## ABSTRACT

## INSTRUCTION OF THROWING EVENTS IN TRACK AND FIELD: AN HISTORICAL ANALYSIS

**by Marilyn Louise Coleman**

Track and field throwing events (discus, javelin, hammer and shot put), originating in ancient Greece and pre-Medieval Ireland and Scotland, require complex physical interaction. An historical analysis of the features of traditional media which have been used as coaching tools in these events – books, video, audio, diagrams, photographs and hypertext – provides the foundation on which future multimedia tools can be developed.

Variables associated with effective coaching are based on technique, science, use of expert models, and motor learning theory. Training in these events is enhanced through the use of multimedia, a tool uniquely suited to the variables of track and field instruction. Additional variables – interactivity, usability and cost – are associated specifically with multimedia and should be considered in the development of future multimedia coaching tools.

# INSTRUCTION OF THROWING EVENTS IN TRACK AND FIELD: AN HISTORICAL ANALYSIS

by
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Department of Humanities

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## APPROVAL PAGE

## INSTRUCTION OF THROWING EVENTS IN TRACK AND FIELD: AN HISTORICAL ANALYSIS

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To my parents, Elane and Deloris Coleman; my sister, Dr. Alisha Knight and her family Vincent, Brandon and Rachel; and all of my grandparents, aunts, uncles, cousins and friends.

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# CHAPTER 1

# INTRODUCTION

This thesis is intended to be a contribution to the coaching community from the technical communication community. Coaches should be educated about how to teach the throwing events in track and field because the actions involved are complex and unintuitive. It is important that they understand the way people learn physical skills and the media available as coaching tools are important. This thesis will help coaches select the best instructional media based on the skill level of their athletes. Developers of new tools should be aware of the variables that make coaching effective.

The best coaches and athletes are students of their sport. History allows students to appreciate the development of the sport from its origin to the present. It also provides the background information that allows us to generate the variable list for effective coaching and instructional tools.

Each new medium is an improvement over its predecessor. Learning about the interaction of media and track and field instruction media is important because it allows us to study each medium and see how it can be improved. We can use current technology to contribute to new media based on what we learned from the past. Comprehensive knowledge of existing media helps technical communicators choose the most relevant features based on the variables associated with effective instructional tools.

## 1.1 Objective

The objective of this thesis is to demonstrate that multimedia is uniquely qualified as a coaching tool in the throwing events of track and field: discus, javelin, shot put and hammer. Traditionally, track and field coaches have used video, books and training clinics as resources for instructing athletes. The technology to create updated multimedia coaching tools has only recently been available, yet there are a limited number of products commercially available for teaching the throws.

In this thesis I will investigate the following: the history and description of the throwing events in track and field; the theory of motor learning; the features of an effective multimedia coaching tool; and media that are currently used in coaching. I will also give recommendations for future multimedia coaching tools.

## 1.2 A Brief History of Track and Field

Track and field events are among the oldest sports still in existence throughout the world. The throwing events – discus, javelin, hammer and shot put – are categorized as field events and are the most technical and complicated events in the sport. Athletes have to control the movement of their bodies and the movement of the throwing implement. Successful athletes should know how the principles of physics, biomechanics and aerodynamics interact in the throws. A fifth event, the weight throw, will not be discussed here because it uses a technique that is identical to the hammer throw.

The throwing events in modern track and field competitions come from religious festivals of ancient Greece, and Scottish and Irish festivals. The Greeks invented the discus and javelin, while the Scots and the Irish invented the shot put and hammer. In the

following sections I will present the background of the festivals where the throwing events were first introduced.

### 1.2.1 Religious Festivals of Ancient Greece

In Ancient Greece, several religious cults honored a particular god, such as Hera, goddess of vegetation, with a festival. Although many cults hosted athletic competitions, the most famous festival is the Olympic Games, hosted by the Olympian cult, which eventually replaced the other festivals as people began to worship Zeus as the main god. The Olympians started the five-day festival in 776 B.C. that was held every four years to honor Zeus.

Only men were allowed to compete, except for a footrace for young maidens as a rites of passage into womanhood (Scanlon 98). Some sources including Drees say that unmarried women were allowed to be spectators: "[. . .] anyone could come to the games as a spectator with the virtual exception of married women [. . .]" (56). However, more recent sources doubt that any women were allowed to watch the games. Mouratidis explains that the ban on female spectators was probably due to the potential distraction to warriors (53-54). Some historians might have assumed that single women were allowed to watch because their presence was permitted for this race.

It is interesting to note that even in ancient Greece, there was discussion among the philosophers and enlightened intellectuals about whether athletes should be treated with privilege in society. This argument discussed the change in the original reason for the games and was one of many factors, which contributed to the demise of the ancient games. Drees writes about Isocrates' opinions about men of leisure:

> *His censure was justified by events, for in the course of time the athletic contests lost their religious significance and eventually became an end in themselves. In this oration Isocrates made the telling point that, no matter how strong a wrestler was, other people were not likely to benefit from his strength, whereas the wisdom acquired by men who had patiently devoted themselves to their studies might well prove a source of comfort and help to their fellow men.* (62)

The debate about the importance of athletics in civilized society is thousands of years old and has not yet been resolved. It is clear that opposition to the celebrity of athletes has not diminished the popularity of sports.

Another factor in the demise of the Olympics was the spread of Christianity. The growing belief in Jesus Christ eliminated the need for festivals that honored the old Greek gods: "Early Christian Romans banned what they viewed as pagan Olympics" (Brown 5).

**1.2.1.1 Origin of the Discus Throw.** The discus was invented by the Greeks and is described in mythological writings: there are several theories that attempt to explain the origins of the event. One account states that soldiers traveling across bodies of water who needed to unload excess weight before crossing would throw their round saucer-shaped shields across the water onto the bank on the other side. The discus developed into a competitive event and the earliest discus competitors probably used rounded stones found on river banks. Eventually, the Greeks began to use bronze and iron to make the implements in a round plate-like shape (Drees 72). Today, discuses are made of wood or plastic and have a metal core and rim. Lower quality practice discuses are made of molded rubber or plastic with no metal parts. A modern discus is shown in Figure 1.1.


**Figure 1.1** A modern discus.
Source: MF Athletic Company. 11 Dec. 2004 <http://www.everythingtrackandfield.com>.

There is mention of the discus in Greek mythology: "The method of throwing the discus and the place from which it was thrown (the *balbis*) are described by Philostratus in a passage in which he refers to the death of Hyacinthus, who was accidentally killed by Apollo with a discus" (Drees 72-74).

