Designing a resistance training program is a complex process that requires the recognition and manipulation of seven **program design** variables (referred to in this chapter as steps 1 through 7). This chapter discusses each variable, shown in the sidebar, in the context of three scenarios that enable the strength and conditioning professional to see how training principles and program design guidelines can be integrated into an overall program.

The three scenarios include a basketball center (scenario A) in her preseason, an American football offensive lineman (scenario B) during his off-season, and a cross-country runner (scenario C) during his in-season. It is understood that in each scenario, the athlete is well conditioned for his or her sport, has no musculoskeletal dysfunction, and has been cleared for training and competition by the sports medicine staff. The athletes in scenarios A (basketball center) and B (American football lineman) have been resistance training since high school, are accustomed to lifting heavy loads, and are skilled in machine and free weight exercises. The high school cross-country runner in scenario C, in contrast, began a resistance training program in the preseason only four weeks ago, so his training is limited and his exercise technique skills are not well developed.

Step 1: Needs Analysis

The strength and conditioning professional's initial task is to perform a **needs analysis**, a two-stage process that includes an evaluation of the requirements and characteristics of the sport and an assessment of the athlete.

Evaluation of the Sport

The first task in a needs analysis is to determine the unique characteristics of the sport, which includes the general physiological and biomechanical profile, common injury sites, and position-specific attributes. This information enables the strength and conditioning professional to design a program specific to those requirements and characteristics. Although this task can be approached in several ways (30), it should at least include consideration of the following attributes of the sport (20, 43):

- Body and limb movement patterns and muscular involvement (**movement analysis**)
- Strength, power, hypertrophy, and muscular endurance priorities (**physiological analysis**)
- Common sites for joint and muscle injury and causative factors (**injury analysis**)

Other characteristics of a sport—such as cardiovascular endurance, speed, agility, and flexibility requirements—should also be evaluated. This chapter, however, focuses only on the physiological outcomes that specifically relate to resistance training program design: strength, power, hypertrophy, and muscular endurance.

For example, a movement analysis of the shot-put field event reveals that it is an all-body movement that begins with the athlete in a semicrouched stance, with many joints flexed and adducted, and culminates in an upright stance with many joints extended and abducted. The most heavily recruited muscles (not in order) are the elbow extensors (triceps brachii), shoulder abductors (deltoids), hip extensors (gluteals, hamstrings), knee extensors (quadriceps), and ankle plantar flexors (soleus, gastrocnemius). Physiologically, shot putting requires high levels of strength and power for a successful performance. Also, enhanced muscular hypertrophy is advantageous since the muscle's ability to produce force increases as its cross-sectional area becomes greater (40). The muscular endurance requirement is minimal, however. Due to the repetitive nature of training and competition, the muscles and tendons surrounding the shoulder and elbow joints tend to be injured due to overuse (98).

Assessment of the Athlete

The second task is to **profile** the athlete's needs and goals by evaluating training (and injury) status, conducting a

Athlete Scenarios

Scenario A		Scenario B		Scenario C	
Sex:	Female	Sex:	Male	Sex:	Male
Age:	20 years old	Age:	28 years old	Age:	17 years old
Sport:	Collegiate basketball	Sport:	Professional American football	Sport:	High school cross-country running
Position:	Center	Position:	Offensive lineman	Position:	(Not applicable)
Season:	Beginning of the preseason	Season:	Beginning of the off-season	Season:	Beginning of the in-season

variety of tests (e.g., maximum strength testing), evaluating the results, and determining the primary goal of training. The more individualized the assessment process, the more specific the resistance training program for each athlete can be.

Training Status

An athlete's current condition or level of preparedness to begin a new or revised program (**training status**) is an important consideration in the design of training programs. This includes an evaluation by a sports medicine professional of any current or previous injuries that may affect training. Also important is the athlete's **training background** or **exercise history** (training that occurred *before* he or she began a new or revised program), because this information will help the strength and conditioning professional better understand the athlete's training capabilities. An assessment of the athlete's training background should examine the

- type of training program (sprint, plyometric, resistance, and so on),
- length of recent regular participation in previous training program(s),
- level of intensity involved in previous training program(s), and
- degree of **exercise technique experience** (i.e., the knowledge and skill to perform resistance training exercises properly).

Table 17.1 provides an example of how such information might be used to classify athletes' training status as beginner, intermediate, or advanced. The strength and conditioning professional should realize that the three classifications exist on a continuum and cannot be definitively demarcated.

