Many sports like basketball, rugby and soccer involve intermittent patterns or bursts of activity that place large demands upon a complex hybrid of physical fitness abilities. These abilities include speed-agility-quickness (SAQ), dynamic balance and flexibility, strength, power, reactivity, anaerobic capacity and coordination (1, 2). Successful conditioning programs for these athletes therefore tend to adopt an integrated-style approach where the multiple parameters needed for their sport (Figure 1-1) are addressed through a structured conditioning (SC) methodology (i.e., controlled volume, intensity and order) or a randomized conditioning (RC) methodology (i.e., establishing training environments that mimic the sport, and allow athletes to control their own effort) (3). Both are very effective, but each has its place. SC is generally used to develop and fine tune motor skills, and improve each parameter more independently, whereas RC is effective in developing sports-specific capacity and endurance (4). This integrated approach to training however, has now gained popularity amongst fitness enthusiasts who seek more variety in their training program, or with those individuals gravitating towards competitive-type workouts or challenges (e.g., Tough Mudder).

Figure 1-1: The health- and skill-related parameters of physical fitness.

Although each parameter can directly or indirectly impact another parameter, it is speed, agility and quickness (SAQ) that are often viewed as having the greatest overall effect on performance (5 - 7). SAQ generally describes a discrete set of skills required to respond to stimuli, to accelerate, decelerate, and change direction (multi-directional) efficiently in a fast, smooth and repeatable manner. However, if we examine each component more closely, distinct differences become apparent. Speed defines maximal rates of movement and is more linear in nature whereas agility can be thought of as the ability to accurately and rapidly change direction. Quickness on the other hand refers to one’s ability to explosively accelerate from stationary positions, but relies heavily upon agility when directional changes are involved. Therefore it appears that speed and agility-quickness may be independent qualities of fitness that do not transfer effectively to each other. Considering how many sports place greater demands upon the individual’s ability to move rapidly within shorter distances (e.g., 0 – 5 meter), accelerate quickly (within 5 – 15 m), and in shorter bursts (less than 5 – 6 seconds), many coaches tend to
emphasize agility and quickness over speed in their programs (3, 8). An easy way to differentiate speed from agility-quickness is to use the analogy of gears in a motor vehicle where:

- 1st gear = reactivity, plus agility and quickness.
- 2nd gear = quickness or acceleration (agility to lesser degree).
- 5th gear = speed.

But, agility-quickness is not an independent quality of performance or fitness. Success in building agility-quickness is highly dependent upon commensurate improvements in strength, power, reactivity, coordination, dynamic balance and dynamic flexibility. Furthermore, effective agility-quickness training also improves the body’s neural responsiveness and ability, which is developed through many perfect repetitions. This in turn, improves technique, reduces risks of injury, and can even accelerate returns from injury during rehabilitation (6).

Agility training should always emphasize body alignment (e.g., maintaining a lowered center of gravity, sustaining dynamic stabilization during movement, identifying optimal athletic positions); promote movement economy and improve the body’s ability to effectively tolerate forces associated with acceleration and deceleration, all of which all take time to perfect. Consequently, these motor skills and mechanics are generally developed over time during the off-season, then progressively fine-tuned towards late pre-season, and then maintained during the in-season phases of an overall training macrocycle. Here is where coaches need to understand the differences between using closed- versus open-skill agility drills as part of their SC methodology.

- Closed-skill or pre-determined drills are those where the coach selects a drill, then provides adequate instruction to control movement patterns and intensity beforehand. This enables individuals to focus upon motor skill development and improving technique. For example, the coach may direct individuals through an agility ladder (e.g., Icky shuffle), but provide coaching cues to improve technique during the movement (e.g., visual focus, arm and shoulder action). These closed-skill drills are emphasized more heavily when learning new movement patterns, during off-season training and as part of a warm-up phase of any training session (Figure 1-2). By contrast, the RC methodology, in which real events are simulated (e.g., a live scrimmage), makes it more difficult for individuals to develop or control movement quality.

- Open-skilled or reactive drills (Figure 1-2) are those where the coach selects a drill, but individuals are instructed to respond to various, relevant stimuli that are provided throughout the drill. This format more closely mimics true athletic performance and increases the work intensity, taxes energy systems and favors movement quantity over movement quality. Open-skill drills are emphasized more heavily during the conditioning phase of a workout and during late-preseason or in-season workouts. For example, the coach may utilize a lateral runs drill where individual react to visual or verbal cues offered by the coach. The cues may be as simple as pointing left or right, using odd and even numbers digits (e.g. odd to move left; even to move right) or via verbal cues (e.g., “one” or ‘two’) or may be more advanced using cueing and coordination. In this case the coach may call out either ‘verbal’ or ‘visual’ to cue the appropriate stimulus, then offer both a visual (e.g., 3 fingers) and a verbal (e.g., ‘4 minus 2’) cue simultaneously, forcing individuals to process and react to the appropriate stimulus.
Both open- and closed-skill drills should begin with movement patterns performed in the sagittal plane, then systematically progress, based upon volume or mastery into the frontal and transverse planes before incorporating multiple directions into one drill. For example, a coach may use a simple Stop-and-Start drill (closed-skill, sagittal plane) to physiologically and biomechanically prepare the body for deceleration, and to instruct proper acceleration mechanics (Figure 1-3) before progressing to a modified T-drill used in an open-skill, multi-directional format. Here, individuals will run through the drill, rapidly changing direction in response to any verbal or visual cues offered by the coach.