According to Philostratus, the *balbis* was a mound of dirt that sloped in the front. The thrower stood with his right foot against the mound while his left foot rested on the sloping surface. He then bent his head backwards until he could see the right hand side of his body and threw the discus as if he were lifting an object from the ground, putting the whole force of his body into the movement.

There are few references of the discus throw after the end of the ancient Olympic games. The event was reintroduced in the early modern Olympic competitions where the throwing method was similar to the freestyle technique of ancient Greece. Competitors were required to throw with both the left and right hands until 1912, and this style was practiced in other competitions until 1920.

**1.2.1.2 Origin of the Javelin Throw.** The javelin throw is also a Greek event that evolved from the use of spears in battle. The competition javelin was about six feet long, smaller and lighter than the spears used by the military. The ancient javelin was made out of wood and had an *amentum* or small loop made of rope attached behind the center of mass that helped the thrower carry the javelin and assist in creating additional force and a rotational spin during the flight of the javelin. Wood was used until the late 1980s when aluminum replaced it. A modern Javelin is shown in Figure 1.2.

**Figure 1.2** A modern javelin with an aluminum shaft and steel point.
Source: MF Athletic Company. 11 Dec. 2004 <http://www.everythingtrackandfield.com>.

It is likely that the javelin throwers in ancient Greece were required to aim at a target during competition and were judged on distance and accuracy.

> *We might perhaps feel inclined to assume that, since the contestants had already demonstrated their ability to throw for distance in the discus, the judges would have been more likely to have tested their accuracy with the javelin. A wooden post, a suspended shield or a circle painted on the ground could have served as a target. (Drees 75)*

Competitors were required to aim at fixed targets as late as the 19th century (Encyclopedia of Track and Field 196).

In accounts of festivals and sports in medieval Britain, there is mention of "hurling the lance," which is possibly the javelin throw, and throwing metal objects called diskos, which could have been British-style discuses (Birley 36). The Roman conquest of western Europe may have brought versions of the javelin and discus to the region.

Although the javelin is one of the oldest events and a cornerstone of the ancient Olympic Games, it was not introduced in the modern Olympics until 1908. Early competitions allowed free-style grips, and, like the discus, required athletes to throw with their left and right hands (Encyclopedia of Track and Field 196).

### 1.2.2 Irish and Scottish Festivals

Both the hammer throw and shot put are products of the Scottish and Irish culture. Ireland's Tailteann Games were held from 1829 B.C. until around 1168 or 1198 A.D. Other early competitions included the Fenach Taill Lenn Games held from 500 B.C. to 500 A.D. on the Black Water in Ireland (Bowerman 308). Much of the format for modern track and field competitions, including throwing and running events, comes from Scottish immigrants who formed Caledonian clubs and hosted replicas of the traditional Highlands festivals from Scotland called the Caledonian Games.

The Caledonian Games were introduced to the United States by Scottish immigrants in the first half of the 19th century as a way of preserving the heritage of their homeland. Scottish festivals had been held in America since 1836 and the first Caledonian Club started in Boston in 1853. By 1870, there were over one hundred clubs located across the country (Redmond 111).

After the Intercollegiate Association of Amateur Athletics was created in 1876, the first track and field meet on the collegiate level was held. This meet included running, jumping and throwing events, which were similar to the Caledonian Games at Princeton and other colleges' athletic field days. This format was similar to current track and field meets: "The inevitable conclusion is that the sport of track and field athletics in the United States owes much to its Scottish pioneers" (Redmond 117).

**1.2.2.1 Origin of the Hammer Throw.** There are varying accounts of the origin of the hammer throw, but the earliest references to hammer-like events are from the Tailteann Games. The 'Roth Cleas' or 'Wheel Feat' may have originated in the town of Telltown, County Meath, where athletes threw either a chariot wheel or a spoke of a wheel with the hub attached (Redmond 24). Hammer competitions were first held in Scotland around 300 A.D. and eventually migrated to England (Bowerman 308).

The hammer has gone through many transformations since its origin. In the event's early years – after the days of the chariot wheel – the implement was either an actual blacksmith's hammer or a round stone attached to a wooden handle. Between 1612 and 1852, the Cotswold Olimpick Games held in Britain had the hammer throw, which used a sledge hammer (Birley 81). In the 1860s, when the hammer throw was introduced into university sports, the implement was made of a 16-pound shot with an oak handle. The modern implement is a shot-like metal ball with metal handle attached with a thin metal wire (Black). A modern hammer is shown in Figure 1.3.

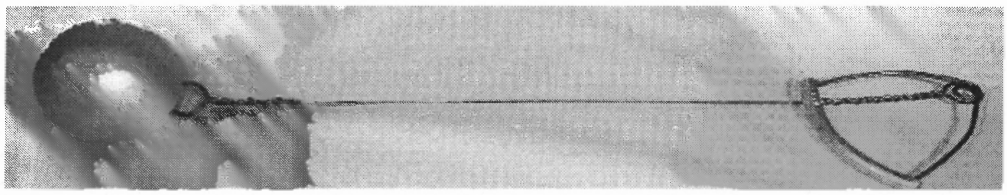


**Figure 1.3** A modern hammer with wire and handle.
Source: MF Athletic Company. 11 Dec. 2004 <http://www.everythingtrackandfield.com>.

The popularity of the hammer throw increased in the mid 19th century with the introduction of the Caledonian Games. The modern style of throwing the hammer was developed by Irish and Irish-American throwers, who dominated the event from the 1900

Olympic Games in Paris through the 1932 Games in Los Angeles. The hammer throw has been popular in New England states where the Scottish and Irish heritage is strong. This region is one of few in the country where the event is included in high school competition.

**1.2.2.2 Origin of the Shot Put.** The shot put can be traced to Irish and the Scottish chieftains who kept stones at their doors in order to hold throwing contests as to measure masculinity. A fictional account of tournaments featuring King Arthur's knights in the 11th century mentions that "casting the stone" was a popular activity in British holiday festivals (Birley 18-36). In the 1300s, during the Black Plague and war against France, there was a ban on civilian sports, including casting the stone, so that able men could concentrate on archery and other skills needed for battle (Birley 38).

The name of the event has changed several times over the years. By the 19th century, "casting of the stone" was generally referred to as "putting of the weight." The word "put" is an old Scottish verb meaning to thrust. This term came to be used when the throwing action was restricted to require keeping the weight on the neck and not letting the elbow lead the hand. A "weight" is an old English measure equaling 16 pounds, which is still the weight of the modern men's competition shot. The name 'shot,' comes from the occasional substitution of a cannon ball for a stone from the middle ages onward. Today, shots are made of iron, brass, and stainless steel for outdoor competition. Shots made of plastic shell filled with weighted pellets are for indoor competition because they do not damage indoor surfaces. A modern shot made of stainless steel is shown in Figure 1.4.

**Figure 1.4** A modern shot made of stainless steel.
Source: MF Athletic Company. 11 Dec. 2004 <http://www.everythingtrackandfield.com>.

The shot put was included in the first modern Olympics although it was not an event that originated in Greece. In the 1904 Games, there was an additional competition with a 65-lb heavy shot, probably in the tradition of the original Scottish heavy events.

# CHAPTER 2

## TECHNIQUE AND SCIENCE OF THE THROWS

The instruction of the throwing events is relevant to the field of technical communication because the athletes must apply physics, mathematics, aerodynamics and kinesiology. Instructors and coaches need to be skilled in communicating to athletes how to improve their performance. Although the science is important, coaches who instruct young athletes must keep in mind that they might not have had enough exposure to math and physics to understand relationship to athletics. Many adults, as well as children, have an aversion to math. A skilled coach can apply the principles of good technical communication by customizing instructions to the appropriate level of complexity for a particular audience.

Figure 2.1 shows the variables associated with effective instruction of athletic skills: the significance of technique, the relationship between science and athletics, appropriate use of expert models as examples and the learning process of how people learn physical skills. The technique and science variables will be addressed in this chapter. The use of expert models and the learning process will be addressed in Chapter 3. In this chapter, I will describe the basic movements required for each event and explain how physics comes into play in the throws. I will also explain why athletes should make adjustments technique based on their body size and athletic ability.

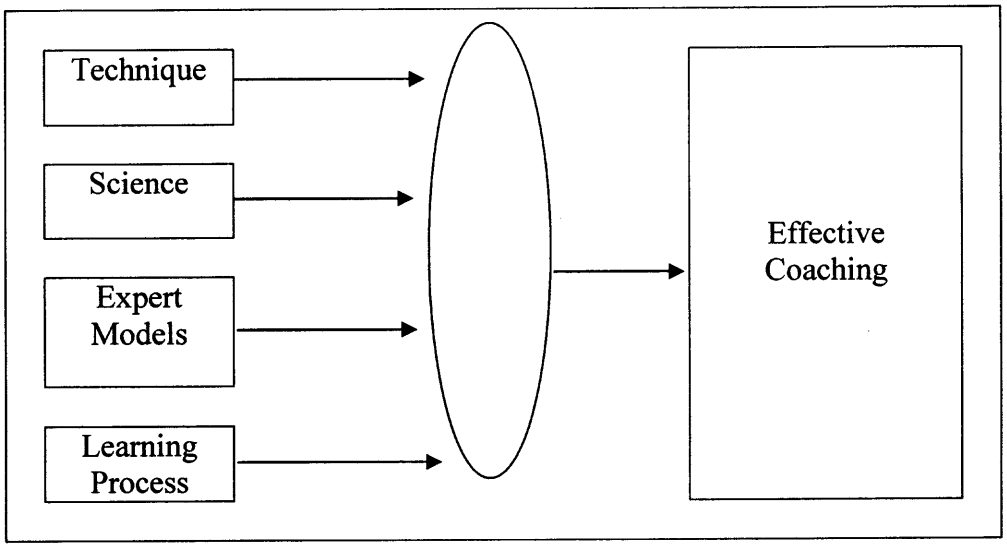



**Figure 2.1** Predictor Variables associated with effective instruction of athletic skills.

## 2.1 The Significance of Technique

Proper technique in field events affects the performance of athletes and safety to spectators, athletes and officials. Clearly, a thrower wants to achieve the longest distance possible, but safety is an important consideration as well. Although athletes do not aim to hit a specific target, there is an area, called the sector, in which the implement must land in order to be a legal, measurable throw. When technique is executed perfectly, the implement should land straight ahead of the circle in the center of the sector. An athlete who does not use the correct technique could have a throw land outside the sector or even behind or on the side of the throwing circle (or javelin runway), injuring bystanders or officials.

Competitors and bystanders should learn the customs and culture of the throws. At most track and field facilities, there is one circle each for the shot put, discus and hammer and one runway for the javelin; several athletes must take turns during practice

and each thrower goes out into the field to retrieve his or her implement. All athletes who walk into the field should pay attention to current throwing activity and should check to make sure that the field is clear before throwing. Most injures occur when an athlete walks out into the sector to retrieve an implement thrown in practice or competition without paying attention to the activity in the circle or runway.

Recently, the major concern for safety is the javelin throw, especially at the high school level. The javelin is not a heavy implement, but its original purpose in ancient Greek times was as a battle spear used to pierce the body of the enemy. The sharp metal point can be fatal when thrown at a high velocity, and as a result some high schools have taken the javelin out of competition. Some states that still allow the javelin require that a rubber end piece be put on the end of the implement.

Tony Naclerio, Rutgers University throwing coach and Olympic coach for the throws in 1996, produced a video on safety considerations entitled, Keeping it Safe Around the Shot Put, Discus and Javelin. He has also been called as an expert witness in trials involving injuries in high school javelin competitions. Naclerio states that there are three preparations for maintaining safety in the throwing events: rules, facilities and technique. The rules dictate when and where the athlete can throw. The sector is clearly marked as the area where the throw is likely to land. The facilities involved in safety include the cage for the discus and hammer as well as flags and cones that act as barricades. Good technique enhances safety because the athlete will be more likely to release the implement at the proper point, ensuring that it will land within the sector lines (personal interview).

The discus is relatively light (2 kilogram for men and 1 kilogram for women) but travels at high speeds. Discuses are made of wood surrounded by a metal ring or rubber, both of which could be painful on impact with the body. An enclosure, or cage, is required for the hammer throw and strongly recommended for the discus throw because the flights of the implements are unpredictable. The wire, ball and handle of the hammer are also sources of potential danger: the forces exerted on the hammer during the rotation and release cause stress on the wire which will weaken over time. There have been instances where the wire has snapped, sending the ball flying into the cage or on some unpredictable path and throwing the athlete just as quickly off balance in the opposite direction. Many high school competitions do not include the hammer throw because of the potential danger.

A common problem among novice throwers is attempting to compensate for poor technique by using strength rather than skill to overpower the throw. This is called "muscling" the implement and it can cause serious injury, such as sprains to ankles and knees or pulled muscles. The thrower could lose balance and trip over the edge of the throwing circle.