Physical Testing and Evaluation

Physical evaluation involves conducting assessments of the athlete's strength, flexibility, power, speed, muscular endurance, body composition, cardiovascular endurance, and so on. In this chapter, the needs analysis focuses on assessing maximal muscular strength, but a comprehensive assessment goes beyond that.

To yield pertinent and reliable data that can be used effectively to develop a resistance training program, the tests selected should be related to the athlete's sport, consistent with the athlete's level of skill, and realistically based on the equipment available. The result of the movement analysis discussed previously provides direction in selecting tests. Typically, major upper body exercises (e.g., bench press and shoulder press) and exercises that mimic jumping movements to varying degrees (e.g., power clean, squat, leg press) are used in testing batteries.

After testing is completed, the results should be compared with normative or descriptive data to determine the athlete's strengths and weaknesses. Based on this evaluation and the needs analysis of the sport, a training program can be developed to improve deficiencies, maintain strengths, or further develop physiological qualities that will enable the athlete to better meet the demands of the sport.

Primary Resistance Training Goal

The athlete's test results, the movement and physiological analysis of the sport, and the priorities of the athlete's sport season determine the primary goal or outcome for the resistance training program. Typically, this goal is to improve strength, power, hypertrophy, or muscular endurance. Despite a potential desire or need to make improvements in two different areas (e.g., strength *and* muscular endurance), an effort should be

TABLE 17.1 Example of Classifying Resistance Training Status

	Resistance training background				
Resistance training status	**Current program**	**Training age**	**Frequency (per week)**	**Training stress***	**Technique experience and skill**
Beginner (untrained)	Not training or just began training	<2 months	≤1-2	None or low	None or minimal
Intermediate (moderately resistance trained)	Currently training	2-6 months	≤2-3	Medium	Basic
Advanced (well resistance trained)	Currently training	≥1 year	≥3-4	High	High

*In this example, "training stress" refers to the degree of physical demand or stimulus of the resistance training program.

made to concentrate on only one training outcome per season. An example of how the strength and conditioning professional may prioritize the resistance training emphases during the four main sport seasons is shown in table 17.2.

Step 2: Exercise Selection

Exercise selection involves choosing exercises for a resistance training program. To make informed exercise selections, the strength and conditioning professional

Application of the Needs Analysis

(Refer to the first scenario table in the chapter for a description of the scenario athletes.)

Scenario A Female collegiate basketball player Preseason	Scenario B Male professional American football lineman Off-season	Scenario C Male high school cross-country runner In-season
SPORT EVALUATION **Movement analysis** *Sport:* Running and jumping, ball handling, shooting, blocking, and rebounding *Muscular involvement:* All major muscle areas, especially the hips, thighs, and shoulders **Physiological analysis (primary requirement)** Strength/power	**SPORT EVALUATION** **Movement analysis** *Sport:* Grabbing, pushing, repelling, and deflecting opponents *Muscular involvement:* All major muscle areas, especially the hips, thighs, chest, arms, and low back **Physiological analysis (primary requirement)** Hypertrophy	**SPORT EVALUATION** **Movement analysis** *Sport:* Running, repetitive leg and arm movements *Muscular involvement:* All lower body muscle areas, postural muscles, shoulders and arms **Physiological analysis (primary requirement)** Muscular endurance
ATHLETE'S PROFILE **Training background** • Has resistance trained regularly since high school • Possesses excellent skill in performing free weight and machine exercises • Just completed a 4×/week resistance training program in the off-season consisting of *Upper body exercises* (2×/week): 6 exercises (2 core, 4 assistance), 3 sets of 10RM-12RM loads *Lower body exercises* (2×/week): 6 exercises (2 core, 4 assistance), 3 sets of 10RM-12RM loads	**ATHLETE'S PROFILE** **Training background** • Has resistance trained regularly throughout high school, college, and his professional career • Possesses excellent skill in performing free weight and machine exercises • Just completed a 2×/week resistance training program in the postseason[b] consisting of *All exercises performed in each session:* 8 exercises (3 core, 5 assistance; 2 lower body, 6 upper body), 2-3 sets of 12RM-15RM loads	**ATHLETE'S PROFILE** **Training background** • Just began resistance training in preseason • Has only limited skill in performing free weight and machine exercises • Just completed a 2×/week resistance training program in the preseason[c] consisting of *All exercises performed in each session:* 7 exercises (3 core, 4 assistance; 3 lower body, 4 upper body), 1-2 sets of 15RM loads
CLASSIFICATION OF RESISTANCE TRAINING STATUS Advanced	**CLASSIFICATION OF RESISTANCE TRAINING STATUS** Advanced	**CLASSIFICATION OF RESISTANCE TRAINING STATUS** Beginner
PRIMARY PRESEASON RESISTANCE TRAINING GOAL Strength/power[a]	**PRIMARY OFF-SEASON RESISTANCE TRAINING GOAL** Hypertrophy	**PRIMARY IN-SEASON RESISTANCE TRAINING GOAL** Muscular endurance
COMMENTS [a]The preseason will address both of these goals through a combination of appropriate exercise selection and volume-load assignments.	**COMMENTS** [b]Due to the extreme physical demands of American football, this athlete's postseason training volume was greater than is often assigned for the active rest phase of a typical program.	**COMMENTS** [c]Because this athlete just began his resistance training program, his frequency was limited to only 2×/week in the preseason rather than the 3 or 4 sessions/week typically completed by better-trained individuals.

