago, it's probably something that one shouldn't be eating now. This means no candy, no pastries, and if it's wrapped in a bright package, it's definitely out.

That's not to say one can't eat these things. The occasional donut or trip to a fast food joint won't

hurt. In fact, occasional indulgence in junk food might actually help an athlete stay on track mentally. Rather than try to keep their diet absolutely perfect, the author would recommend one follow a 90:10 rule. If one makes good dietary choices 90% of the time, it won't matter if the other 10% are less than perfect.

Supplements:

In recent times, supplement companies have pushed their products so hard that it might seem like progress is impossible without the latest expensive formulation, but nothing could be further from the truth. Supplements are just what their name suggests, supplementary. They are effective, very much so in some cases, but they're something one adds in after their diet is in order.

Rather than touch on every useful supplement out there, the author is only going to cover the absolute basics. These supplements, though not fancy in any way, are well-studied, cheap, and effective. Before moving on to anything other than these, it's advised that one have their training and diet totally under control. And people should also be honest with themselves. The average high school athlete does not need to spend \$100+ per month on fancy supplements to drop their 100M time by .1. One should train, rest, and eat according to their level of development. The following supplements are listed in order of importance.

Fish Oil:

Simple fish oil, as found in capsule or liquid form, is perhaps the single most boring supplement ever created, however, it also happens to be one of the most effective. The consumption of the two fatty acids found in fish oil, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), provide widespread health benefits that are almost too numerous to count. These benefits include: lowering blood pressure, preventing inflammation, inhibiting atherosclerosis, protecting against tumors, and helping treat psychological disorders such as ADHD, depression, and even schizophrenia (Narayan, Miyashita, & Hosakawa, 2006). Needless to say, supplementing with fish oil is a true no-brainer.

In terms of dosage, one should not look at the amount of fish oil consumed, but rather at the amount of EPA and DHA consumed. Recommendations vary greatly from source to source, but studies indicate around 3 grams of EPA and DHA combined on a daily basis can produce health benefits, while intakes of 5 grams may actually be counterproductive due to excessive oxidation effects (Arnesen &

Seljeftot, 2010). Regardless of dosage, the biochemical properties of EPA and DHA make it prone to oxidation, so if one is going to take fish oil then they should also take antioxidants (vitamin E, vitamin C, etc.).

Multivitamins:

Just as boring as fish oil, multivitamins won't directly make one run faster, jump higher, or hit harder, but they will ensure that one gets the daily minimum of important vitamins and minerals that their diet might otherwise be lacking. In a complete diet, this isn't too much of a concern, but in diets with less variety and poor food choices, it becomes one. Vitamins are not meant to replace the nutrients from food, merely to supplement them and fill in any gaps that may occur.

Protein Powder:

For someone who works, goes to school, trains, has a social life, or some combination of the four, having quality food on hand at all times can be difficult. Not only does cooking meals high in protein usually take a bit of time and preparation, but they can also be difficult to carry around even once they're made. This is where protein powder comes in. It's not meant to be the primary source of protein, but is there to replace meat when eating meat is difficult or impossible.

By protein powder, the author is not referring to weight gainers or other products loaded with extra ingredients either, he just means protein powder, the most common forms of which are whey and casein. Whey protein is digested and absorbed more quickly, while casein is digested and absorbed more slowly. In certain cases, this difference in absorption rates makes one protein better than another. For instance, ingestion of whey protein immediately after exercise leads to higher levels of protein synthesis than casein (Tang, Moore, Kujbida, Tarnopolsky, & Phillips, 2009). However, casein takes longer to digest, and so is useful when one needs to go a long time in between meals.

Vitamin C, D, & E:

Vitamins C and E are powerful antioxidants that help prevent cellular damage that occurs from intense exercise or dietary intake (Brooks, Fahey, and White, 1996). Vitamin D is essential in helping prevent cardiovascular disease, cancer, and a number of other problems (Anagnostis, Athyros, Adamidou, Florentin, & Karagiannis, 2010). Their long list of benefits aside, these three vitamins are

essential to health and athletes need more of them than other populations.

Regarding dosages, the RDA outlined by the US government are far too low, especially for athletes. More realistic dosages would be 2000 mg per day for vitamin C, 1000-2000 IU per day for vitamins D and E. Though extreme overdosing with vitamins C and E pose no serious threat, massive overdosing with vitamin D can lead to overt toxicity and heart disease amongst other problems.

Creatine:

Creatine monohydrate, often mistakenly associated with steroids even though there is no link between the two, is one of the cheapest, yet most effective supplements on the market. Creatine supplementation has been shown to increase intramuscular creatine stores, rate of strength gain, rate of power gain, anaerobic endurance, anaerobic work capacity, and gains in lean mass among many other benefits (Kreider, 2003). Consumption of 5 grams per day is more than enough for any athlete. Commonly suggest loading phases in which up to 20 grams per day are ingested are not necessary.

Along with all of its benefits, creatine also brings rumors of adverse effects on the kidney and liver. These rumors are just that though, rumors, and have no basis in empirical study (Poortmans & Francaux, 2000). Creatine consumption is completely safe, but those who have pre-existing kidney or liver issues may want to steer clear, just in case.

Nutritional Timing:

Not only is getting the correct nutrients necessary for optimal progress, but getting them at the right time is important too. There are certain periods of the day where ingesting certain types of food are particularly important.

The single most important time for the correct administration of nutrition is around training sessions. Pre-workout, one needs to make sure they have adequate liver and muscle glycogen stores for energy and protein with which their muscles can rebuild themselves. Eating too little or not at all will result in a lack of both, but eating too much could result in decreased performance as well. Not only will an excessively full stomach put pressure against the diaphragm and make respiration more difficult (Yessis, 1990), but many people become sleepy after a large meal due to the insulin response, and tired is no way to enter a training session. In order to meet these needs, it is suggested that one consume a fast digesting protein (such as whey) and high glycemic index carbohydrates roughly 30 minutes prior

to training. The size of the meal should be large enough to provide adequate nutrition, but small enough so that there is no feeling of satiety.

For peri-workout nutrition, nothing is really required, but for long, intense workouts involving a high workload and intense perspiration, one would be advised to consume a beverage containing simple sugars and electrolytes. Such a solution allows for greater work output and endurance over the course of the session (Ivy, Costill, Fink, & Lower, 1979) and helps to prevent dehydration and keep glycogen levels high without eliciting a large insulin response.

Post-workout nutrition is perhaps the most important, because if the proper nutrients aren't there, the body will not be able to rebuild itself after its efforts. Post-workout, the prime concern is making sure muscle protein synthesis exceeds muscle protein breakdown. This can be done by providing adequate levels of dietary protein (preferably fast digesting protein like whey) as well as causing an insulin response via ingesting large amounts of simple carbohydrates (Kumar, Atherton, Smith, & Rennie, 2009). Dehydration may also be an issue. At this point, water alone would suffice, but if maintaining thirst is a problem, sweet sports drinks may be employed (Brooks, Fahey, and White, 1996). Typically speaking, after a hard workout, an athlete would want to consume protein and carbohydrates in a 1:2 ratio with a minimum meal size of 30 grams of protein and 60 grams of carbohydrates along with a liter or more of water. The larger drain the athlete caused in the session, the larger their post-workout meal should be.

Besides around workouts, there are two other times of day in which nutrient timing is especially important: upon waking and before going to bed. Upon waking, one has just undergone an 8 hour fast and their liver is low on glycogen while their blood glucose levels are falling. Eating immediately upon waking is necessary to ensure optimal functioning. A simple, balanced meal will do the trick nicely.

Before going to bed, one is preparing themselves to go on an 8 hour fast in which, despite an almost total lack of activity, muscle can be lost. To prevent this, ingesting a meal consisting largely of slow digesting protein (such as casein) can go a long way in maintaining and even building muscle mass. Casein can be found in supplemental powders as well as in milk and other dairy products.

Hydration:

Though far from glamorous, water is an essential part of life. Inadequate hydration can lead to negatively skewed testosterone to cortisol levels (Maresh et al, 2006), decreased strength, higher

perceived rates of exertion, lowered endurance (Kraft et al, 2010), and even heat stroke. Making sure one is properly hydrated before, during, and after exercise is of great importance.

Athletes can easily sweat out multiple liters of water over the course of an intense training session and in order for their bodies to function, that water needs to be replaced. For a highly active athlete, consuming roughly 4 liters (1 gallon) of water per day is a good guideline. If athletes are reluctant to drink, sweet sports beverages during and after workouts work very well to rekindle thirst and rehydrate.

Recovery Methods:

In addition to applying proper nutritional principles and getting a solid 7-8 hours of sleep per night (the absolute two most important and most effective recovery practices), one can also speed up physical and mental recovery through a number of restorative methods. Restorative methods can be broken down into two categories: intersession and intrasession. Intersession methods help speed up recovery between separate training sessions, while intrasession methods work to speed up recovery between work sets inside of a single session.

In terms of actually speeding up recovery between sessions, very few methods show any real benefits as far as speeding up the restoration of muscle function goes. Most methods that are commonly prescribed have no actual effects or are merely placebos. The following table describes a few intersession methods that genuinely have some value.

Method	Description/Prescription
Active Recovery	Active recovery includes any form of exercising that is not physically taxing in the least. This includes going for a walk, cleaning house, tai chi, or anything similar. As long as it involves moving around but isn't causing more fatigue, it falls under the category of active recovery. All active recovery methods speed up the rate of muscle glycogen resynthesis (Choi, Cole, Goodpastor, Fink, & Costill, 1994) and help increase blood flow, which aids in nutrient transport to damaged muscles. They have also been shown to decrease cortisol levels in stressed individuals (Jin, 1992). As for prescription, 20-30 minutes of easy activity per day while keeping one's heart rate under 120 beats per minute should be adequate.
Massage	Massage, as applied by a skilled practitioner, can decrease muscle stiffness, increase blood flow, increase relaxation (measured via parasympathetic nervous activity), and reduce muscular soreness from exercise, however it does not affect exercise-induced decreases in muscle function (Weerapong, Hume, & Kolt, 2005). All in all, massage is good at facilitating recovery and making one feel better, but it will not immediately restore function. The length and execution of massage is dependent upon the practitioner. 20-30 minutes is typically good for most forms of massage. Deep tissue massage should not be used as a recovery method, as it alone requires recovery time.
Sleep	Though it has already been mentioned, the importance of sleep cannot be overstated. Sleep disturbance has been shown to alter glucose metabolism and appetite (Spiegel, Leproult, & Van Cauter, 1999), decrease neural plasticity and learning (Walker & Stickgold, 2005), and reduce cognitive performance (Van Dongen, Baynard, Maislin, & Dinges, 2004). In order to perform and recover, athletes need their sleep. Athletes are advised to go to sleep and wake up at the same time each day and get between 7-9 hours per night depending on their personal needs. Naps (10-30 minutes) after training are also beneficial.
Water Immersion	Mere immersion in water has been shown to both reduce muscle edema and increase blood flow without any increase in energy expenditure (Wilcock, Cronin, & Hing, 2006). Both of these benefits should lead to an increase in the rate of recovery. Water immersion is also very relaxing, and allows athletes mental down time in which to recoup. The best water to immerse one's self is near body temperature or colder. Duration of immersion is up to the athlete, but it should probably be kept to under an hour.

Intrasession recovery methods help one recover from exertion between work sets and allow one to sustain higher levels of output for longer. Again, there aren't a lot of methods that actually work, but the few that do are simple and fairly effective.

Method	Prescription/Description
Cold Compresses	Laying a cold compress on the abdomen between work sets has been shown to enhance performance (Vorobyev, 1978). The mechanism through which this works may be an increase in nervous output caused by the fight or flight/survival (sympathetic) response. Simply lying prone and placing an icepack over the solar plexus for a couple of minutes between sets should do the trick.
General Relaxation	Laying down, breathing deeply, and trying to relax one's muscles can go a long way in recovering between work sets. Laying down allows for easier blood flow to clear metabolic waste, deep breathing allows for psychological recovery, and relaxing one's muscles aids in the clearing of metabolic waste and speeds up ATP resynthesis.
Shaking	Manually shaking one's limbs and relaxing their muscles helps relieve tension, increase blood flow, and speed up ATP resynthesis. One can shake the limb itself, or use their hands to physically shake the individual muscle groups loose.

By properly applying intersession and intrasession recovery methods, one can train harder, train longer, train more often, and recover from it all too. Though none of the above methods need be applied (except for sleep), they will greatly enhance the effectiveness of any given training program. Training is only one half of the puzzle. The other, equally important, half is recovery. One should not neglect it.

Wrap Up:

Though it's commonly glossed over by a majority of young athletes, proper nutrition is vital in maximizing their performance. If concerned solely with performance, just getting enough calories with the right balance of macronutrients will suffice, regardless of the foods they're received from. However, concerning health and performance longevity, if one wants to prevent health problems and keep themselves going over the long run, getting their nutrients from healthy sources (as outlined in this chapter) will go a long way.

Similarly, training is a very taxing activity. The body is put under high levels of stress and expected to adapt. By supplying the body with proper nutrition and helping along it along with recovery methods, one can ensure they're recovering (and therefore progressing) as quickly as possible. In short: train, eat, sleep, repeat.

7

The Mind

If one has spent enough time around coaches, parents, or sports in general, they've probably heard the phrase, "Sports are 10% physical and 90% mental." While the author wouldn't go that far (sports are ultimately decided by physical ability), nervous system functioning and the mental game play a big role in athletic success.

Short Term:

In the short term, the nervous system is responsible for movement, skill acquisition, the ability to express physical qualities, and even physiological changes such as shifting muscle fiber type (Bacou et al, 1996).

Motor skills, upon which all movements (sporting actions included) are based, are learned just like all other skills. And like all other skills, a high level of competency is not possible without repetition. At the outset of the learning process large amounts of activity can be seen in the cerebral cortex, but as familiarity with the skill increases cerebral cortex activity declines and control of the movement is left up to the cerebellum (Mader, 2006). The cerebellum also pre-programs ballistic movements, and since the functioning of the cerebellum is largely beyond consciousness, movements lasting less than 0.4 seconds cannot be consciously changed during their performance (Thomas, 1970).

The implications of the above are that as an ability is being learned, there is more conscious input given to performing it (which is bad, as conscious input can disrupt the movement), but as proficiency increases, conscious input decreases and the movement becomes more or less "automatic." When a movement is so well-practiced that an athlete is essentially able to shut off their conscious input and let their subconscious do the work, the athlete is said to have entered the zone. The goal of all athletes should be to be able to enter the zone, as the zone represents a merging of action and awareness resulting in a total focus on a single task and the peak of that athlete's performance potential

(Csikzentmihalyi, 1990).

In order to enter the zone, one must have mastered their skill and must also be able to “let go” mentally and give themselves over fully to the moment. The path to mastering a skill is fairly straight forward. All it requires is years (usually a decade or more) of constant practice with feedback coming from an expert (Ericsson, Prietula, & Cokely, 2007). Simple enough, right? Letting go, on the other hand, is a little bit more difficult.

Some people (talented athletes, artists, musicians, etc.) are born with the ability to “let go” and allow their mind and body to sync up harmoniously. Others however, have difficult quieting the chatter of their thoughts and are unable to let their conscious grip slip away. For these people, special training means are necessary, specifically meditation. Though the author does not necessarily believe in or condone all of the teachings of Zen Buddhism, he does like its focus on being in the moment. Among many other practices, Zen Buddhists have the goal of living entirely in the moment, and they go about accomplishing this task through mindfulness and meditation.

In Zen Buddhism, the common form of mediation is known as *Zazen*. In *Zazen*, practitioners focus on doing away with all interfering thoughts and focusing solely on the moment. They focus on their body, on their breathing, and on only the instant they're inhabiting.

Though the author wouldn't advise everyone to try and become a Zen master, he would suggest that athletes employ meditation in their daily routine. Not only can it help remove excess interference in athletics and everyday life, but it can also reduce physical and mental stress (Yang, Su, & Huang, 2009), lower blood pressure (Anderson, Liu, & Kryscio, 2008), fight depression, and even combat substance abuse (Chiesa & Serretti, 2009).

In order to meditate, one needs to find a quiet area and seat themselves comfortably. Keeping the back straight, the head slightly bowed, and the hands in the lap, one needs to close their eyes, relax their body, and breathe deeply through the nose, focusing on breathing into the belly rather than into the chest. While breathing deeply, one should strive to stop thinking and instead focus their attention on their body as a whole as well as the rhythm and action of their breaths. In order to help one's self focus, they can count each breath. As proficiency increases, they can count every other breath, and then every third, and then every fourth, and so on until they no longer need to count to keep themselves in the moment. 20-30 minutes per day of this can go a long ways, especially if performed following a training session or prior to bed.

Meditation aside, motor learning is also somewhat state-dependent, especially as it relates to reflexes. Reflexes reinforced or extinguished in one setting will not necessarily display the same level of conditioning in other settings (Siff, 2003). This “setting” can be environmental, social, or purely cognitive in nature. For this reason, it's important that if one trains in one specific setting (the same place, with the same people, in the same mental state) they're able to replicate most of the factors when it comes time for competition. If they aren't, they may find their performance is flat.

If one doubts the effects of conditioning on sports performance, then they would probably be interested to know that even things like drug tolerance and withdrawal can be classically conditioned (Siegal, Hinson, Krank, & McCully, 1982). From here, it's no stretch to assume that athletic performance is the same.

In order to prevent a loss of performance when competing in a new venue, it is suggested that athletes develop easily replicable cues that they perform prior to engaging in training (before each set, preferably). In time, the athletes will come to associate these cues with the upcoming work, and the cues will signal the mind and body to prepare itself for the intense physical activity yet to come. The cue can be something as simple as taking three deep breaths and mentally stating, “Let's do it,” or something similar. If one performs these actions before every, or even most working sets, then come competition time, the athlete will be able to repeat their procedure as usual, even if they are at a different venue, and their body and mind will prepare itself for action. This is a basic example of classical (Pavlovian) conditioning in action.

Continuing with the topic of motor learning, it's a given that people learn through performing actions, but they can also learn by watching or even thinking about them. Scattered throughout the various regions of the brain are a type of cell known as mirror neurons. Mirror neurons fire both when performing a movement as well as when watching another execute said movement (Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). In this way, it's thought humans can learn movements merely by watching, or even visualizing them.

Though the neuroscience in support of this concept is relatively new, athletes have been watching other athletes, watching game film, and visualizing their goals for decades. If one wants to perfect their sporting skill they should not only perform it with regularity, but watch others (with good form) do the same. Athletes should also take time to quietly think and visualize themselves performing their sporting movements, both immediately prior to actually performing them and at odd times

throughout the day. Both decades of cumulative experience as well as literature support the use of visualization in increasing sporting skill (Liggett & Hamada, 1993; Siff, 2003).

As with actual training, frequency will result in faster gains, but there is a point of diminishing returns. It's also important to only watch those with good form as well as picture one's self performing with optimal form so as to ensure proper recruitment patterns are reinforced. Finally, it's important to make the visualizations as realistic as possible, including input from as many senses as one can manage.

On a session to session basis, the mind can play a large role in determining maximal performance levels. For instance, increased psychological arousal has been shown to increase both strength and power production (Weinberg, Jackson, & Seaboune, 1985; Tod, Iredale, McGuigan, Strange, & Gill, 2005). An effective way to increase psychological arousal for athletes is to use self talk or instructional training. Self talk can increase arousal levels, change relative muscle contributions, and even alter muscle tone. However, it is important that the administration of self talk or instruction be limited by the capacity of individual athletes as performance will decrease if the attention demands of a task exceed the attention capacity of an athlete (Schmidt & Wrisberg, 2000). In other words, if an athlete has enough on their mind already, don't add to it with arousal techniques.

If self talk techniques are used, they can be as simple as "be fast, be powerful," or "quick, relaxed, loose," or anything relevant to the task. Instruction can focus on recruiting certain muscle groups or hitting certain positions in a given movement. Both can be combined with visualization exercises in which one pictures themselves performing the work set or movement perfectly at high intensity, perhaps even at an intensity higher than they're capable of. Again, the more realistic one's visualizations, the more impact they will have.

Having a visible, concrete goal to strive for also helps performance (Ford et al, 2005) via mental mechanisms and form alterations. It's difficult to judge the true intensity of a performance without a finish line to cross, a stopwatch to deliver a time, or a hurdle to leap. As such, athletes may, even unconsciously, end up not giving full effort. For this reason, it's important that athletes have a definite goal to strive for in order to maximize their performance. Competition, having someone perform alongside of them, can have similar benefits. As with instructional and self talk applications however, definite goals and competition can cause some athletes to try too hard, excessively alter their forms, and actually wreck their performance.

Knowing which mental techniques to apply to which athletes and when comes down to knowing one's athletes and understanding their mental states. This is one example of where coaching can be more of an art than a science and it takes experience to know who will respond best to what.

Long Term:

Rome wasn't built in a day and neither are athletes. Strengthening tissues and refining proper motor patterns to a level satisfactory for elite sporting competition takes a lot of practice over a long time. This means that it's not enough to put in an intense training session here or there, but to do so consistently for years on end. Anyone can work themselves hard a hand full of times, but it's the ability to do so for years or even decades that sets the truly great apart.

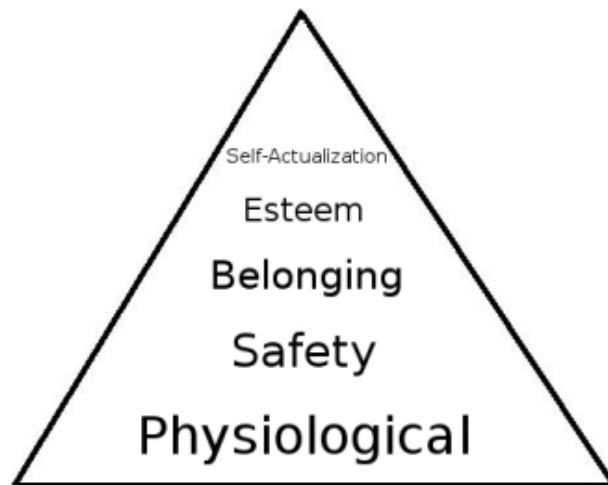
In chess, music, business, athletics, and virtually all other fields, expertise is gained through deliberate practice, but ordinary practice, even over time, is not enough for most to reach the highest levels of mastery. To become an expert in a given field requires not just practice, but intense practice in which one constantly challenges their limits and operates outside of their comfort zone. Even then, the path isn't a short one. Becoming an expert usually takes at least a decade, and depending on one's area of interest, can take considerably longer. But those who make it in the end, those who persevere, who push themselves, and who ultimately succeed all share a few common traits, chief amongst which is discipline (Ericsson, Prietula, & Cokely, 2007).

If one doesn't have the discipline to make themselves train nearly every day, to push their limits, to eat healthy, or to do whatever it happens to take to achieve their goals, they'll never reach their full potential. The ability to consistently make one's self do things that are uncomfortable, costly, and just plain difficult is something few are born with. Discipline, however, cannot exist without motivation.

Motivation is the drive to complete a goal. If one is hungry, they'll be motivated to get food. If one wants to fit in with a group, they might be motivated to change the way they dress, act, and talk. And if one wants to become a great athlete, they'll be motivated to train hard, eat right, and perfect their skills. Depending on the perceived importance of the goal, motivation levels will differ.

In his hierarchy of needs, Maslow (1996) outlines a number of needs in order of their typical importance (from most to least): physiological needs, safety needs, the need for belonging, the need for esteem, and the need for self-actualization. Physiological needs include food, water, air and sleep. Motivation to obtain these is necessarily high as the lack of any one of them will result in death. Safety

needs include shelter and protection from danger. After food, these are what people seek out next. The need for belonging is the basic need people display to be part of groups. After their survival and safety are taken care of, people then need to be a part of something larger than themselves, regardless of whether that's a family, group, church, team, or whatever. The need for esteem includes the need to be seen as and to feel competent, valuable, and worthwhile. This is the fourth most important need along the hierarchy. And finally, there's the need for self-actualization. Self-actualization is the need to fulfill one's potential and become the best they can possibly be.



Becoming a great athlete falls under self-actualization, and as such, the motivation to accomplish the goal will usually (in most people) be weaker than the motivation to achieve the goals beneath it on the pyramid. There are exceptions however, the starving artist who forgoes food and lives in poverty in order to express himself being one of them. Regardless, it's hard to focus on self-actualization when other, more important, needs are unmet. As such, the first step to building motivation (and discipline) is making sure that the four most important needs in the hierarchy are met. Once one has a good support system, self-esteem, and is in no danger of dying from one thing or another, they can focus on fulfilling self-actualization with no pressing distractions.

Maslow (1987) identified 15 characteristics that self-actualizing people shared. These characteristics include:

1)	Efficient perception of reality: They do not let their own wishes and desires color their perceptions. Consequently, they are able to detect the deceitful and the fake.
2)	Acceptance of themselves, others, and nature or fate: They realize that people, including themselves, make mistakes and have frailties, and they accept this fact. They accept natural events, even disasters, as part of life.
3)	Spontaneity: Their behavior is marked by simplicity and honest naturalness. They do not put on airs or strain to create an effect. They trust their impulses.
4)	Problem-focus: They have an interest in the larger philosophical and ethical problems of their times. Petty issues hold little interest for them.
5)	Affinity for solitude: They are comfortable with being alone.
6)	Independence from culture and environment: They do not go in for fads. They prefer to follow their self-determined interests.
7)	Continued freshness of appreciation: They have a “beginner’s mind,” for which every event, no matter how common, is experienced as if for the first time. They appreciate the ordinary and find pleasure and awe in the mundane.
8)	More frequent peak experiences: A peak experience is a momentary feeling of extreme wonder, awe, and vision, sometimes called the “oceanic feeling.” They are special experiences that appear to be very meaningful to the person who has one.
9)	Genuine desire to help the human race: All self-actualizers tend to have a deep and sincere caring for their fellow humans.
10)	Deep ties with relatively few people: Although they care deeply about others, they have relatively few very good friends. They tend to prefer privacy and allow only a select few people to really know them.
11)	Democratic values: They respect and value all people and are not prejudiced in terms of holding stereotypes about people based on superficial characteristics, such as race, religion, sex, and age. They treat others as individuals, not as members of groups.
12)	Ability to discriminate between means and ends: They enjoy doing something for its own sake, rather than simply doing something for the goals the activity can fulfill.
13)	Philosophical sense of humor: Most humor is an attempt to make fun of a perceived inferiority of a person or a group of people. Self-actualizers do not think such jokes are funny. Instead, what they find funny are examples of human foolishness in general.
14)	Creativity: Creativity can be thought of as the ability to see connections between things – connections that no one else has seen before. They are more likely to be creative because of their fresh perceptions, even of ordinary things.
15)	Resistance to enculturation: Cultures tell us how to behave, how to dress, and even how to interact with each other. Self-actualizers remain detached from culture-bound rules. They often appear different from and act different from the crowd.

Table Taken from Larsen & Buss (2008)

Though some are born with the characteristics listed above, they can and need to be consciously developed in most. By attempting to emulate the characteristics above, one can put themselves in a better position to accomplish their goals, as the characteristics lend themselves to being able to focus on and accomplish tasks with minimal external and internal interference.

In the pursuit of self-actualization, some people end up neglecting or alienating those close to them or they may be so focused on perfection (an impossible goal) that they end up getting down on themselves or losing self esteem. These things should be avoided at all costs, because while friendships and failures may cause a slowing of progress in the short term, they're necessary for support and learning in the long term. While some people can and do put self-actualization further down the pyramid, most are unable to function this way and need to keep their baser needs fulfilled.

Once the lower needs are fulfilled, there are plenty of strategies for building and maintaining motivation for one's athletic goals. The first step in building motivation is having a goal for it to apply to. Obviously, if one is reading this book, their goal is to become a better, or maybe a great athlete. This, however, is vague. The most effective goals are those that are concrete, high, and realistic (Locke & Latham, 2002). Rather than just state that one wants to be a great athlete, they need to sit down and identify the steps necessary to reach the end goal. The next step is breaking down the steps necessary to achieve each of the aforementioned steps. From there, it's just a matter of taking things one small goal at a time.

For a sprinter whose end goal is to run <10 seconds in the 100 meter dash, their first goal might be to run <11.50. In order to do that they may set up mini-goals, such as getting stronger in select lifts, jumping further or higher in certain drills, or refining their body composition. Once they meet those goals, they can reassess, raise the bar a little higher, and start over.

In addition to the goals being concrete, high, and achievable, they also need to be taken seriously and judged to be worth the effort (Locke & Latham, 2002). To show that one takes a goal seriously, and to help them continue to do so, one of the best strategies is to inform others about it. By telling others, one makes themselves accountable, which in itself will provide extra motivation. The importance of thinking the goal is worthwhile is self explanatory. The more important one judges a goal to be, the more motivation they'll have to complete it. Some people care about their self-actualization so much that they forsake their esteem, belonging, and even safety in order to pursue it.