There are several advantages of throwing well and using proper technique besides the reduced risk of injury. Scholarships are available for athletes who compete at a regional and national level in intercollegiate competition. The throwing events are often overlooked sources of vital points in championship competitions. Athletes who are taught proper technique from the beginning stages of learning will be at an advantage over those who lack quality instruction.

Track and Field is a sport that offers many events and allows for participation at all ages. The throws are a viable option for people who are not particularly fast or who have no interest in running. The throwing events are a good entrée into sports for children of a heavier build who may have been discouraged from joining other sports teams. A comprehensive program incorporates various aerobic, anaerobic and flexibility exercises.

There are also opportunities for participation in masters-level competitions for athletes thirty-five years of age and older. The throwing events are alternatives for athletes who prefer activities other than running to remain physically active for life.

## 2.2 Basic Throwing Techniques

This section describes the basic motion of each event. Each of the throwing events has a distinctive technique, optimal angle of release and optimal speed and height of release. The success of the throw depends on the athlete's size, strength, speed and level of expertise. An effective instructor can relay the technical principles to the athlete while making adjustments based on the athlete's individual ability.

The shot put, discus and hammer are thrown from a circle and the javelin is thrown from a strip of grass or track called a runway. During competitions, there are at least two officials monitoring the events: one official watches the thrower's feet to make sure they do not touch the circle and the other watches the landing of the implement to make sure that it lands within the sector. If the thrower's foot crosses outside the circle or runway or if the implement lands outside the sector, the official calls a foul and the

thrower's attempt is disqualified. The sector judge marks the spot where the implement lands in order to measure the distance of the throw.

After the implement is thrown, the official monitoring the thrower will say "mark" indicating that the throw is legal and ready to be measured. Then the thrower must exit from the back half of the circle. If the throw is not legal, the official will indicate that the throw is a foul and will not be measured. In the following sections, I describe the basic motion of each throw, assuming that the athlete is right handed. A left-handed athlete should use the opposite directions. Table 2.2 at the end of this section summarizes a few milestones in the evolution of techniques in each event that are discussed below.

### 2.2.1 Discus

In the discus, the athlete competes from an 8-foot 2 ½-inch circle painted onto a concrete slab (some circles are made of a metal ring screwed into the concrete). To avoid a foul, the thrower must remain in the circle during the throw and the implement must land within the sector. (See Figure 2.2.) The discus can be made of rubber, but better quality implements are made of wood and have a metal weight in the center with a ring around the outside. In men's competition, the discus weighs 2 kilograms and in high school boys' competition, the discus weighs 1.6 kilograms. In women's and high school girls' competition, the discus weighs 1 kilogram.

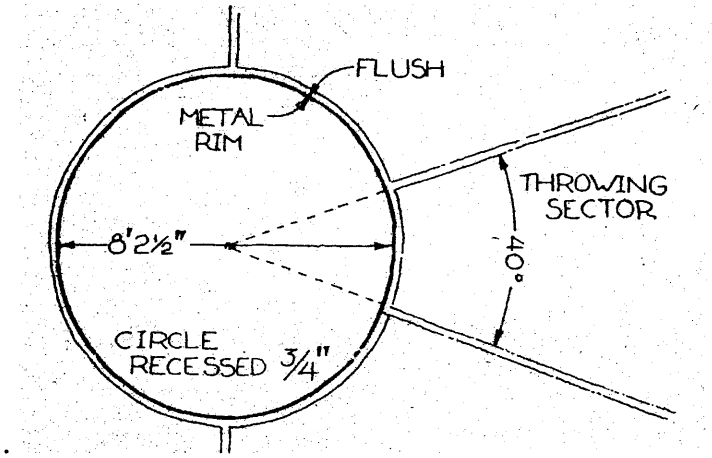



**Figure 2.2** The discus circle and sector.
Source: Michael Brown, Track & Field Rules in Pictures (New York: Putnam, 1990) 60.

The starting position is with both feet to parallel in the back of the circle. The discus is held in the right hand at the second knuckle. The athlete begins the throw by pushing off the right foot and pivoting on the left foot in a counter-clockwise direction, keeping the right arm holding the implement as far back as possible. The right foot lands in the center of the circle as the thrower remains in a squatting position as the left foot immediately swings around to the front of the circle. As the left foot lands, the thrower pushes off the right leg and swings the right arm around to release the discus into the sector.

There are discuses with different weight distributions that assist throwers based on their skill level. (See Table 2.1.) Wooden and plastic discuses have a metal rim and core that can be adjusted to create more or less spin when the implement is thrown. Higher rim weights mean that the metal rim around the outside of the discus is heavier and the metal core is lighter and causes a faster spin when released properly.

Ecker explains that the spin allows the discus to behave like a gyroscope, allowing the discus to remain level in flight, allowing the air to carry it longer before it drops to the ground (182).

**Table 2.1** Discus Rim Weights

| Discus Type | Rim Weight | Skill Level |
|---|---|---|
| Very High Spin | 85 – 92% | Advanced |
| High Spin | 75 – 80% | Above Average |
| Low Spin | 70 – 75% | Intermediate |
| Center Weighted | 50 – 60% | Beginner |

Source: MF Athletic Company. 11 Dec. 2004 <http://www.everythingtrackandfield.com>.

### 2.2.2 Javelin

The javelin throw is different from the other events in that the athlete travels up a runway and releases the implement from behind the foul line at the end of the runway into the sector. The runway is 13 feet 1 ½ inches wide and the length is between 98 feet 6 inches and 120 feet. (See Figure 2.3.) In men's and high school boys' competition, the javelin weighs 800 grams and must be between 260 and 270 centimeters in length. In women's and girls' competition, the javelin weights 600 grams and must be between 220 and 230 centimeters in length.

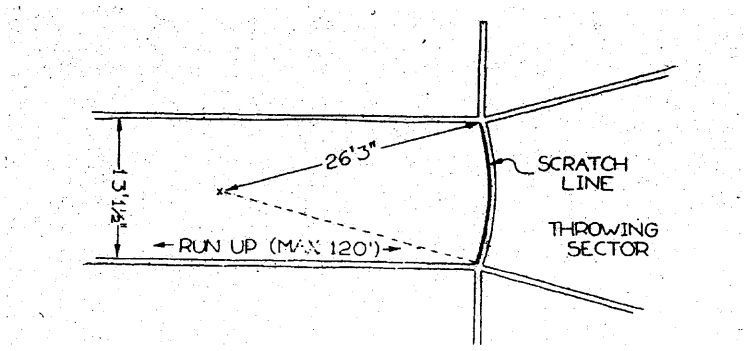



**Figure 2.3** The javelin runway and sector.
Source: Michael Brown, Track & Field Rules in Pictures (New York: Putnam, 1990) 61.