The information in this table reflects one approach to evaluating the requirements of a sport and profiling an athlete.

TABLE 17.2 Example of General Training Priorities by Sport Season

Sport season	Priority given to: Sport practice	Priority given to: Resistance training	Resistance training goal*
Off-season	Low	High	Hypertrophy and muscular endurance (initially); strength and power (later)
Preseason	Medium	Medium	Sport and movement specific (i.e., strength, power, or muscular endurance, depending on the sport)
In-season	High	Low	Maintenance of preseason training goal
Postseason (active rest)	Variable	Variable	Not specific (may include activities other than sport skill or resistance training)

*The actual training goals and priorities are based on the specific sport or activity and may differ from the goals listed here.

must understand the nature of various types of resistance training exercises, the movement and muscular requirements of the sport, the athlete's exercise technique experience, the equipment available, and the amount of training time available.

Exercise Type

Although there are literally hundreds of resistance training exercises to select from when one is designing a program, most involve primary muscle groups or body areas and fall into categories based on their relative importance to the athlete's sport.

Core and Assistance Exercises

Exercises can be classified as either core or assistance based on the size of the muscle areas involved and their level of contribution to a particular sport movement. **Core exercises** recruit one or more large muscle areas (i.e., chest, shoulder, back, hip, or thigh), involve two or more primary joints (**multijoint exercises**), and receive priority when one is selecting exercises because of their direct application to the sport. **Assistance exercises** usually recruit smaller muscle areas (i.e., upper arm, abdominal muscles, calf, neck, forearm, lower back, or anterior lower leg), involve only one primary joint (**single-joint exercises**), and are considered less important to improving sport performance. Generally, all the joints at the shoulder—the glenohumeral and shoulder girdle articulations—are considered one *primary* joint when resistance training exercises are categorized as core or assistance. The spine is similarly considered a single primary joint (as in the abdominal crunch and back extension exercises).

A common application of assistance exercises is for injury prevention and rehabilitation, as these exercises often isolate a specific muscle or muscle group. The muscles that are predisposed to injury from the unique demands of a sport skill (e.g., the shoulder external rotators for overhand pitching) or those that require reconditioning after an injury (e.g., a quadriceps contusion) can be specifically conditioned by an assistance exercise.

Structural and Power Exercises

A core exercise that emphasizes loading the spine directly (e.g., back squat) or indirectly (e.g., power clean) can be further described as a **structural exercise**. More specifically, a structural exercise involves muscular stabilization of posture during performance of the lifting movement (e.g., maintaining a rigid torso and a neutral spine during the back squat). A structural exercise that is performed very quickly or explosively is considered a **power exercise**. Typically, power exercises are assigned to athletes when they are appropriate for the athlete's sport-specific training priorities (45).

Movement Analysis of the Sport

In the needs analysis (step 1), the strength and conditioning professional has identified the unique requirements and characteristics of the sport. The exercises selected for a resistance training program that focus on conditioning for a particular sport need to be relevant to the activities of that sport in their body and limb movement patterns, joint ranges of motion, and muscular involvement. The exercises should also create muscular balance to reduce risk of injury from disproportionate training.

Sport-Specific Exercises

The more similar the training activity is to the actual sport movement, the greater the likelihood that there will be a positive transfer to that sport (8, 19, 20, 42, 72, 86). This is the specificity concept, also called the specific adaptation to imposed demands (SAID) principle. Table 17.3 provides examples of resistance training exercises that relate in varying degrees to the movement patterns of various sports. The strength and conditioning professional should find this table helpful when trying to identify sport-specific exercises. For example, the