In addition to proper goal-setting, people tend to perform tasks (jobs specifically) better and more often when they enjoy them (Judge, Thoreson, Bono, & Patton, 2001). One would expect this to generalize over to other tasks (training). Assuming it does, the benefits of enjoying one's training are obvious. Most athletes love their sports, but not all of them love the training that might go into it. For instance, virtually nobody likes long sprints in practice and quite a few athletes really dislike weight

training. For them, performing these tasks takes more discipline, and thus is less likely to get done.

In order to ensure that proper training is applied even if discipline might be lacking, or to make things easier even if the discipline is present, one should try to get themselves to like training and all of its components (resting, eating right, etc.). Besides just thinking positively about the actions, one can also use operant (Skinnerian) conditioning to help themselves learn to like various aspects of training.

The operant conditioning procedure used is called reinforcement. Reinforcement involves the delivery of a reinforcer after the performance of a desired behavior. A reinforcer is any event that increases the rate of a behavior and is delivered only after a behavior is performed (Miller, 2006). In simpler terms, if one doesn't like running 400 meter sprints, but wanted to increase their willingness to perform 400 meter sprints more frequently, they could reward themselves with a reinforcer after each time they run one. The reinforcer can be anything from a coach's word of approval, to a cookie, to a tick mark in a journal, to getting to listen to their I-pod for the remainder of the session. As long as it motivates the athlete to perform the behavior, and is delivered only after the behavior is performed, it's a reinforcer.

Not all reinforcers are equal however. To make sure that a reinforcer is as effective as possible, it needs a few key characteristics. For one, it can't be readily available. If an athlete can get the reinforcer any time they want, they probably won't be motivated to work for it. Two, the reinforcer works best if it's delivered immediately after the performance. The smaller the gap in time between the performance of the behavior and the delivery of the reinforcement, the better. And the third thing is that the reinforcer should only be delivered after the performance of that one behavior. They should not be able to acquire it for doing other things, especially for failing to perform the desired behavior.

Common reinforcers include: tasty food, words of approval or praise (from one's self or others), getting to listen to music, a new song for one's MP3 player, or any small item that one wants. Another thing that also works well for some is keeping a training journal. If one holds themselves responsible enough, the mere act of filling out one's training journal, especially if they've just set a new personal best, acts as a reinforcer. The effect can be magnified by keeping a journal online where others can view it. This way, the athlete is not only accountable to themselves, but to those viewing their journal as well.

Through the use of reinforcement, one can drastically increase the frequency of certain behaviors, and by applying this carefully to one's sports training, they can make sure they work hard

and stay on the right track. Reinforcement is a valuable tool for building and maintaining motivation, and there's no reason not to incorporate it into a plan.

A final long term psychological tool that can be applied is the occasional use of particularly hard sessions to put things into perspective. Getting one's self to do heavy back squats can be difficult, but 4 sets of 6 reps will seem a lot easier after one does a crazy session like 10 sets of 10 reps or 5 sets of 20 reps. Similarly, 200 meter sprint repeats are hard, but 400 meter sprint repeats are even harder. These type of sessions may actually be physically counterproductive, producing extreme soreness, vomiting, and generally tearing an athlete down. However, their mental benefits outweigh any physical damage they may do. Still, it's important to use them sparingly, once every few months or so just to remind the athletes what real hard work is. It's also important that they're kept away from important competitions and that the athletes are given plenty of time to recuperate afterwards. These sessions are meant to be physically and mentally draining. A final word of warning, the massive volumes involved and the fatigue they generate will lead to a breakdown in form. Coaches and athletes need to be careful here, as too great of a breakdown can result in injury.

And last but not least, though it's not really a tool or practice, the author believes strongly in athlete education. Though it probably isn't necessary, and in some cases may even be counterproductive, the author believes that people should understand what they're doing and why, regardless of what it is. This doesn't mean every athlete needs to know how their bodies function down to a cellular level, but they should have a basic grasp on anatomy, physiology, and sports science in general. The same goes for biomechanics. Athletes should strive to understand the specifics of their sporting movements to help them perform optimally. One needs to be careful that they don't focus too much on the minutia however, and keep their attention where it needs to be: on the big picture.

Decision Making:

Besides cultivating a strong body, one should seek to cultivate a strong mind as well. Free will is an amazing gift, but some people use it in a far more directed manner. What makes some people be able to kick smoking on a whim, while others struggle with the habit for years, if not decades? Both have the choice, but why is one man strong enough to make his choice and stick with it while the other waffles and eventually gives in? Inborn affinities aside, the answer is their varying strength of will.

Those with more will power are able to more easily make and stick with difficult decisions. For

those without this ability, there is hope. Much like strength, will power is something that can be trained and has plenty of room for improvement.

One can think of making a decision as comparable to lifting a weight. Some decisions are harder than others to make and stick to, just as some weights are heavier and harder to lift. And just like some people are born stronger than their peers physically, some are born stronger than their peers in terms of will power. Still, no matter how strong one is born, they can always become stronger through repetition and overload. The same goes for making decisions and seeing them through.

Like most other tasks in life, making hard decisions and then not going back on them is a skill. It's something that people learn and reinforce through practice. By making gradually more difficult decisions over time, people can build up their capacity to make even harder ones in the future. If one wants to reach their full potential, not just in athletics, but in life, then they need to start developing the ability to use their will power as soon as possible.

Wrap Up:

Since the physical development of great athletes is so prominent, it can be easy to overlook the mental aspect of sports and training, yet to do so would be a big mistake. While it's true that some athletes are so prodigiously talented that they can dominate in their given sport without any consideration given to their mind, most need the focus and work ethic that proper psychological practices can instill. By working to build not just the mind, but the body as well, one can develop a well rounded athlete capable of pushing themselves as hard as they need to while simultaneously being able to keep their wits about them.

8

Standards and Testing

Though in the end it all comes down to how well one performs on the field, high level competitive sports usually require extremely high levels of physical ability. Exactly how much physical ability one requires depends on their sport, their skill, and their level of competition, but in most cases, more is better. The following chapter will cover performance standards for a number of strength and power sports. Keep in mind however, that these standards are merely guidelines. Just because one doesn't meet them doesn't mean they can't be great at the sport the standards are written for. And on the opposite side of the coin, some people will need to exceed the standards if they want to have any hope of competing at the highest levels.

Testing procedures will also be covered in this chapter. Some things, like sport form, need an expert's eye to be properly assessed, but there are some tests that are easy to learn and apply for everyone.

Standards:

The following standards have been pulled from books/articles written by high level coaches as well as sports teams' testing criteria and results. These numbers are for the best of the best speed and power athletes, so one should see them as ultimate goals and should not get depressed about falling short of them. Again, these standards are for or are set by professional athletes. One should keep that in mind while reading.

Speed Athlete Standards:

The following strength standards were outlined for world class speed athletes by Dintiman, Ward, and Tellez (1997). Numbers indicated in the table are one rep maximums relative to bodyweight, so "1.3" means the athlete can lift a max of 1.3 times their bodyweight in a given lift.

Level	Snatch	Clean	Full Squat	Front Squat	Deadlift	Bench Press	Military Press
Very Poor	0.5	0.9	1.3	1.2	1.3	0.8	0.4
Poor	0.7	1.1	1.6	1.4	1.6	1.1	0.6
Average	0.9	1.3	1.9	1.6	1.9	1.4	0.8
Good	1.1	1.5	2.5	2.0	2.5	1.7	1.0
Excellent	1.3	1.7	2.5	2.0	2.5	2.0	1.2

*The repeating “2.5” and “2.0” on Full Squats, Front Squats, and Deadlifts are not a typo.

Further speed and power standards for world class long jumpers were outlined in the USATF's “Fundamentals of the Long Jump” (2009).

Test	Ranking	Result
30M Sprint (FAT)	Average Good Elite	3.92 seconds 3.86 seconds 3.80 seconds
10M Fly Sprint (30M accel)	Average Good Elite	0.99 seconds 0.97 seconds 0.94 seconds
150M Sprint (HT)	Average Good Elite	15.8 seconds 15.4 seconds 14.9 seconds
Broad Jump	Average Good Elite	3.3 meters 3.4 meters 3.5 meters
Full Squat Max (times bodyweight)	Average Good Elite	2.0 2.1 2.2
Clean Max (times bodyweight)	Average Good Elite	1.5 1.6 1.7

Speed and Power Athlete Standards:

The upcoming numbers are from the US Bobsled & Skeleton Federation's combine scoring table (2009). Each event has a score from 50-100 by ones. In the interest of saving space, the author is only going to list the standards for 90 and 100 points.

It should be noted that the sprint times are measured by running through two lasers with a 1 meter fly-in zone before the first one. This makes the times roughly 0.5 seconds faster than if fully automatic timing were used. This may make the speed numbers seem a little low for athletes on the

lighter side, but they are meant to apply to people in the neighborhood of 200-240 lbs.

Points	30M Sprint	60M Sprint	30M Fly Sprint	Broad Jump	OHB Shot Toss	Full Squat	Clean
100	3.55 seconds	6.50 seconds	2.90 seconds	3.35 meters	18.0 meters	200 kilograms x 3 reps	150 kilograms x 1 rep
90	3.68 seconds	6.70 seconds	3.03 seconds	3.16 meters	16.0 meters	175 kilograms x 3 reps	130 kilograms x 1 rep

Though there's no scoring system, the annual NFL combine provides a great deal of information about what world class athletes are capable of. In order to keep things simple, the following chart will include the average of the top 5 scores in the 2010 combine for the listed positions. One can compare themselves to players of different positions based upon their own size.

Regarding the measurements used, 40 yard dashes are essentially hand times so there may be some inconsistencies. Vertical leaps are also measured in an inefficient way. Reach is measured with two hands and the athlete is then allowed to jump and reach with one. For a more accurate vertical leap comparison, one should subtract 3" from the vertical leap scores given below.