**Figure 1-3: Stop-and-Start: Forward-backward Sprints**
**Instructions:**

- Begin but backpedaling 5 yards from the starting cone, then complete a 10-yard forward sprint, followed by a 2nd 5-yard backward pedal, then sprint forward again 10-yards, and repeat this pattern through all the cones.

When training to improve agility, it is also important to ensure that all drills performed subscribe to appropriate work-to-recovery ratios to promote movement quality and not simply movement quantity. As illustrated in Table 1-1, the three energy system’s contributions to exercise vary significantly by intensity and duration (8). A good coach recognizes the appropriate recovery intervals needed between each work interval and aims to promote maximal performance. A common error in interval design involves confusion between maximal performance and maximal effort. For example, if an athlete’s best effort on a 40-yard dash is 5-seconds then working at 90–100 % of maximal performance would imply times within 10 % (0.5 seconds) of that best performance. However, if an individual is not allowed adequate recovery and performance times slow to 7-seconds for each interval (i.e., decrement of 40 %), then one must begin to question the purpose of continued training (i.e., quantity rather than quality).

**Table 1-1: Contributions of each energy systems by intensity and duration**

<table>
<thead>
<tr>
<th>Duration of Event</th>
<th>Event Intensity</th>
<th>Primary Energy System</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 6 seconds</td>
<td>Extremely High</td>
<td>Phosphagen</td>
</tr>
<tr>
<td>6 – 30 seconds</td>
<td>Very High</td>
<td>Phosphagen and Fast Glycolytic</td>
</tr>
<tr>
<td>30 – 120 seconds</td>
<td>High</td>
<td>Fast Glycolytic</td>
</tr>
<tr>
<td>2 – 3 minutes</td>
<td>Moderate</td>
<td>Fast Glycolytic and Oxidative</td>
</tr>
<tr>
<td>&gt; 3 minutes</td>
<td>Lower</td>
<td>Oxidative</td>
</tr>
</tbody>
</table>

Once individuals have mastered the necessary biomechanics needed for efficient movement, coaches should then aim to develop the bioenergetic pathways needed using the guidelines presented in Table 1-2 (8). Although these guidelines speak to biological recovery of each energy pathway, a coach has to consider allowable recovery time of the sport (e.g., time clock in football) and progress programs to meet those needs as best as possible.

For athletes relying primarily upon the phosphagen system for their sport, intervals should always be conducted at 90–100 % of maximal performance or power and utilize 1-12 to 1-20 work-to-recovery ratios (with light active or passive recoveries). For example, a 5-second sprint would ideally require 60 – 100 seconds of recovery. Although time inefficient, a coach can creatively maintain elevated work rates throughout a session by designing supersets or circuits that allow appropriate muscle recovery while simultaneously targeting other muscle groups in the process.

By comparison, when training the fast glycolytic pathway, biological work-to-recovery ratios call for a 1-to-3 to a 1-to-5 ratio. In other words, a 30-second interval may necessitate 90 to 150-seconds of active recovery – active recoveries maintain the muscle pump to clear hydrogen and lactate into circulation. Here too, a good coach can creatively maintain work-rates throughout the session during recovery with supersets and circuits, but with this system which impacts the body more globally (i.e., blood lactate v. isolated muscle fatigue), the coach must carefully plan to ensure that any work performed during recovery do not work impede the body’s
ability to keep clearing lactate from the exercising muscles, impede reconversion of lactate back to usable energy or impede regeneration of the lactate buffer in the blood by doing another activity that further elevates blood lactate. For example, performing a series of KB hip swings fatigue after 30 seconds of plyo box jumps will not help clear lactate from the blood nor help restore the lactate buffer, whereas a plank (iso-prone abs) with slow mountain climbers (active recovery) will.

Table 1-2: work-to-recovery ratios for the two anaerobic systems.

<table>
<thead>
<tr>
<th>Energy System</th>
<th>% of Maximal Power</th>
<th>Bout Duration</th>
<th>Work-to-Rest Ratio</th>
<th>Type of Recovery</th>
<th>Recovery Time between Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphagen</td>
<td>90 – 100 %</td>
<td>5 – 10 sec</td>
<td>1:12 to 1:20</td>
<td>Passive / Active</td>
<td>36 - 48 hours</td>
</tr>
<tr>
<td>Fast Glycolytic</td>
<td>75 – 90 %</td>
<td>Start with 15 – 30 sec</td>
<td>1:3 to 1:5</td>
<td>Active</td>
<td>36 hours</td>
</tr>
</tbody>
</table>

Although coaches may approach training with different philosophical ideals, certain fundamental truths always exist – that being that a systematic, structured and evidence-based approach will almost always increase the likelihood of success. However, in light of the growing popularity of high-intensity interval training (HIIT) that has now captured the attention of the fitness world, effective coaching must now consider the principles of bioenergetics and the difference between maximal performance and maximal effort. By using our knowledge and understanding of good science, we can help others train smart and effectively, not just train hard.

References: