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Baseball (Part II): A Periodized Speed Program

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BASEBALL MOVEMENTS ARE quick, ballistic, and powerful in all planes of the body: frontal, sagittal, and transverse. They require a player to start, stop, and change direction in an instant. Baseball performance also requires the element of speed. When running to first base, players are expected to step on the base in 4.0–4.4 seconds after hitting the ball in fair territory (3). Additionally, they are expected to be able to steal second base in 3.6 seconds or less, and run from first to third base in 7.4 seconds (3). Those teams that possess speed have a distinct advantage both offensively and defensively. From an offensive standpoint, they create problems for the opposing team because the defense must get the ball to a base or into the infield faster due to the speed of a player in the batter's box or player(s) on the base path(s). Defensively, a team can cover more ground and even makeup for misjudgments of the baseball's path. Those players who have speed are, at times, more highly sought after in college and professional athletics than those with average speed because they can move faster on the field. Major League Baseball scouts are looking for speed because of the advantages it produces for their team. For all of these reasons, speed is a valuable commodity. Thus, it is important for the strength and conditioning specialist or baseball coach to design an effective periodized baseball-specific speed program that will enhance performance for position players.

Bioenergetics

Before describing the periodized speed program, it is important to discuss the primary energy systems used during baseball. Because baseball is a speed and power sport, it utilizes both the anaerobic energy systems to provide the bulk of the needed energy. Approximately 80% of the energy is supplied by the ATP-PC system, 15% by glycolysis, and 5% from oxidative phosphorylation (aerobically) (6). Therefore, optimal baseball speed performance requires a training program that will maximize ATP production via the ATP-PC pathway. However, it is important to remember that although the ATP-PC system is the predominant energy system for baseball, all systems are in use at any given time (20).

Because the energy requirements of baseball rely heavily on the anaerobic system, the conditioning of the baseball player needs to focus on anaerobic, not aerobic training. There is not a significant relationship between aerobic endurance and anaerobic performance (20). Koziris et al. (12) reported that there was an insignificant relationship between aerobic power and anaerobic performance indices among recreationally trained individuals. They suggested that when participating in a sport where individual actions last less than 15 seconds (such as baseball), increasing aerobic power would not be the best way to improve anaerobic performance. They recommended using interval training because it would be a better training tool than aerobic conditioning. Coleman (4) states that if

Table 1
Using Interval Training to Train Specific Energy Systems*

Maximum power (%)	Primary system stressed	Typical exercise time	Range of exercise-to-rest period ratios
90—100	Phosphagen	5—10 s	1:12 to 1:20
75—90	Fast glycolysis	15—30 s	1:3 to 1:5
30—75	Fast glycolysis and oxidative	1—3 min	1:3 to 1:4
20—35	Oxidative	>3 min	1:1 to 1:3

* Adapted from Conley (5).

80% of the conditioning period is completed jogging, 80% of the time is spent training to be slow. Like Koziris et al. (12), Coleman (4) suggests that baseball players train with interval sprints to improve speed, power, and aerobic capacity at the same time.

Specificity of Training

According to Kirksey and Stone (11), the keys to developing a sprint program are sport-specific biomechanics and physiology, as well as previous experience. Specificity is the most important training principle. It prescribes that the type of activity used in training will produce the adaptations seen in the mechanical, metabolic, and neuromuscular systems (11, 20). This means that when training progresses closer to the season, it should occur at game speeds or higher to mimic the type of running performed on the field, as well as match the intensity (physiological demands) and recruit the appropriate motor units (those that stimulate fast-twitch muscle fibers) needed to excel in the game of baseball.

Speed

The purpose of sprint training is to increase the speed of the position players on the team. Speed is the ability to move the body through a range of motion in the least amount of time (8). Speed can be divided into 2 phases, acceleration and maximum velocity. Acceleration can begin from either standing still or from striding. It is further subdivided into 2 categories, pure acceleration and transition. The pure acceleration phase lasts for about 15 m, while the transition phase lasts from 15–30 m. The maximum velocity phase lasts from 30–60 m (14). To be fast, position players must be able to accelerate quickly to reach their top speed.