The thrower gains speed by running with the javelin over the shoulder. With four to six steps left, the thrower takes the final steps crossing the right foot over the left while drawing the javelin back as far as possible with the torso on a backward-leaning position. On the second to last step, the right foot lands and the left foot lands, the thrower rotates the torso forward in the direction of the sector and releases upwards into the sector.

Recall from Chapter 1 that javelins of ancient Greece were made of wood and had a loop that throwers used to help propel the javelin. Wood was used for javelins through the 1980s. Currently javelins are made of an aluminum shaft, a steel head with a sharp point, and a grip that is made of a cord wrapped around the center of the shaft. Like the discus, variations of javelin design can help advanced throwers achieve greater distances. A feature called the meter rating indicates how stiff the javelin will be in the air when it is thrown at that distance. For example, an athlete who throws close to 50 meters should choose a javelin with a meter rating of 50. A higher meter rating is best for elite throwers because the implement will be more stable when thrown at higher speeds: ". choose a javelin that has a meter rating slightly above how far you throw. As the meter rating increases the javelin becomes stiffer, reducing vibration during flight, resulting in longer throws" (MF athletic). Meter ratings for men's javelins typically range from 50 to 90 and ratings for women's javelins typically range from 25 to 80.

### 2.2.3 Hammer

In the hammer, the athlete competes from a 7-foot circle painted onto a concrete slab (some circles are made of a metal ring screwed into the concrete). Figure 2.4 shows a hammer and shot put circle. Most facilities have separate hammer and shot put circles.

However, the stop board can be removed if a separate circle is not available. The thrower must remain in the circle during the throw and the implement must land within the sector to avoid a foul. The hammer is made of three pieces: a shot-like ball, a handle and a thin wire connecting the ball and handle. In men's competition, the hammer weighs 16 pounds and in high school boys' competition the hammer weighs 12 pounds. In women's and girls' competition, the hammer weighs 4 kilograms.

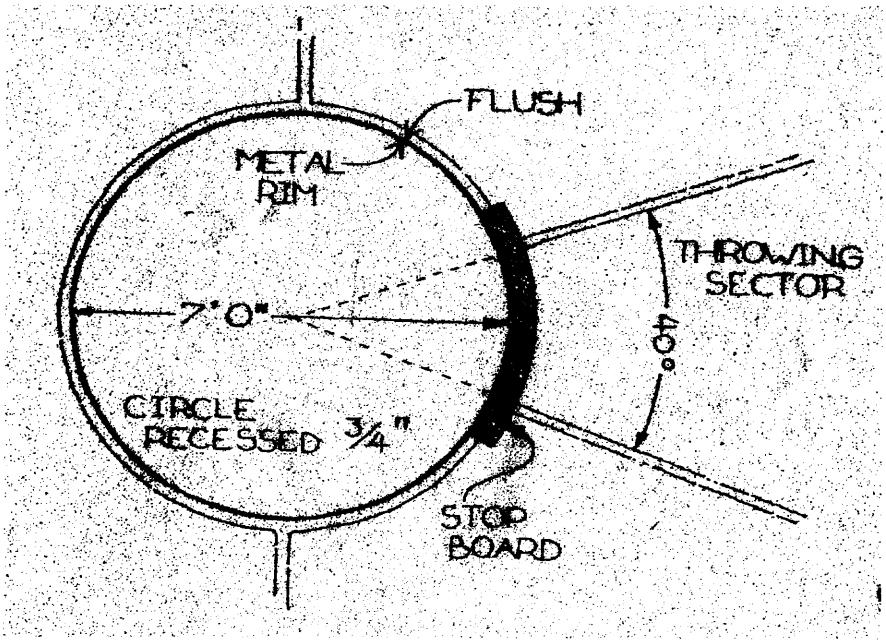



**Figure 2.4** Shot put and hammer circle and sector. The stop board is not used for the hammer throw.
Source: Michael Brown, Track & Field Rules in Pictures (New York: Putnam, 1990) 59.

The athlete begins the throw at the back of the circle with both feet parallel and closer together than in the discus. The thrower wears a glove on the left hand, which holds the handle of the hammer as the right hand overlaps the left. The thrower winds the hammer around the head once before beginning the throw. On the second wind, the thrower pushes off the right foot to begin to move counter-clockwise and pivots on the left foot, almost rolling heel to toe. Most throwers rotate three times before releasing the

hammer, but this number ranges from one for a beginner to four for an elite athlete. When the thrower completes the final turn, as soon as the right foot lands, they push up with the legs and pull on the hammer wire. When the torso faces the front of the circle, the athlete releases the hammer into the sector.

Unlike the discus and javelin, there are not many variations in the hammer that enhance performance. The quality of the implement's construction is a small factor: the ball-bearing swivel that connects the wire to the ball on brass hammers tends to be smoother than on iron hammers. Iron hammers are also prone to rust, unlike stainless steel and brass hammers, which can make the swivel less smooth.

### 2.2.4 Shot Put

In the shot put event, the athlete must compete from a seven-foot circle painted onto a concrete slab (some circles are made of a metal ring screwed into the concrete). There is a toeboard (or stop board) attached to the front of the circle that keeps the thrower from stepping outside the circle resulting in a foul (disqualified attempt). The implement is a metal ball called a shot, which the athlete puts, or pushes off the neck. Although this is a throwing event, the shot is not thrown like a baseball: the rules of the event dictate that it must not leave contact with the neck until the release begins. In men's competition, the shot weighs 16 pounds and in high school boys' competition the shot weighs 12 pounds. In women's and high school girls' competition, the shot weighs 4 kilograms.

There are two techniques available for the shot put: the traditional glide technique created by Parry O'Brien in the 1950s, and the rotational, or spin, technique similar to the discus created by Aleksandr Baryshnikov in the 1970s. In the glide technique, the thrower begins with the shot under the neck and the right foot at the back of the circle

(the back of the circle is the farthest point from the sector). (See Figure 2.4 above.) The thrower bends over the knee and kicks back with the left leg. The right foot lands in the center of the circle while the torso remains facing the back of the circle. At the moment that the right foot lands, the thrower pushes up off the right leg, turns the torso counter-clockwise and begins to put the shot, releasing it up and out into the sector when the torso faces the sector. In the rotational technique, the thrower moves as if throwing the discus as described in Section 2.2.1 except he or she keeps the shot pressed against the neck until the release.