Again, the numbers given below are not for one man, but are composites of the top 5 scores in each position. If one could equal all of these numbers and is the correct size for the position, then by all means, they should probably be in the NFL or at least working their way there.

Position	40 Yard Dash	Vertical Leap	Broad Jump	Bench Press (225 lbs)
Cornerback	4.47 seconds	40"	10'8"	21 reps
Running Back	4.41 seconds	39.5"	10'2"	24 reps
Linebacker	4.60 seconds	40"	10'1"	31 reps
Offensive Line	4.99 seconds	33.5"	9'4"	37 reps

Pure Power Athletes:

The following are reported stats for some of the best shot putters in history. Few if any of the numbers are verified, so take them all with a grain of salt. Still, as far as the author is concerned they seem reasonable, though the depth on the squats may be questionable in some, if not most, cases.

Name	Height	Weight	Shot Put	Vertical Leap	Broad Jump	Squat 1RM	Clean 1RM	Bench Press 1RM
Ulf Timmerman	6'4"	262 lbs	75'8"	36"	11'2"	805 lbs	485 lbs	550 lbs
Werner Gunther	6'6"	278 lbs	74'7.5"	35"	11'2"	761 lbs	452 lbs	518 lbs
Sergei Smirnov	6'2"	306 lbs	73'1"	32"	9'10"	850 lbs	490 lbs	575 lbs
Greg Tafralis	6'	295 lbs	72'1.75"	33"	10'	880 lbs	520 lbs	638 lbs
Andy Bloom	6'1"	265 lbs	69'3"	38"	11'	740 lbs	405 lbs	350 lbs

Testing:

As stated earlier in the chapter, the ultimate test is how well an athlete performs on the field, track, court, or whatever. However, having tests and indicators can help to guide one's training and allow for the measurement of progress when not in season. As such, while testing is not necessary, it can be helpful.

With the way training works, sometimes it can be difficult to determine if one is actually improving. Some lifts might be going up while others are going down and all the while one's bodyweight might be fluctuating too. How does one know if they got stronger, more powerful, or more reactive? This is where indicators come in.

Indicators are general movements that allow for the easy measurement of one or more qualities. Indicators are usually simple or familiar in nature and involve displays of power rather than strength. They're reliable regardless of bodyweight and can be compared to one another to get an idea of what's going on with one's training as a whole. And best of all, they're simple to apply, compare, and get results from.

The following are a few of the author's favorite indicators.

Vertical Leap:

The vertical leap (also known as the countermovement jump or CMJ) is a great test of overall lower body power. Due to its more quad-dominant nature (Hubley & Wells, 1983), the vertical leap is a good predictor of the ability to change direction, decelerate (Girard & Millet, 2009), and accelerate (Requena, de Villarreal, Gapeyeva, Erelina, Garcia, & Paasuke, 2010), abilities which most team sports require.

While limb length and tendon attachment point differences mean that it's hard to use the CMJ as

a predictor of ability between athletes (unless their anthropometry is very similar), it can be used by individuals to track progress over time.

Broad Jump:

The broad jump (also known as standing long jump or SLJ) is a test of lower body hip power. It's similar to the vertical leap, but there is far less emphasis on the quadriceps and far more on the hip extensors (Robertson & Fleming, 1987). The SLJ is a good predictor of overall lower body power, but is a better predictor of early acceleration ability than the CMJ when height is accounted for.

As with the CMJ, limb lengths, tendon attachment points, and height play significant roles in determining performance, so the SLJ should not be used as a predictor of ability between athletes (unless their anthropometry is very similar), but it can be used to track individuals' progress over time.

Depth Jump:

The depth jump is another good test of general lower body power with a larger focus on the quads and plantar flexors. Also, whereas the CMJ largely tests voluntary concentric strength, the depth jump can provide a measure of reactive strength as well. This allows it to more accurately predict sprint performance than the CMJ (Bissas & Havenetidis, 2008; Kale, Asci, Bayrak, Acikada, 2009).

The drop height from which the depth jump is performed is dependent upon the ability of the athlete being tested. Athletes should use the box that allows them to rebound highest.

Bounding:

Bounding from a stand still is to the SLJ roughly what the depth jump is to the CMJ. It's a test of mostly hip and plantar flexor power that relies more on reactivity and is therefore more applicable to sprint speed. The standard number of bounds per set is three and athletes can choose to go either right, left, right or left, right, left depending on their preference.

Sprint coach Frank Dick has a chart in which he correlates standing triple jumps to sprint speed. However, as with trying to use any non-specific task to predict ability in between individuals, it does not accurately apply to all populations. Limb lengths, tendon insertion points, and skill at the movement all affect the outcome, in the case of this particular chart, so does sprinting ability. The following numbers are supposed to correlate for speed athletes only. Strength athletes may be able to

bound, but without the skill, reactivity, and structure of a sprinter, they will not be able to run as fast.

There is some overlap in the jump scores. That is not a typo.

<u>Projected 100M Time (seconds)</u>	<u>Standing Triple Jump (meters)</u>
10.20-10.65	9.20-10.00
10.70-11.10	8.50-9.10
11.20-11.70	7.90-8.50
11.80-12.20	7.50-8.10
12.30-12.70	7.20-7.80
12.80-13.20	6.80-7.40

Reactive Strength Index:

Reactive strength index (RSI) can be calculated in two ways. Way one is by subtracting one's squat jump (a jump without a countermovement) height from their countermovement jump height. Way two is by subtracting one's countermovement jump height from their maximum depth jump rebound height. RSI indicates how much one is able to take advantage of their stretch reflex and reactive ability. The higher their RSI numbers, the more reactive the athlete is.

RSI (CMJ – SJ) has been shown to be a good predictor of late acceleration, top speed, and speed endurance (Smirniotou et al, 2008). Despite it's relation to sprinting speed however, RSI measurements are heavily dependent upon the quads and calves.

Posterior Chain Reactive Strength Index:

A posterior chain reactive strength index (PCRSI) can be calculated by recording a best broad jump score and then a best standing triple jumping score. One then needs to divide the standing triple jump score by their broad jump score. The higher the number, the greater reactivity one has in their glutes, hamstrings, and calves. A PCRSI of 3 or above indicates exceptional reactivity.

Wrap Up:

The standards listed in this section are for the best of the best, and so if one meets them they're probably doing alright for themselves. And as for the tests, they're just useful tools to help coaches keep track of progress across various strength qualities. It's not even necessary that one be good at any of the tests, as long as they're good come game time. Still, they can provide useful feedback when

competition isn't an option. It is recommended that coaches test their athletes and develop their own standards and testing scores over time. Keeping detailed logs of all players under their care over time will help immensely in this task.

9

Miscellaneous

Chapter 9 is a catch-all for everything that didn't quite fit into the previous eight chapters. The things covered truly are miscellaneous in nature and include a broad range of categories, though of course, it will all still be training-related.

Footwear:

Footwear is a big problem area amongst the athletic population. In an attempt to outsell their competition, shoe companies have devised all manner of fancy cushioning systems which, over time, have become excessive to the point of becoming performance detriments.

The thick soles and elevated heels of most modern day athletic shoes prevent optimal movement patterns. Not only do the inflexible soles prevent the muscles of the feet from performing their job, but the elevated heels and cushioning systems lead to altered gait patterns. Unshod or minimally shod runners tend to land on their forefoot or midfoot when running, while those in modern shoes heelstrike (come down on their heels first) (Lieberman et al, 2010). Forefoot or midfoot running results in much lower impact forces than heelstriking, regardless of footwear. This can explain the high incidence of impact-related injuries sustained by runners and other athletes annually.

Footwear not only changes impact forces and touchdown mechanics, but other factors as well. Those running barefoot have shorter stride lengths when compared to shod runners, but make up for it with lower impact forces and shorter contact times (Squadrone & Gallozzi, 2009). This can largely be attributed to the lack of over-striding that appears in heelstriking runners.

To promote optimal foot function, and therefore both performance and health, the author would suggest minimalistic shoes while training. Spikeless cross country waffles work very well, as do the slightly more unorthodox Vibram 5 Fingers fitted shoe. As a rule of thumb, the less shoe there is and the thinner and flatter its sole, the better. Raised heels should be avoided at all costs. Going barefoot

works the best of all, but there's the fear of hazards hidden in the grass or on the track. One stray piece of glass can ruin months of training. As such, it's probably better to keep one's shoes on if at all in doubt.

While making the transition from shod to unshod (or less shod), one needs to be careful to ease themselves into it. It takes time for the body to adapt to the new loading patterns caused by the drastic changes in footstrike and if one neglects to reduce either the volume or intensity of their training, the chance of injury can be high.

Equipment:

With the number of fancy fitness gadgets peddled on TV or in magazines and the vast expanse of specialized machines covering nearly every gym floor, it's easy to start thinking that one needs exotic equipment to succeed. Thankfully, especially for those on a budget (the author included), nothing could be further from the truth. The most important equipment is actually the simplest and cheapest and most of it can be found for free.

As far as sportsmen are concerned, the most important piece of equipment that they can have at their disposal is a flat, open area in which to sprint, jump, cut, and anything else they could want to do. This includes fields, basketball courts, tracks, or even long hallways. Not only are most of these areas readily available and free to access, but they come with chairs, bleachers, and other furnishings that can easily be used for shock training or other drills. Really, it's just a matter of using what's available in one's environment and improvising from there.