Speed Components

When developing a speed program, the strength and conditioning specialist or baseball coach must understand the components of speed, which are stride frequency, stride length, form, and speed endurance (1). Stride frequency is the number of steps taken in a specific period of time. Parsons and Jones (16) state that one of the best ways to improve stride frequency is by sprint-assisted exercises because it allows the player to run at increased linear speed. Towing, downhill running (a 4° slope is op-

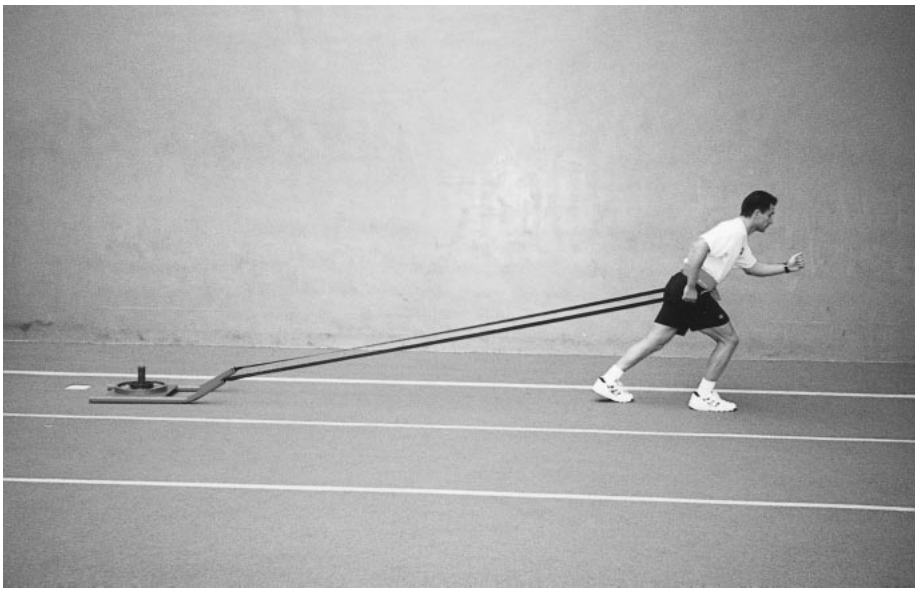

Figure 1. **Example of a sled pull drill. Use no more than 10% of body weight.**

Table 2
Off-Season Speed Program (Mesocycle 1)

Week	Day	Drills	Distance	Rest	Intensity
1	1 (T)	Stride	3 × 220 yd	1:3	Hard (H)
		Stride	6 × 110 yd	1:3	
	2 (F)	Stride	2 × 220 yd	1:3	Easy (E)
		Stride	4 × 110 yd	1:3	
2	1 (T)	Stride	4 × 220 yd	1:3	(H)
		Stride	8 × 110 yd	1:3	
	2 (F)	Stride	3 × 220 yd	1:3	(E)
		Stride	6 × 110 yd	1:3	
3	1 (T)	Stride	5 × 220 yd	1:3	(H)
		Stride	10 × 110 yd	1:3	
	2 (F)	Stride	4 × 220 yd	1:3	(E)
		Stride	8 × 110 yd	1:3	
4	1 (T)	Stride	4 × 220 yd	1:3	(H)
		Stride	8 × 110 yd	1:3	
		Stride	10 × 30 yd	1:5	
	2 (F)	Stride	4 × 220 yd	1:3	(E)
		Stride	6 × 110 yd	1:3	
		Stride	6 × 30 yd	1:5	
5	1 (T)	Stride	6 × 220 yd	1:3	(H)
		Stride	10 × 110 yd	1:3	
		Stride	10 × 40 yd	1:5	
	2 (F)	Stride	4 × 220 yd	1:3	(E)
		Stride	8 × 110 yd	1:3	
		Stride	8 × 40 yd	1:5	
6	1 (T)	Stride	6 × 220 yd	1:3	(H)
		Stride	10 × 110 yd	1:3	
		Stride	10 × 60 yd	1:6	
	2 (F)	Stride	4 × 220 yd	1:3	(E)
		Stride	8 × 110 yd	1:3	
		Stride	8 × 60 yd	1:6	
7	1 (T)	Stride	10 × 60 yd	1:6	(H)
	2 (F)	Stride	6 × 60 yd	1:6	(E)

timal), and treadmill running are examples of exercises that can increase stride frequency (19).

Stride length is the distance covered between each step. It can be increased by improving speed strength, which is the ability to complete maximal force during high-speed movement (1). Examples of exercises that can increase stride length are resistive running, such as pulling a weighted sled (no more than 10% of body weight) or using a running harness, running uphill or up steps, or running chutes.

Form running, which means using correct running form while performing specific running drills, is essential to running movement because it stresses efficiency and economy. Drills that can be used to improve running form are high knee marching with a skip, high knee marching with leg extension and skip, and butt kicks (1). For other drills see Fredrick and Szymanski (7) and McFarlane (14).

Speed-endurance training occurs when a player performs repeated maximal or near-maximal sprints with appropriate recovery intervals (1). Speed-endurance work will be achieved by performing interval training that incorporates high-intensity running drills followed by bouts of active recovery (9). According to Conley (5) and Stone and Conley (17), exercise and rest intervals are based on maximum attainable power and substrate recovery times (see Table 1). During active recovery, athletes should walk or jog to stimulate oxidative recovery. This type of training will be based on baseball's primary energy system (ATP-PC) and will be performed by controlling the running times, distances, and recovery periods.

Warm-up and Dynamic Flexibility

Before beginning any of the running or interval drills, a general warm-up of jogging on a track or around a baseball field for 5–10 minutes followed by 15–20 minutes of dynamic flexibility (warm-up) exercises is strongly recommended (2, 4, 7, 10, 13). The purpose of the warm-up is to increase heart rate, core body and deep muscle temperatures, and blood flow to exercising muscles (2, 10). This will provide the players a time to prepare physiologically and psychologically for the practice or game. It will also give them a feeling of readiness and allow them to begin their training without the need of performing static stretching for the lower body. Static stretching should be completed after training when players are cooling down. The main objective of a cool down is to return pooled blood from the exercising muscles back to the central circulation. For examples of static stretches see Allerheiligen (2), Coleman (4), and Holcomb (10).

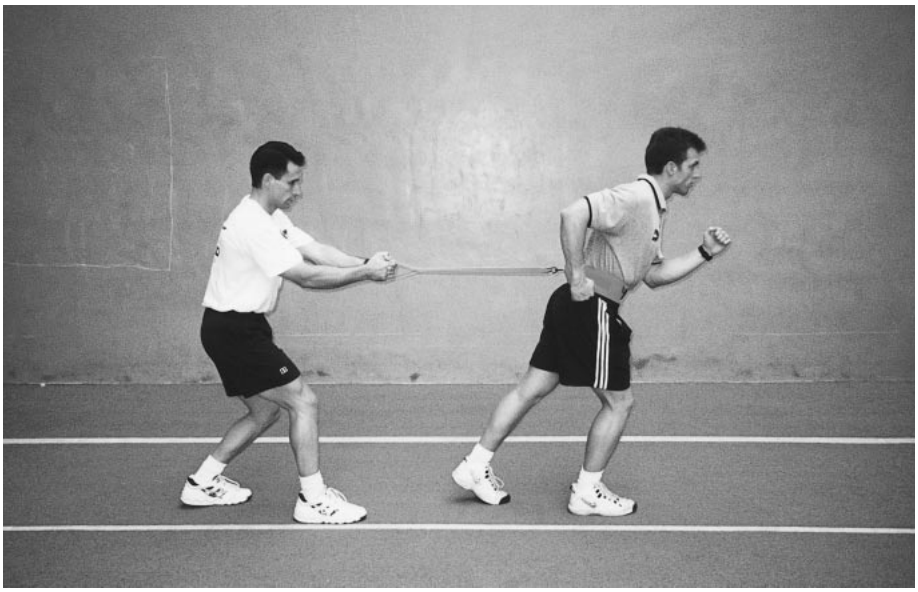

Figure 2. **Demonstration of the harness pull.**

Dynamic flexibility exercises work the muscles used during sprinting in movement patterns exactly like those performed in game situations. They exercise both the large muscles of the hip and back and the smaller muscles of the groin, leg, and ankle (4). These types of warm-up activities should be completed over a distance of 15–20 yd in a "down and back" fashion and should progress from low to high intensity. Because players should avoid fatiguing exercises prior to practice or a game, and because tissues cool down more slowly than they heat up, players should have short rest periods between exercises. This is accomplished by placing players into equally numbered groups that form multiple warm-up lines. The benefits that result from dynamic flexibility movements are improved coordination, balance, flexibility, proprioception, and speed (4, 16). Some dynamic exercises are high knees, butt kicks, and backwards run. As described earlier, these drills also serve as ways to improve running form. See Coleman (4), Fredrick and Szymanski (7), and Parsons and Jones' (16) listings of dynamic warm-up and flexibility exercises.

Training Cycles

The year-round (macrocycle) collegiate baseball speed program is divided into 4 training phases; postseason/active rest, off season, preseason, and in-season (4, 15). Within the macrocycle are 2 or more mesocycles. Mesocycles are typically 6–8 weeks long and continuously become more demanding as the season approaches (4). Each mesocycle is divided into 2 or more microcycles that are typically 1 week long, but could last up to 4 weeks, depending on the training program (18). The level of intensity increases and the volume decreases as players become conditioned. The strength and conditioning specialist or baseball coach should alternate hard and easy days of training within each week of a speed program. The determination as to which day is hard and easy depends on the resistance training and other conditioning drills (agility and plyometric) performed by the players over the course of each week. In each detailed table, intensity is labeled as hard (H) or easy (E); however, those can be changed

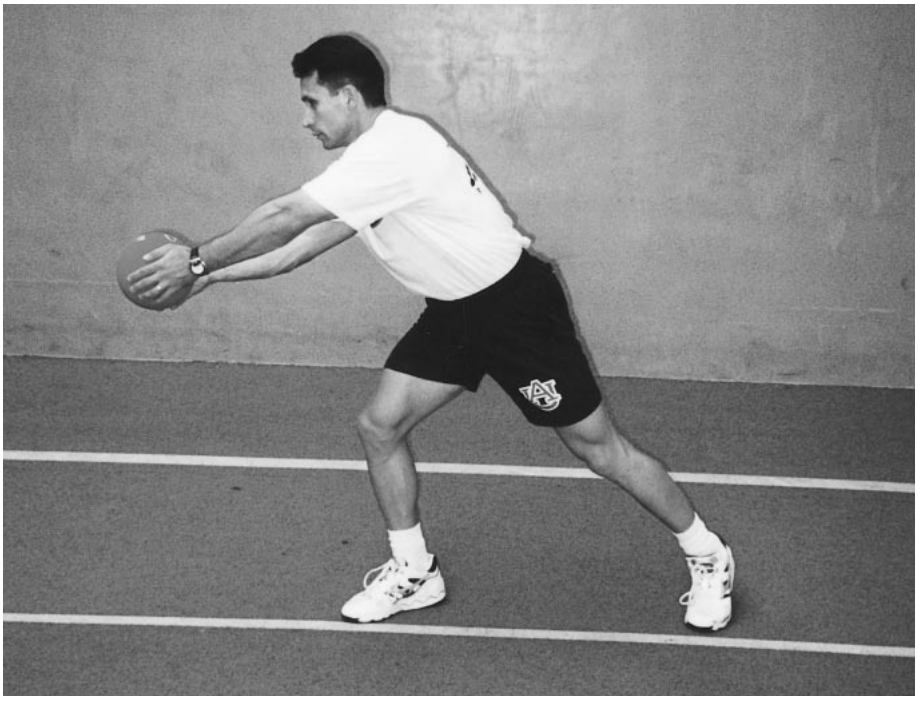

Figure 3. **The initial movement of a medicine ball toss/sprint workout.**

Table 3
Off Season Speed Program (Mesocycle 2)

Week	Day	Drills	Distance	Rest	Intensity
8	1 (T)	Stride	12 × 60 yd	1:6	Hard (H)
		Accelerations	4 × 30 yd	1:6	
		Base running		1:12—1:20	
	2 (F)	Stride	8 × 60 yd	1:6	Easy (E)
		Accelerations	4 × 30 yd	1:6	
		Base running		1:12—1:20	
9	1 (T)	Stride	12 × 60 yd	1:6	(H)
		Accelerations	6 × 30 yd	1:6	
		Base running		1:12—1:20	
	2 (F)	Stride	8 × 60 yd	1:6	(E)
		Accelerations	6 × 30 yd	1:6	
		Base running		1:12—1:20	
10	1 (T)	Stride	10 × 60 yd	1:5	(H)
		Accelerations	8 × 30 yd	1:6	
		Base running		1:12—1:20	
	2 (F)	Stride	8 × 60 yd	1:5	(E)
		Accelerations	6 × 30 yd	1:6	
		Base running		1:12—1:20	
11	1 (T)	Stride	10 × 60 yd	1:5	(H)
		Sprints	6 × 30 yd	1:12	
		Starts	4 × 10 yd	1:12	
		Base running		1:12—1:20	
	2 (F)	Stride	8 × 60 yd	1:5	(E)
		Sprints	4 × 30 yd	1:12	
		Starts	4 × 10 yd	1:12	
		Base running		1:12—1:20	
12	1 (T)	Stride	8 × 60 yd	1:4	(H)
		Sprints	8 × 30 yd	1:12	
		Starts	6 × 10 yd	1:12	
		Base running		1:12—1:20	
	2 (F)	Stride	6 × 60 yd	1:4	(E)
		Sprints	6 × 30 yd	1:12	
		Starts	6 × 10 yd	1:12	
		Base running		1:12—1:20	
13	1 (T)	Stride	6 × 60 yd	1:4	(H)
		Sprints	10 × 30 yd	1:12	
		Starts	8 × 10 yd	1:12	
		Base running		1:12—1:20	
	2 (F)	Stride	6 × 60 yd	1:4	(E)
		Sprints	8 × 30 yd	1:12	
		Starts	8 × 10 yd	1:12	
		Base running		1:12—1:20	

according to the player's training schedule. Also, the exercises become more sport-specific as each new cycle is introduced and the beginning of the season becomes closer. Furthermore, strength and conditioning specialists or baseball coaches need to consider carefully the player's stage of maturation. Training age or the number of years that the player has been training is a major determining factor for increasing the volume and the intensity of training (8).

Postseason/Active Rest

Although the end of the collegiate baseball season is usually in May, many players continue playing baseball throughout the summer months until they arrive back on campus for fall workouts. Thus, the month of August is truly the end of the playing season. A transition phase of active rest is recommended for the 3–4 weeks following the long combined seasons (4). This is the period when the players should remain active with general physical activity and recover mentally and physically from the 2 seasons. Furthermore, it is a time to rehabilitate any injuries that may have occurred while playing (8). Additionally, there is a 1-week transition phase of active rest between both Mesocycle 1 and Mesocycle 2 and Mesocycle 3 and Mesocycle 4 to allow for player recovery before the next training cycle begins.

Off Season

After recuperating during the active rest phase, baseball players should be back in school for the fall semester or quarter to begin fall practices. The off season typically occurs over the period of 13 weeks, starting in late September and stopping in mid-December for the holidays. The goal of the off-season program is to prepare the players for larger workloads and more baseball-specific training. General conditioning and speed-endurance training are the types of exercises performed in this phase (11). Interval training with the appropriate work-to-rest ratios can improve the use of the ATP-

PC, glycolytic, and oxidative energy systems (17). During rest intervals, the baseball player should walk or jog to stimulate oxidative recovery. By following such a training regime, the baseball player will be laying a solid base for the regular season. The programs in Table 2 and 3 are designed to begin with low work loads that progress to more demanding high-intensity interval training. Work-to-rest ratios between 1:3–1:6 were chosen to place the greatest demand on the glycolytic system during Mesocycle 1 because most of the exercises last longer than 10 seconds (5, 17). At the end of Mesocycle 1 (week 6), there is a period of active rest (week 7) to allow for recovery before starting Mesocycle 2 (week 8).