### 2.3 Evolution of Throwing Techniques

Major changes in technique began in the early 1900s. It is possible that the revival of the Olympic Games contributed to increased interest in the sport. The Games also allowed athletes from different countries to watch each other perform and learn from each other. Several athletes began to experiment with implements and technique. In the discus throw, American throwers Phil Fox and Eric Krenz were the first to begin the throw with their backs to the sector (Payne 21).

In the 1950s a club-level athlete from Spain threw distances over the world record in a practice using an illegal – and dangerous – discus-style spin with soap on his hands to facilitate the release of the javelin. Shortly afterwards, the International Amateur Athletics Foundation (IAAF) standardized the rules for the javelin which stated that athletes cannot turn their backs to the sector and must throw the javelin over the shoulder. Americans Bud and Dick Held made javelins more aerodynamic by experimenting with design (Payne 29).

The shot put used a freestyle technique until the early 1950s when American Parry O'Brien created the glide technique that is still the standard method. In the 1970s, Russian thrower Aleksandr Baryshnikov adapted the discus style rotation to the shot put (Encyclopedia of Track and Field 177-179). Table 2.2 gives a summary of milestones in the development of throwing techniques.

**Table 2.2** Evolution of Throwing Techniques

| | |
|---|---|
| **Discus** | |
| Ancient Greece through 1800s | Underarm throw or free-style method. |
| 1928 | Women's discus first included in the Olympics. |
| 1930s | Phil Fox and Eric Krenz (USA) pioneered standard technique of starting with back to direction of the throw. |
| 1946 | Bon Fitch further developed rotational style. |
| **Javelin** | |
| Ancient Greece through 1800s | Javelin throwers were judged on distance as well as accuracy aiming at fixed targets. |
| 1932 | Women's javelin first included in the Olympics. |
| 1950s | Bud and Dick Held (USA) applied aerodynamic principles to javelin design. |
| 1956 | A club-level Spanish athlete (name unknown) threw distances over the world record using Discus-type technique and soaping his hands. |
| **Hammer** | |
| Before the1930s | Jump turns where athlete pivots on the left toe and hops to the next position in the circle. |
| 1930 | Germans developed modern heel and ball-of-foot turning action that maintained contact with the ground throughout the throw. |
| After WWII | Russians developed a lean-away and a progressively increasing lead on the hammer from start to delivery. |
| 1950s | Russian thrower Stanislav Nyenashev created four-turn method. |
| 2000 | Women's hammer first included in the Olympics. |
| **Shot Put** | |
| Early 1920s | Hop-step technique with thrower starting facing the sector. |
| 1928 | Women's shot put first included in the Olympics. |
| Early 1950s | Parry O'Brien (USA) created modern glide technique starting facing away from the sector. |
| Mid 1970s | Aleksandr Baryshnikov created discus-like rotational technique. |

Sources: Howard Payne, Athletics: Throwing (London: Pelham, 1976); Encyclopedia of Track and Field (New York: Prentice-Hall Press, 1983); and Harry Lovering Gill, Track and Field Athletics for Coach and Contestant (Champaign: Bailey and Himes, 1925).

## 2.4 The Significance of Science

In this section, I will discuss the principles of physics and biomechanics involved in the throwing events. Effective coaching tools should address these principles in a way that helps athletes understand how science affects performance. Coaches and athletes should understand the complexity involved in these events which allow to improve technique and to avoid common errors and injuries.

Kinesiology, the scientific study of human motion, is key in the relationship between science and sports. Kinesiology is often divided into two fields: anatomic and mechanical. Anatomic Kinesiology is the study of muscles, bones and joints and their involvement in human movement. The term "biomechanics" has replaced "mechanical kinesiology" and comes from the Latin word *bio* meaning life and mechanics, which is the field of Newtonian physics dealing with the effect of forces on bodies and motion. Biomechanics is defined as "the study and analysis of humans in motion, sport object motion and forces acting on animate and inanimate bodies" (Northrip, Logan and McKinney 2).

In each event, there is a launch phase in which the athlete prepares for release of the implement and a flight phase in which the implement is released into the air. During the launch phase, the application of forces is most relevant: the athlete must use his or her body to apply force to the implement to overcome its inertia. During the flight phase, the implement is acting as a result of the forces applied by the athlete. Here, the principles of aerodynamics, the study of objects traveling through the air, apply as well (Vaughan 214).

For all of the throwing events, the optimal distance depends on the athlete's ability to apply the best technique to throw the implement at the ideal speed, angle and height of release. Although it is important for students of the sport, both coaches and athletes, to understand the scientific aspects of throwing, it is not a substitute for good technique. As Bunn explains:

> *[. . .] those who are skeptical [about explaining human movements by mechanical principles] would say there is no one right way to execute a technique. Each must adopt the style that best fits his own peculiarities [. . .] All recognize individual differences, and on occasion such differences may require slight adjustments in technique. However, individual differences do not alter basic principles. (11-12)*

Most coaches would agree that it is important to teach the basic principles early in the athlete's training. It is much more difficult to correct poor technique that was learned early in the athlete's training than it is to make adjustments to a good foundation of solid basics.

Newton's laws of motion help explain why physics, the concept of force in particular, is important and how these laws are applicable to the throwing events. As Dyson explains, in track and field, there are two main sources of forces: internal, where force is generated by the muscular actions of the athlete; and external, including the downward pull of gravity and air resistance (28-33). Many beginners and spectators of the throwing events assume that most of the force comes from the arm. The entire body acts as one system with every body part contributing to the throw. In the case of the shot put, the legs, which are much more powerful than the arms, contribute the velocity needed to overcome the inertia of the implement.

The leg muscles, the largest and strongest muscles in the body, account for the majority of the forces produced in the throw. The arms add some force to the system, and although it is important that the arms be as strong as possible, they mainly provide guidance for the implement (Dyson 210). Many novice throwers believe that they can compensate for less than ideal technique by using the arms, but this mistake can result in injury or a loss of balance, causing the athlete to step outside the circle or the implement to land outside the sector.

Newton's first law, also called the law of inertia, states that a body continues in a state of rest or of uniform motion in a straight line unless it is compelled by external forces to change that state. It is much more difficult to start a body in motion than it is to keep it moving. This explains why the thrower should maintain the movement of the implement during the launch phase. If the implement were to come to a stop at any point during the throw, it would be difficult to effectively transition into the flight phase because much of the thrower's effort would be needed to restart the movement rather than to release the implement.