Beyond having open space in which to move, the other thing sportsmen really benefit from is access to weights. Not single-use machines or gimmicky contraptions, but plain old barbells with metal plates. In order to get a great strength training workout, all one really requires is a basic barbell and enough plates to provide loading. The range of exercises a barbell allows one to perform is staggering, and with a little ingenuity, even more can be thought up. Beyond that, a squat rack, or even squat stands would be useful, but again, while they allow one to perform several beneficial movements with some degree of safety, they're not necessary. Dumbbells also have their place, and are the third and final important “must have” as far as weights are concerned, but even they're not really that important. Machines and the like are strictly unnecessary.

So simply, all the equipment one needs, in order of importance, is:

- A flat, open area in which to run, jump, and train.**
- A barbell with enough plates.**
- A squat rack**
- Dumbbells (loadable so size is never a problem)**

While one pretty much has to find an open area and has to purchase weights, a squat rack doesn't necessarily have to come from a store. Purchasing an adjustable rack with safety catches can run from 500 to a few thousand dollars, and for most people, this is well out of their price range. So instead, the author would suggest that one take matters into their own hands, head down to their local hardware store, and build themselves a rack.

Using only a table saw, a power drill with a few bits, 2x8s, wood glue, clamps, common brackets, screws, and plumbing supplies, one can build themselves a long lasting, sturdy rack capable of supporting more than enough weight to keep them in business for years, and at a much cheaper cost than picking up a finished product at a store. Just as a note though, before one gets all excited and goes to buy supplies, wooden racks can not be stored outside. So unless one has room inside for a homemade rack, they should stick with one made from metal.

The materials required for this project are:

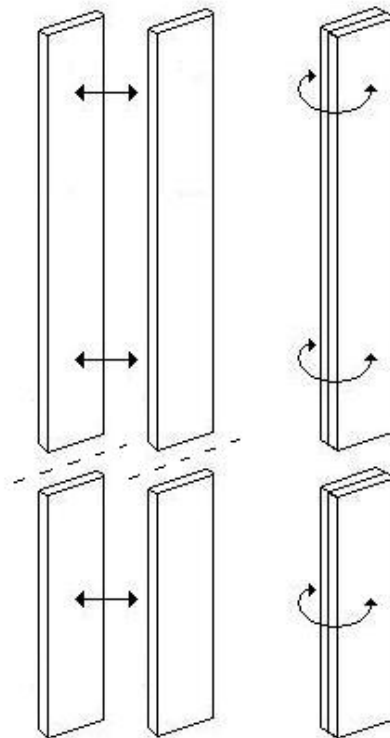
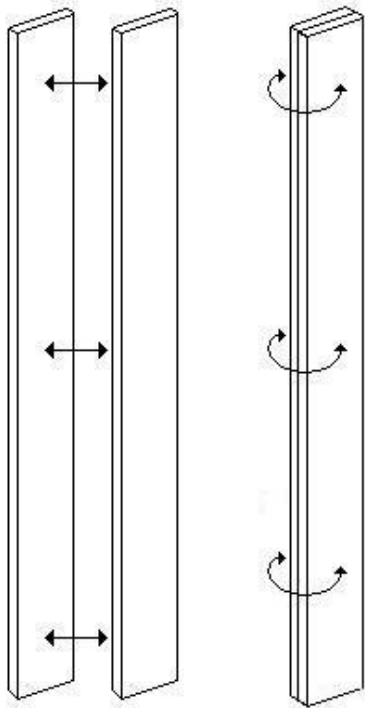
- 1 table saw**
- 1 power drill with 1 1/4" wood boring bit & phillips head screwdriver bit**
- 14 2x8s**
- 16 RTA2Z rigid tie angle connectors (or similar design)**
- wood glue**
- clamps or vises**
- wood screws**
- 2 1x36" black pipes**
- 4 1x6" black pipes**
- 2 1x1" black pipe 90 degree elbows**
- 4 1" galvanized floor flanges**

Once the materials are acquired, all one needs is some open space, patience, and a lot of elbow grease. And just as a note, the dimensions of the rack can be modified as space limitations necessitate.

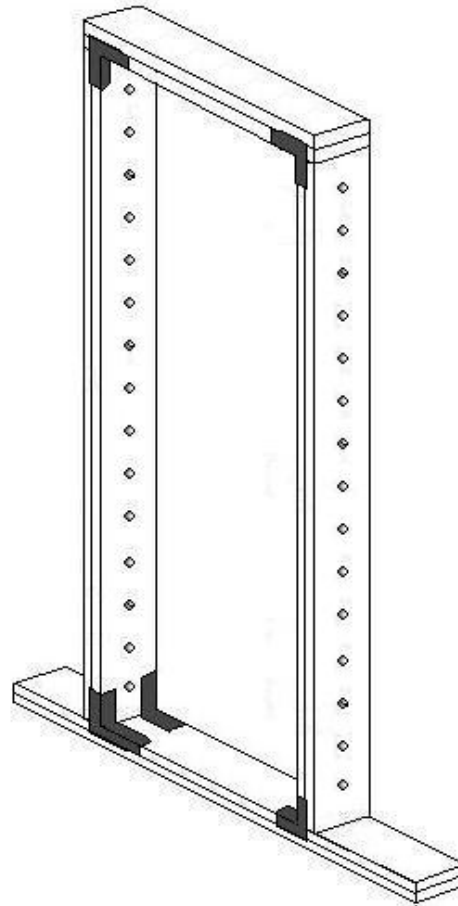
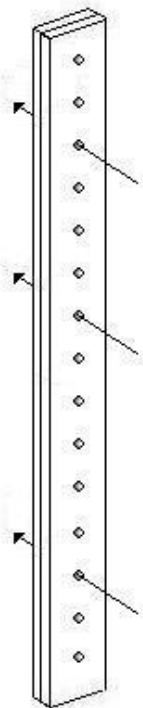
The rack in it's current form is around 8.5' tall. Not everyone has such high ceilings at their disposal.

Now for the instructions:

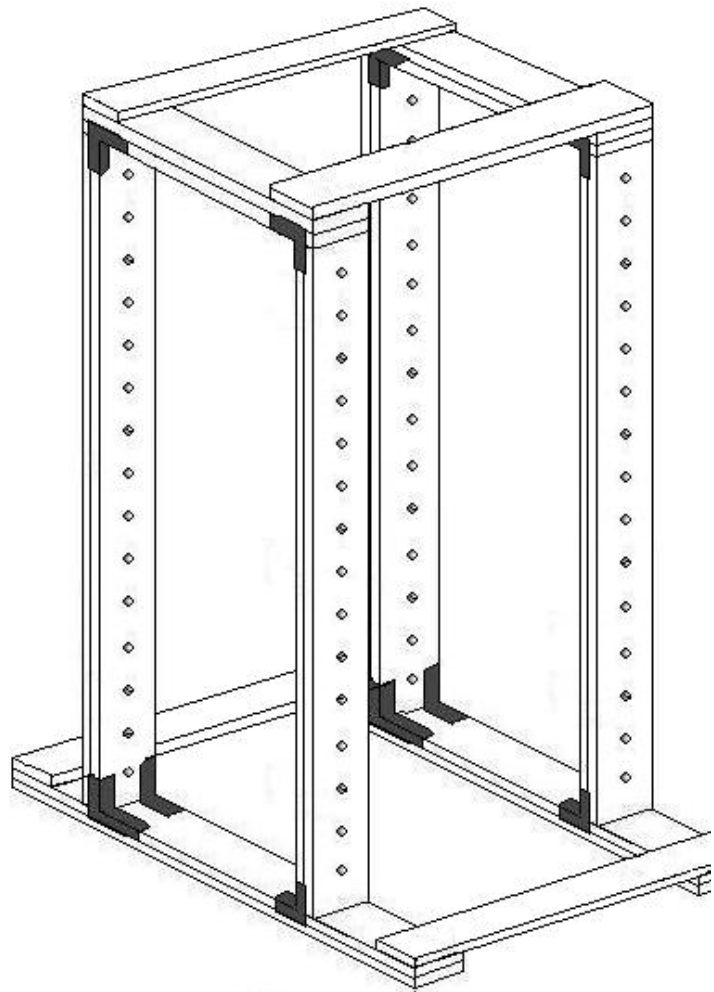
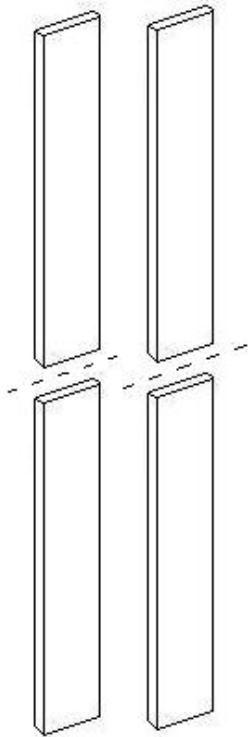
Step 1: Liberally apply wood glue to one flat side of a 2x8 and then stack another 2x8 on top of it. Secure them together with clamps and allow to dry. Repeat three times. You will end up with 4 separate pieces.		Step 2: Take one 2x8 and cut it into a 5' length and a 3' length. Repeat three times. Wood glue and clamp the 3' pieces together and the 5' pieces together. You will end up with four separate pieces.
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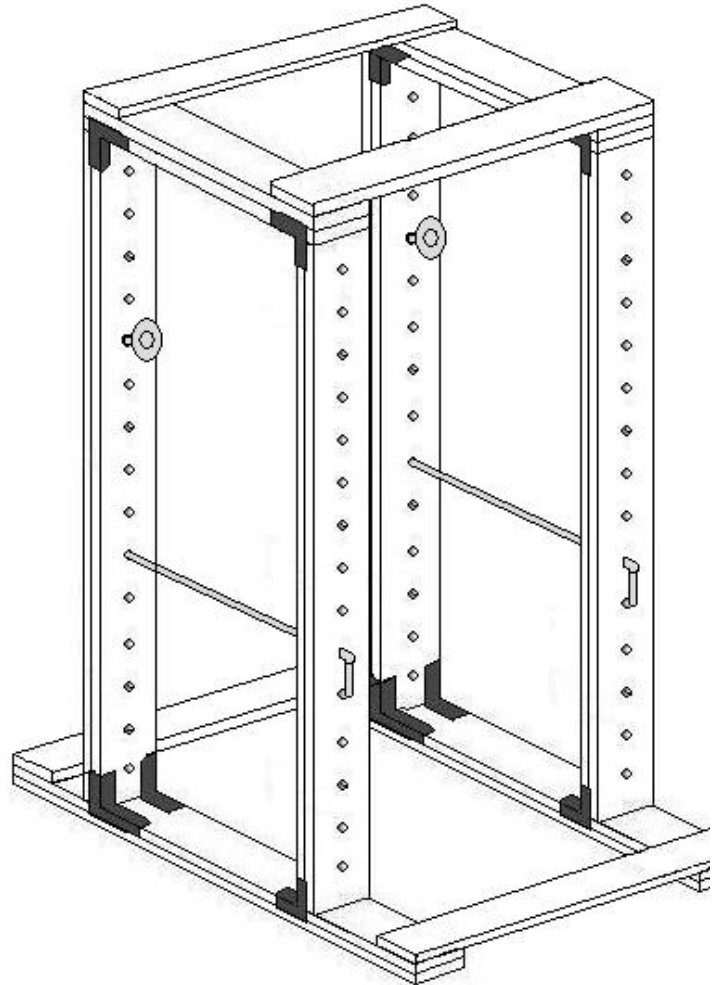
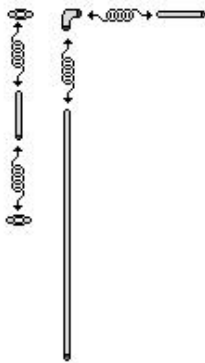
Step 3: Taking the doubled up full length 2x8s from step one, drill holes through the center of each board with the center of each hole 6" from the center of the hole below it.		Step 4: Use the rigid tie angle connectors to secure the cut and glued 2x8s together as shown in the diagram below. There is one rigid angle tie for each corner, meaning 8 per half and 16 total. Repeat once.
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Step 5: Take the two remaining 2x8s and cut them in half, width-wise. This should yield four 4' long pieces.		Step 6: Place the 4' pieces between the two frames as shown in the diagram and secure them in place with wood screws.
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Step 7: To make a hook, screw a galvanized floor flange onto both ends of a 6" pipe. To make a safety catch, screw together a 36" pipe, a 90 degree elbow, and a 6" pipe.		Step 8: Take a step back and enjoy your finished product. If it doesn't look something like the picture below, something went wrong somewhere in the process.
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Assuming one has the necessary tools at their disposal, the above power rack can be built for roughly \$100, a huge savings over purchasing a rack. And though it's made of wood, it's extremely sturdy. The author has built one of nearly identical design and it has held up under 600+ pounds of loading. If one does decide to build themselves equipment, they should know how to operate power