In Table 3 (Mesocycle 2) the work-to-rest ratios that occur between strides begin at 1:6 (week 8) and end at 1:4 (week 13) over the course of the 6-week training period. This increases the demands placed on the body and serves to improve the player's ability to recover. Also in Table 3, accelerations, starts, sprints, and base running drills are introduced to make the speed training more specific to baseball's movements. Acceleration drills are completed by jogging, striding, and sprinting for 10-yd intervals over 30 yd. Start drills are performed by players taking their lead-off stance, using the appropriate crossover step, and sprinting for 10 yd. This helps players work on their explosiveness and technique for base stealing or advancing to other bases. Sprint distance was kept at 30 yd because players are completing 60-yd strides and running bases (30–60 yd). Finally, coaches are encouraged to use their imagination when designing base running drills. The distance between bases is 30 yd. Thus, the distance from home plate to second

Table 4
Preseason Speed Program (Mesocycle 3)

Week	Day	Drills	Distance	Rest	Intensity
1	1 (T)	Stride	8 × 100 yd	1:5	Hard (H)
		Stride	8 × 60 yd	1:5	
		Sprint	6 × 60 yd	1:12	
		Base running		1:12—1:20	
	2 (Th)	Stride	6 × 100 yd	1:5	Easy (E)
		Stride	6 × 60 yd	1:5	
		Sprint	6 × 60 yd	1:12	
		Base running		1:12—1:20	
2	1 (T)	Stride	4 × 100 yd	1:3	(H)
		Accelerations	6 × 30 yd	1:12	
		Sprints	6 × 60 yd	1:12	
		Base running		1:12—1:20	
	2 (Th)	Stride	6 × 60 yd	1:5	(E)
		Accelerations	6 × 30 yd	1:12	
		Sprints	6 × 60 yd	1:12	
		Base running		1:12—1:20	
3	1 (T)	Stride	4 × 30 yd	1:5	(H)
		Sled pulls	4 × 20 yd	1:12	
		Accelerations	4 × 30 yd	1:12	
		Base running		1:12—1:20	
	2 (Th)	Stride	4 × 30 yd	1:5	(E)
		Accelerations	4 × 30 yd	1:12	
		Sprints	6 × 60 yd	1:12	
		Base running		1:12—1:20	
4	1 (T)	Stride	4 × 30 yd	1:5	(H)
		Break away pulls	6 × 20 yd	1:12	
		Med ball toss w/sprint	6 × 20 yd	1:12	
		Base running		1:12—1:20	
	2 (Th)	Stride	4 × 30 yd	1:5	(E)
		Harness pulls	5 × 10 yd	1:12	
		Sprints	4 × 60 yd	1:12	
		Base running		1:12—1:20	
5	1 (T)	Stride	4 × 30 yd	1:5	(H)
		Overspeed assisted towing	5 × 20 yd	1:12	
		Med ball toss w/sprint	6 × 15 yd	1:12	
		Base running		1:12—1:20	
	2 (Th)	Stride	4 × 30 yd	1:5	(E)
		Break away pulls	4 × 20 yd	1:12	
		Starts	6 × 10 yd	1:12	
		Base running		1:12—1:20	
6	1 (T)	Stride	6 × 30 yd	1:5	(H)
		Base running		1:12—1:20	
	2 (F)	Stride	4 × 30 yd	1:5	(E)
		Base running		1:12—1:20	