Newton's second law, or the law of acceleration, states that the acceleration of a body is proportional to the force causing it. Bunn explains that since acceleration means a change in velocity or speed of a body, the force applied must be greater than that required to maintain a uniform speed for the body if the body accelerates (9). The athlete must create internal force with the muscles to generate the forces necessary to accelerate. If there is deceleration the athlete will have difficulty transitioning from the launch phase of the throw. According to Biomechanist and author Tom Ecker, a 10% increase in speed

at the point of release will result in a 21% increase in distance with all other factors remaining constant (Ecker 10).

Newton's third law, or the law of interaction, states that for every action (or force) there is always an equal and opposite reaction (or force). In the throwing events, athletes use their muscles to exert an internal force against the ground in order for the ground to push back on them as they release the implement. The stronger the legs of the athlete, the more internal force he or she is able to produce to add to the sum of forces acting on the implement as it goes into the flight phase.

Even if the coach and athlete completely understand the physics, simply moving faster does not guarantee a good performance. The release speed of the implement is the most important factor in the distance of the throw, but the direction or trajectory angle to be discussed in the aerodynamics section is also important. The goal of the launch phase is to generate the greatest amount of controlled speed as possible, while allowing the athlete to make a controlled transition into a release position for an optimal angle of release. An athlete who moves too quickly is likely to lose control and fail to enter the release phase of the throw in the desired position. An athlete who moves too slowly will not generate the acceleration needed to provide the force needed for desired distances.

Aerodynamics is the study of forces and the resulting motion of objects through the air. The shape of the object, the rotation during flight, effect of gravity and the trajectory are all important during the flight phase of the throw. The trajectory is the path followed by a freely moving, unsupported body and depends on the velocity in which the object leaves its base of support and the angle in which it is initially released into the air.

Each event has its own optimal trajectory angle and speed but with variations based on the technique and ability of the athlete. (See Table 2.3.) The discus and javelin, which are lighter than the shot and hammer, are more designed for aerodynamic flight and more sensitive to poor release technique.

A mathematical consideration in the throw is the angle of release. Normally, the optimal angle of a trajectory of an object to achieve the maximum possible distance is 45°, assuming that the object will land at the same vertical level as it was released. Obviously, height of the release is higher than the point where it lands because the thrower releases it above ground level. The optimal angle of release depends on the height and arm length of the thrower and is different for each event.

**Table 2.3** Optimal Angles of Release

| Event | Optimal Angle of Release |
|---|---|
| Discus | 34° - 40° |
| Javelin | 30° - 40° |
| Shot Put | 40° - 42° |
| Hammer | 42° - 44° |

Source: Tom Ecker, Basic Track and Field Biomechanics (Los Altos: Tafnews, 1985) 164-198.

## 2.5 Anatomical Considerations

In the throwing events, the athlete combines strength, speed and technique to perform the throw. Yet, each athlete has different physical traits that affect performance. Based on the laws of physics and the principles of biomechanics, a tall thrower with longer limbs

usually has an advantage over a shorter thrower. However, smaller athletes tend to be more agile and can overcome the lack of height with speed, strength and excellent technique.

A taller thrower has the advantage because the height of release is an important factor in determining the distance. The leg and arm length of the athlete contribute to the height of release. Normal parabolic curves that describe trajectories assume that the object is launched from the same height as where it lands. This point is illustrated in Figure 2.5. If points A and B are at the same level, the object released from point A will land at B. If point A is higher than the landing point C, the distance that the object travels will be greater than when they were released at the same level. Therefore, with all other factors being equal, the higher the height of release, the greater the distance that the object will travel. (See Table 2.4.)

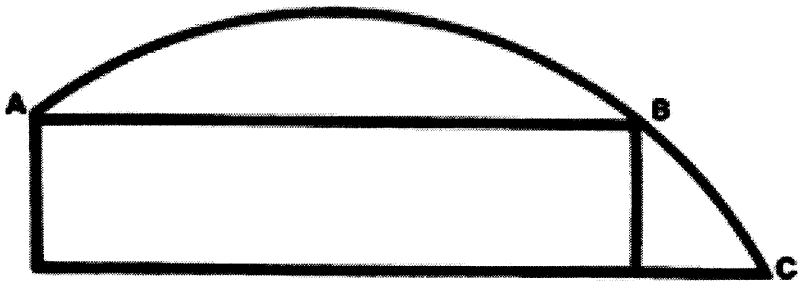



**Figure 2.5** Release height for trajectories.
Source: Tom Ecker, Basic Track and Field Biomechanics (Los Altos: Tafnews, 1985) 35.

**Table 2.4** Examples of Shot Put Distances Thrown at Various Heights at a Speed of 44 feet per second

| Height of Release | Angle of Release | Distance Thrown |
|---|---|---|
| | 45° | 66' 5" |
| 6.5' | 40° | 66' 7" |
| | 35° | 65' 0" |
| | 45° | 66' 10" |
| 7' | 40° | 67' 0" |
| | 35° | 65' 6" |
| | 45° | 67' 8" |
| 8' | 40° | 68' 0" |
| | 35° | 66' 7" |

**Source:** Geoffrey H.G. Dyson, The Mechanics of Athletics (New York: Holmes & Meier, 1977) 219.

Although height is an asset, it can also be a disadvantage. An extremely tall athlete – six-feet four or taller – might have difficulty remaining in the throwing circles for the discus, hammer and shot put. Naclerio calls the seven-foot shot put and hammer circles and the eight-foot discus circle "crampy" environments for tall athletes. The thrower must adjust his or her technique in order to remain in the circle during and after the throw in order to avoid a foul (personal interview).

# CHAPTER 3

# LEARNING MOTOR SKILLS

This chapter will address the expert model and learning process variables associates with effective coaching. A good coach should understand how motor skills are learned in order to provide effective instruction. Effective coaching tools should consider the differences in the instructional needs of both novices and advanced learners. In this chapter, I will discuss the way people learn physical skills. There are different techniques that are more effective depending on the athlete's level of experience. Visual aids and verbal instructions are used at all levels, but should be used in combinations that are appropriate for the athlete's skill level. Expert models can be used for demonstrations, but coaches should teach athletes not to copy mistakes that models make.

## 3.1 Understanding Motor Learning

Many researchers study the way people learn. Motor Learning theories address the way people learn physical skills including athletic skills. Drowatzky explains that there are two general schools of thought in the field: connectists and cognitians. Connectists believe that learning is a result of responses to environmental stimuli while cognitians believe that learning is based on past experiences and choices. (13-14) Learning theories are categorized as "emphasizing the mechanistic nature [response to stimuli] or the choice aspects of learning and behavior" (Drowatzky 15).