tools and should wear the proper protective gear when doing so. Once one has the hang of it, the only limit to what they can build, even with the simplest tools, is their imagination.

Winning, Losing, and Testosterone:

The classic saying, “It doesn't matter if you win or lose, as long as you played your best,” is a favorite amongst parents and coaches everywhere, but it's not necessarily true. Sure, it is true that all one can give is their best, but what are the repercussions of winning or losing? Social and economic reasons aside, does it really matter if one wins or loses? The answer is a resounding: yes, it does.

In addition to the money and glory that winning may lead to, it can also result in increased testosterone levels (McCaul, Gladue, & Joppa, 1992). This increase in testosterone may be mediated by mood as its increase appears to be linked not just to the act of winning, but to the cognitive value attached to the victory (Suay et al, 1999). No matter what the mechanism by which the increase is caused, winning does lead to an increase in testosterone levels and these effects can be cumulative.

Athletes who have just won a competition not only experience an increase in testosterone after the match, but enter their next match with higher testosterone levels as well (Booth, Shelley, Mazur, Tharp, & Kittok, 1989). This means they'll benefit from increased confidence as well as any physical effects the testosterone might have.

The main implication of the above is that while giving one's best is truly all they can do, it does matter if one wins or loses. Winning sets one up for future wins and faster progress in the future, both physically and mentally. As such, while it's important to find and go up against challenging competitors in order to push one's self, constantly losing won't do one any favors. Having said that however, constantly thrashing people well below one's skill level probably won't be too beneficial either. One just needs to make sure they're winning on a regular basis, but not in one-sided contests.

It should also be noted that the effects of winning and losing don't just apply when one is actually competing, but appear to apply to anything one is emotionally invested in an outcome as well. Even spectating while having one's chosen sports team win or lose can affect testosterone levels, assuming that one cares about the outcome (Bernhardt, Dabbs, Fielden, & Lutter, 1998). This means that if one is going to get emotionally invested in any contest on a regular basis, they'd better make sure to bet on the right horse.

Music and Performance:

Music is almost inextricably linked with the gym environment. Music is either being pumped in over a speaker system or individual gym-goers have their earbuds in and their MP3 players switched to their favorite songs. As is obvious, people like to listen to music while working out, but it's not just a matter of preference. Listening to music while training carries with it some very useful benefits that require little effort to obtain.

Listening to music while working out can increase anaerobic endurance and power (Simpson & Karageorghis, 2006), increase aerobic endurance and positive intra-set affect (Karageorghis, Mouzourides, Priest, Sasso, Morrish, & Walley, 2009), and lower perceived exertion while simultaneously facilitating a higher workload (Thornby, Haas, & Axen, 1995). This means that, in tasks of endurance, one can perform harder for longer and have a more positive attitude towards the work while doing it. The type of music that works best is still up for debate, but when one is seeking to increase absolute performance levels (speed, time to exhaustion, etc.), the best choice appears to be loud music with a fast tempo (Edworthy & Waring, 2006).

Music can also be used to increase the effectiveness of warm ups. Some athletes may not give enough effort while warming up, but athletes exposed to music while warming up exhibited higher heart rates than those who were not (Eliakim, Meckel, Nemet, & Eliakim, 2007). As such, music may be one solution for helping get lazy teams or players ready for their session.

Bands, Accommodating Resistance, and Overspeed:

Though their usage is unnecessary, elastic resistance bands have a number of unique properties that allow for interesting training effects. Whereas the downward acceleration of a barbell or one's body will always be limited by gravity (9.81 m/s), elastic bands can provide higher rates of loading. Similarly, since the bands act like springs, the further they're stretched, the greater resistance they provide. This means that when applied with movements like squats and presses (in addition to free weights), they help add relatively greater load to the top portions of the lifts, portions which are usually underloaded seeing as weight is usually limited by strength at the end of the ROM. In a sense, this allows one to get more benefit from the entire movement rather than just at the point where leverage is the worst.

In terms of actual application, free weight training with the incorporation of elastic bands is still general work, but it's slightly more specific to the needs of explosive strength and power athletes. As mentioned, resistance bands shift the focus of a given rep from the point of worst leverage (the bottom) to the mid and end points. In traditional lifting, one develops more force in the last 5% of the eccentric phase and the first 5% of the concentric phase, while in resistance band plus free weight lifting, more force is generated in the first 25% of the eccentric phase and the last 10% of the concentric phase (Israetel, McBride, Nuzzo, Skinner, & Dayne, 2010). This redistribution of effort allows for relatively greater loading (as far as intramuscular tension is concerned) over a larger portion of the ROM.

A higher rate of loading (from the bands “throwing” the bar down faster than 9.81 m/s) and a greater relative load over a larger portion of the ROM means that banded work gives slightly different results than free weights alone. Training with bands results in greater increases in peak power and peak force than free weights under similar loading conditions (Wallace, Winchester, & McGuigan, 2006). For athletes, who are all about high power and force outputs, this is very beneficial.

In addition to increasing peak power and force, banded resistance training also increases two other things: soreness and workout complication. The increased focus on the eccentric portion of the movement tends to create delayed onset muscle soreness. And though this does go away once one acclimates themselves to it, the greater eccentric loading still needs to be taken into account when creating a program. The other problem is one of complication. The trouble of having the bands on hand and setting them up every workout can be distracting and might not be worth the benefits. It's all up to the individual though. The author thinks bands are a fun training device and that they can be alternated in with traditional resistance training if it stalls out, but they're definitely not necessary.

In addition to just loading up different portions of the ROM, resistance bands can be used to really focus on eccentric muscle action as well. Reactive lifts involve letting a barbell free fall and then breaking its momentum in an instant at the bottom of the ROM. Traditional reactive lifting can only involve descent accelerations of 9.81 m/s or less, but by adding bands, this speed can be increased. Reactive lifting is the resistance training equivalent of shock training. It comes with most of the same benefits and drawbacks, but is typically easier on the feet and ankles.

The final real use for resistance bands is incorporating them into overspeed shock training. Depth jumps and altitude landings with bands accelerating one towards the ground involve higher forces than stepping off of a box of the same height without the bands, but this effect can be replicated

merely by stepping from a higher box. The real value in overspeed shock training, and this is all theoretical, comes from an augmented perception of gravity. The two otolith sensors in the vestibular system sense linear acceleration (Day & Fitzpatrick, 2005), and during all other shock training that speed is 9.81 m/s. When using bands to shoot one's self at the ground, the rate of acceleration is higher. In theory, this causes a greater neural response than a traditional depth jump, resulting in greater neural and muscular output. These methods are fairly advanced however, and it's not even known for sure by what mechanism they work. The author has had good experiences with them in the past though.

When performing overspeed depth jumps, it's important that the bands are released upon touchdown.

Muscle/Movement Matrices:

The follow charts detail which muscle groups work to create which movements around certain joints. Not every single muscle group will be covered, but the important ones will be. By using this chart, one will be able to break down any given movement into its constituent parts and reason which muscle groups are doing what. This will aid in allocating training properly and will help correct any postural issues that may arise from daily movement patterns. If a muscle on one side of a joint is excessively lax, one needs to train it (with an emphasis on its shortened position) in order to bring the joint back into alignment. As has been said, "If it's sagging, it's lagging." Lax muscle groups need to be strengthened and overly short muscle groups need to be trained in an elongated position. That sentence is basically postural manipulation in a nutshell.

The following charts are organized by which joint the muscle actions deal with.

Muscles acting on the shoulder.

Muscle	Abduction	Adduction	Extension	Flexion	Medial Rotation	Lateral Rotation
Biceps Brachii				*		
Deltoid	*		*	*	*	*
Infraspinatus		*				*
Latissimus Dorsi		*	*		*	
Pectoralis Major		*		*	*	
Supraspinatus	*					*
Teres Major		*	*		*	
Teres Minor						*
Triceps Brachii		*	*			

Note: The posterior fibers of the deltoid create extension and lateral rotation, the anterior fibers create flexion and medial rotation.

Muscles acting on the forearm.

Muscle	Elbow Extension	Elbow Flexion	Pronation	Supination
Biceps Brachii		*		*
Brachialis		*		
Pronator Quadratus			*	
Pronator Teres			*	
Supinator				*
Triceps Brachii	*			

Muscles acting on the shoulder girdle (scapulae).

Muscle	Protraction	Retraction	Elevation	Depression	Upward Rotation	Downward Rotation
Levator Scapulae			*			
Pectoralis Minor	*			*		*
Rhomboids		*				*
Serratus Anterior	*				*	
Trapezius Fibers U		*	*		*	
Trapezius Fibers M		*				
Trapezius Fibers L		*		*	*	

Note: For the trapezius, “U” means upper, “M” means mid, and “L” means lower.

Muscles acting on the trunk.

Muscle	Extension	Flexion	Lateral Flexion	Rotation
Erector Spinae	*		*	
Illiopsoas		*	*	
Multifidus	*		*	*
Obliques		*	*	*
Quadratus Lumborum	*		*	
Rectus Abdominis		*		

Muscles acting on the hip.

Muscle	Extension	Flexion	Abduction	Adduction	Medial Rotation	Lateral Rotation
Adductor Brevis		*		*		*
Adductor Longus		*		*		*
Adductor Magnus	*	*		*		*
Gluteus Maximus	*		*	*		*
Gluteus Medius	*	*	*		*	*
Gluteus Minimus			*		*	
Gracilis				*		
Hamstrings	*					
Illiopsoas		*				*
Lateral Rotators						*
Pectineus		*		*		*
Rectus Femoris		*				
Sartorius		*	*			*
Tensor Facia Latae		*	*		*	

Muscles acting on the knee.

Muscle	Extension	Flexion	Medial Rotation	Lateral Rotation
Gastrocnemius		*		
Gracilis		*	*	
Hamstrings		*	*	* (Biceps Femoris)
Quadriceps	*			
Sartorius		*	*	

Muscles acting on the ankle.

Muscle	Plantarflexion	Dorsiflexion	Eversion	Inversion
Extensor Digitorum Longus		*	*	
Extensor Hallucis Longus		*		*
Flexor Digitorum Longus	*			*
Flexor Hallucis Longus	*			*
Gastrocnemius	*			
Peroneus Tertius	*		*	
Peroneals (Lateral)	*		*	
Soleus	*			
Tibialis Anterior		*		*
Tibialis Posterior	*			*

The above can also be used as stretching matrices. In order to stretch any given muscle, all one needs to do is perform the opposite motion the muscle is responsible for. If it's responsible for many motions, the more one can reverse at once, the greater the potential stretch. For example, the pectoralis major flexes, adducts, and medially rotates the humerus, so to stretch it optimally one would extend, abduct, and laterally rotate their humerus. The same can be done for any other muscle group by referring to the relevant chart.

High Frequency Strength Template:

During the off season one does not have to be in top sporting form all of the time. They have some wiggle room to let their sporting abilities slip and focus on building up their physical and neural qualities. This template can be used in the place of one's regular resistance training to rapidly speed up strength gains for a short period of time. The volume of specific and supplementary work during this time period does not even need to be cut and the strength gains will still be better than decent.

Capitalizing on the fact that motor learning happens best with frequency, the goal of the template is to expose athletes to heavy weights on a regular basis. The format is straight forward, simple, and quite frankly boring, but it will get the job done.

To get started, one needs to pick a major lift for the lower body (or two opposing lifts for the upper body) and determine their 1RM (one repetition maximum) while fresh. From that point, the program centers around using 80-85% of one's 1RM and lifting it frequently while using compensatory acceleration and staying far short of failure.

Basically, all one needs to do for weights on this program (with the exception of supplementary work for smaller muscles and posture) is lift 80-85% of their 1RM for single repetitions with 60-120 seconds of rest in between each rep. Since the relative intensity will be so low (80-85% 1RM usually allows for 5-8 reps to be completed before failure), one should focus on perfect form on every rep and should also lift as hard and fast as possible. When bar speed starts to slow down, the sessions ends. That's all there is too it. Every 3-4 weeks one should retest their 1RM and readjust from there.

Working on a two days on, one day off schedule, one should see quick strength gains. The intensity selected is high enough to see increases in coordination and “neural” strength gains, but light enough to allow for high volume and frequency. Training like this can and does work very well. It takes little time, places little strain on the muscles, and is great for increasing strength to weight ratio. The one thing it's not particularly good for is increasing muscular size, but that's largely dependent on diet anyways.

Logging:

This section doesn't refer to the plaid-clad stereotypical Canadian occupation of choice, but to the act of keeping a log in which to record one's training. Besides training itself, keeping a detailed and

accurate log is perhaps the best thing one can do to ensure progress. Keeping a journal not only helps one keep track of their progress over time, but also helps them feel a sense of self efficacy and control, both of which will drive up motivation.

Though how in-depth one wants to keep their journal is up to them, it is strongly suggested that they do so on paper. Keeping a log in one's head is prone to failure at some point. The human memory is far from perfect and it's nearly impossible to remember what one did on a given Tuesday two years prior.

To get one started, the author will provide a sheet which one can use to track their work. The sheet will be broken down into five sections: condition, warm up, workout, cool down, and notes. "Condition" can include bodyweight, sleep patterns, soreness, subjective physical well-being, and mental state. "Warm Up" details the warm up. "Workout" details the workout and can include exercises, sets, reps, intensities, and rest periods. "Cool Down" includes what was done during the cool down, conditioning work can be included here or in the "Workout" section. And the "Notes" section should contain things such as the perceived difficulty of various parts of the workout, one's physical and mental condition post session, and anything else that needs noting.

Date: _____ **Time:**(start) _____ (end) _____

Condition: _____

Warm Up: _____

Workout: _____

Cool Down: _____

Notes: _____

Wrap Up:

Though the information in this chapter was saved for last, it's still just as important as all of the work that came before it. Paying attention to little things like footwear, music, and proper logging can make a big difference over the long term. Sprint work is damn near useless if done in hiking boots, and some people just can't stomach working out without good music to distract them. These little things can make or break a practice. Coaches need to be aware of this.

10

Summing Things Up

If the author has done his job, the reader now has a road map to take them and/or their athletes from whatever level they may currently be at to as far as their time, genetics, and will power will allow. The format of this book has been kept intentionally simple, but some background is necessary to apply the material within as thoroughly and accurately as possible. Though the book can point one in the right direction and tell them how to get back on track should they ever lose their way, what things really come down to, in terms of improvement rather than absolute ability, is the expertise of the coach and the heart of the athlete.

Coaching is both a science and an art. It's a science in that training is based upon concrete physiological and psychological principles. It's an art in that people are not actually automatons. Feelings, desires, and sheer determination can drastically change training and it's up to the coach to know what each individual under his care needs or can handle. In theory, practice and theory are the same, but in practice, they're not. One can know all of the information in the world, and that will make them smart, but it takes experience and wisdom to properly apply that knowledge. These traits can only come with time.

It should be noted again that training is not a sprint, it's a marathon. Rome wasn't built in a day and neither is athleticism. To see gains in physical and mental ability takes time. In order to get good at something it takes endless repetition and people who are great at a given task tend to thrive on boredom. Learning to work hard day in and day out is necessary if one wants to reach their potential. Training needs to become an inseparable part of themselves. One should want to train and if they miss a session they should be itching to get to the next one. It's this type of determination, this type of drive to better themselves, that results in long term improvements. Even a perfect program can only do so much if the trainee's heart isn't into it, but a substandard program can go a long ways if the man doing it is dead-set on being the best.

For the coach, this long term determination should appear in their study habits. Good coaches

should always be seeking out new information. They should always strive to learn more, to understand more, and to put it all together in an applicable format. Whereas athletes should strive to push their bodies and minds to the limits, coaches need to push their knowledge and wisdom. Books, journals, other coaches, all are great sources for the aspiring coach. And no matter how much experience a coach has or how much they've accomplished, that's exactly what every coach should be: aspiring.

The need for personal growth aside, it's important that one doesn't let their drive to succeed push themselves further than their bodies are ready for. Before one increases the weight or tries to run faster, they need to make sure they're doing it right first. If one takes anything away from this book it should be that proper progression from one step to the next is everything. One should always be pushing for improvements, but not at the expense of proper motor patterns or safety. Coaches and athletes alike need to keep this mind.

Hopefully this book can act as a road map to get one going in the right direction, but admittedly, it's a map with limits. In order to understand what they need to do, one will need more study and more time, but that's okay. The author would advise one to just work hard, believe in their abilities, and enjoy what they do, even if it is uncomfortable at the time. People only get one life, so it's imperative that they use it wisely.

-Roger Nelsen Jr.

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