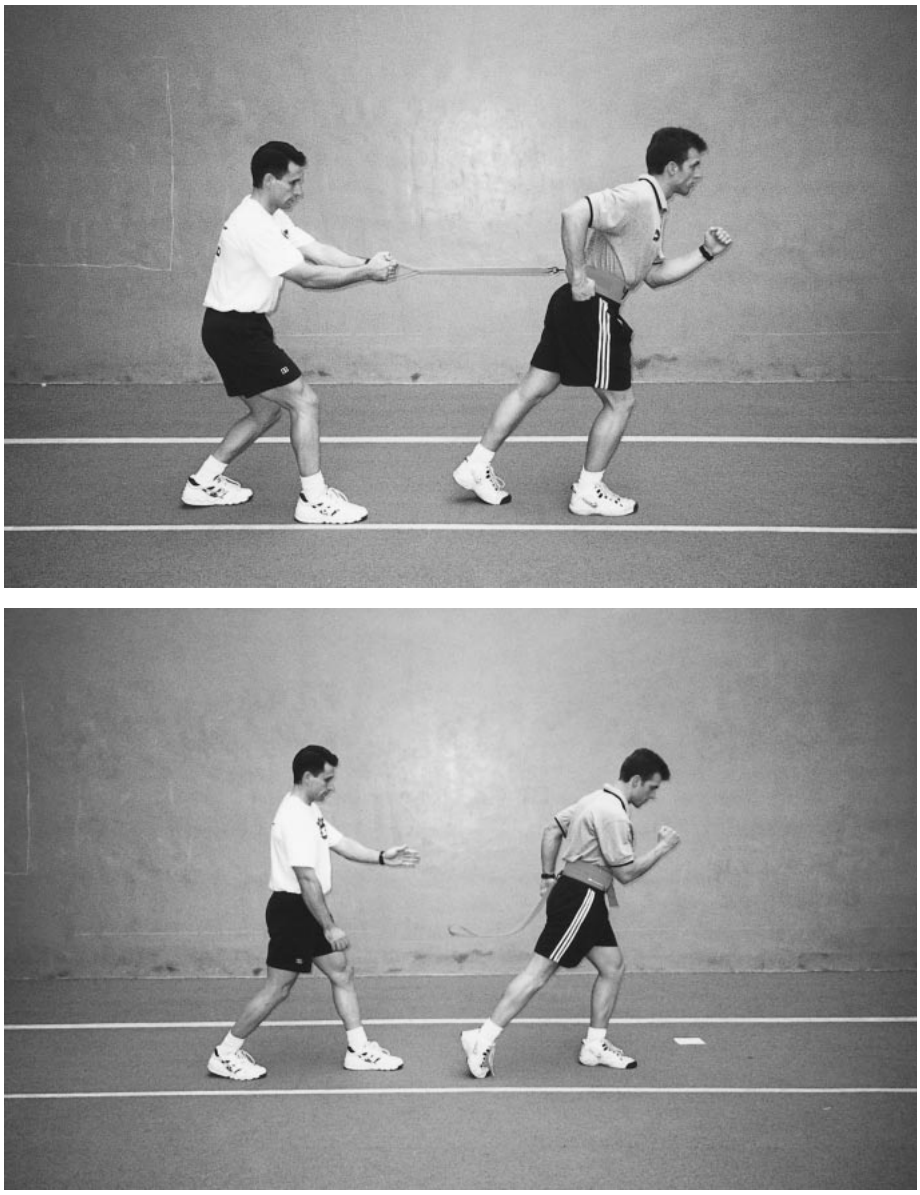

Figure 4. **Break away pull drill demonstration; partner holds harness for resistance, then releases at designated time.**

base or vice versa is 60 yd. Some examples of running bases are as follows: (a) run from home plate to first base; (b) run from first base to third base (walk to home plate); (c) run from home plate to second base; and (d) run from second base to home. Each of these exercises should be performed for 3 sets. During Mesocycle 2, work-to-rest ratios between 1:12–1:20 were selected to allow the ATP-PC system to fully recover while performing short-duration (<10 seconds) exercises like base running, sprints, and starts (5, 17). Work-to-rest ratios from 1:4–1:6 were chosen for strides and accelerations due to the decrease in intensity and to continue to place increased demands on the body to recover.

It is not a sound idea to incorporate continuous aerobic conditioning during this phase because it may actually decrease speed. The adaptations that would occur would be the utilization of slow-twitch (oxidative) muscle fibers, an increase in mitochondrial and capillary density, and oxidative enzymes. This would have a detrimental effect on anaerobic energy production (11). Also, there could be a decrease in muscle size, strength, and power accompanied with aerobic training. This would be counterproductive to speed development and is not recommended.

By mid-December the off season has ended and players leave campus for the holidays. This is a time when the players must continue to train on their own, because detraining can occur within 2–4 weeks. Therefore, it is imperative that players continue to train during the break because when they return to campus, they will start the 3–6-week preseason training phase.

Preseason

The progression from the off season to the preseason program should continue to utilize and develop the ATP-PC system. This will enhance quickness, power, and speed (11). Table 4 displays the training regime of Mesocycle 3. When players return to campus from vacation, week 1 will begin with high-volume and low-intensity exercises. This will use primarily the glycolytic system for energy and will require that the work-to-rest ratios for strides be 1:5 and 1:12–1:20 for sprints and base running (5, 17). Week 2 will incorporate exercises that use both the glycolytic and ATP-PC systems and have a work-to-rest ratio between 1:3–1:5 and 1:12–1:20.

By week 3 (Mesocycle 3) training will be low-volume, high-intensity short sprints (60 yd) with maximal recovery periods. This will tax the ATP-PC system be-

Figure 5. **Demonstration of overspeed assisted towing.**

cause the exercises are of short duration (<10 seconds). Furthermore, players will continue to perform starts in their lead-off stance for 10 yd to mimic the explosive starts that runners execute when running between bases or stealing a base. Also, players will continue to complete acceleration and base-running drills. On-field base-running drills will simulate the game speed movements and fine-tune base-running skills. Also in week 3 and in those that follow, players will be introduced to sled pulls (Figure 1), harness pulls (Figure 2), medicine ball toss with sprint (Figure 3), break away pulls (Figure 4), and overspeed assisted towing (Figure 5). These exercises are designed to improve speed by increasing stride frequency and stride length. The rest times for these exercises will be longer, such as work-to-rest ratios between 1:12–1:20 because the activities last for 5–10 seconds (5, 17).

It must also be mentioned that agility drills and plyometric exercises can be used to improve speed, but these 2 topics deserve their own articles. At the end of Mesocycle 3 (week 5) there will be a 1-week transition phase of active rest (week 6) to allow the players to recover and be optimally prepared for the beginning of the new spring season.

In-season

After finishing the preseason program, teams begin a 3–4-month season. The goal during the in-season (see Table 5) is to maintain the baseball-specific speed and conditioning levels that were increased over the previous training phases. Because the players are running bases quite often during intrasquad scrimmages and games, a high volume of anaerobic training is not recommended. However, it is necessary to run accelerations (30 yd), short sprints (60 yd), and starts (10 yd) 1 or 2 times per week at a high intensity to maintain speed and explosiveness. Furthermore, it is appropriate to run bases (30–60 yd), like those described earlier, 1 or 2 times per week as well. This will reinforce proper running mechanics and keep player's base running skills sharp. At the Division I level, games are typically played on Tuesday, Friday, Saturday, and Sunday with an off-day on Monday. Therefore, Wednesday was chosen as the day to perform running exercises because Thursday is a travel day if teams are not playing at home. Work-to-rest ratios between 1:12–1:20 should be used to allow players to fully recover (5, 17).

Conclusion

The ultimate accomplishment of a speed program is to increase acceleration, quickness, and maximum velocity. This is attained by controlling such factors as volume (frequency and duration), intensity, and recovery. The vital component for achieving increased speed is to implement a periodized training program that incorporates a variety of exercises that stress the appropriate energy systems and increase neurologic (motor unit) activation. This begins with fundamental running drills that develop proper running form before advancing to baseball-specific speed exercises. Strength and condition-

Table 5
In-season Speed Program

Week	Day	Drills	Distance	Rest
1-16	1 (W)	Stride	4 × 30 yd	1:5
		Accelerations	4 × 30 yd	1:12
		Sprints	2 × 60 yd	1:12
		Starts	4 × 10 yd	1:12
		Base running		1:12—1:20

ing specialists and baseball coaches need to use a variety of interval training, acceleration, and baserunning drills to vary their practice sessions throughout the year. These variations will avoid training plateaus and the boredom related to performing the same daily exercises, thus allowing baseball players to obtain one of the vital commodities of baseball—speed. ▲

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