Theorists have also created several categories to describe motor skills. In the case of throwing events in track and field, the shot, discus, javelin and hammer are considered "closed" because the environment in which the action is performed does not change. There is a predetermined set of steps required to complete the action that are not adjusted based on some outside event. Drowatzky states that with practice of closed skills, consistency of movement should be taught and success depends on "consistently replicable habitual movement" (53).

In contrast, an open skill, such as playing tennis, football or chess, is performed in an unpredictable environment to which the performer reacts to change. The performer has to react to visual cues and make decisions based the meaning of the stimulus. Open skills require changes in movement based on change in the environment (Drowatzky 53).

Throwing events can be classified as discrete, meaning that there is a clearly defined start and finish to the action. The athlete enters the throwing circle (or runway for the javelin) and executes a throw. When the implement lands, the thrower is given approval to leave the circle by the official. A continuous skill is one where there is no predetermined start or end such as swimming or running (not in a formal race). These activities can flow for several minutes without a set ending. A serial skill is a combination of discrete and continuous; "The movements last longer than discrete skills, but retains a discrete beginning and end" (Schmidt 6-8). Synchronized skills have steps that are to be followed, but could continue for an undetermined period of time, such as a synchronized swimming or gymnastics routine.

### 3.2 Motor Learning for Novices

In the early stages of learning for a particular skill, the student learns best when given a general idea of how the movement is performed and what the expected outcome should be (Lawther 91). Giving too many details to beginning students is counterproductive since they don't yet understand how the parts of the skill contribute to the whole motion.

> *Many advocate explaining skills in terms of their biomedical, or physical, bases, using concepts such as transfer of momentum and action-reaction. Some of this may be useful but it assumes that learners understand the physical principles well enough to apply them to their new skills [. . .]. (Schmidt 176)*

Demonstration is the most effective way of imparting technique to the beginner; verbal instructions are less effective because as Schmidt explains, "Verbal instructions often provide too much information in a short period of time, so the learner has trouble remembering what was said when it comes time to practice" (Schmidt 103).

For a quick, routine motion such as a throw, demonstrating the entire motion allows the athlete to see the movement as a whole. Verbal instructions are inherently broken into parts by the mere fact that words are used and have been shown to have little additional benefit to beginners.

Hodges and Franks explain two types of demonstration, or modeling, that have slightly different methods: learning models and expert models. A learning model breaks down the skill part-by-part. Expert models show correct technique from start to finish. Models are crucial in creating schema in memory, which help the performer visualize ideal performance:

> *Attention to the modeled action is necessary for the development of a representation of the movement skill in memory, either visually or verbally, which will serve as a reference of correctness to guide the action when required [. . .] When watching a learning model, learners are actively involved in the problem-solving process and, therefore, are concerned with goal attainment, not just copying the model. (Hodges and Franks 799)*

In order for athletes to achieve optimal performance they need to adjust their technique to account for their size, speed, strength and technical ability. The problem with copying an expert model is that athletes do not learn how to adjust ideal technique to their own individual capabilities. For example, an athlete who is 5-feet tall with quick foot movement has different physical abilities than a slower thrower who is 6-feet tall. The two athletes will throw at different velocities and have different release angles and need to adjust their technique to account for their size and speed.

Another disadvantage of copying models is that at elite levels, the athletes are incredibly strong and are able to make mistakes and adjustments that a college or high school thrower can't manage. Not all expert models use perfect technique. It is advantageous to use a model that demonstrates drills or parts of the motion specifically for instructional purposes.

### 3.3 Motor Learning for Advanced Athletes

Once an athlete has intermediate to advanced understanding of the general motion of a skill, different types of instruction are effective for developing advanced skill. Verbal instruction about the different parts of the skill, self evaluation of video and pictures and mental practice are effective in further development of skill (Lawther 130).

Athletes should learn the relationship between the components of the whole movement. Verbal information is more useful here because advanced learners are familiar with the terminology of the skill. They already have a solid understanding of the entire motion and are aware of the components that make up the complete motion so they can put the verbal instructions into a meaningful perspective.

Self-analysis and mental imaging are skills used by advanced learners. In this stage, analysis from photographs and films are useful. Several studies have been performed to determine the effect of mental practice. Mental imaging is not a useful tool for beginners because it is based on application of actual experience of the athlete, not just an image of another person performing the skill: novices would not have enough significant experience to imagine themselves completing an ideal performance.

### 3.4 The Use of Verbal Instruction

Although visual demonstrations are effective, they do not eliminate the need for verbal instructions, especially for people with special learning needs such as "low skill learners, the very young or the very old" (Lawther 92-93).

Lawther explains that verbal instruction is the most common tool used by coaches, but it is not always the most effective or efficient. He references an experiment by Rivines where novices were given demonstrations on how to putt a golf ball or kick a soccer ball. The first group was shown demonstrations without verbal instructions. The second group had the same amount of demonstrations as the first group, but was given an additional two to three minutes of verbal explanations.

He tested the learning rate after eight weeks of practice and found that there was no significant difference between the groups in the performance of the skill. The only distinction was that the group that had verbal explanation scored higher on a written test. (93) Although visual images are more effective for novices, at some point words must be used to explain how to perform a skill. In the beginning stages, the instructor is limited to verbal instruction because the athlete has not yet been able to internalize the relationship between the words and the action:

> *In the beginning do not rely too much on words [. . .] He will not understand the directions. He may be able to give you the meaning of every work used; he may be able to repeat the directions but he has not connected the words with the movements of his hands and body. (Lawther 103)*

As athletes become more knowledgeable in a skill, they are able to process verbal instruction explaining why they are performing the skill the way it is described. At this point, the instructor can break up the action into steps because the student will be able to relate the words to the action in parts and as a whole. They are also able to choose aspects they want to focus on from an existing pool of knowledge (Lawther 104).

Most coaches do not study motor learning theory, but they should be conscious of the learning styles. Coaches should be educated on the differences between the way beginning and advanced athletes learn. Coaching tools should consider different learning styles.

# CHAPTER 4

# INSTRUCTIONAL MEDIA

This section will describe the media that have been used to instruct athletes. I will provide a brief history of each medium and explain how it is used in the instruction of throwing events. I will also discuss how effective each method is for both beginners and advanced throwers based on the theories of motor learning described in the previous chapter. Each of these media can be used in various combinations to create an effective multimedia tool. Also, traditional instructional tools like video and books can be improved through the application of the variables associated with effective instruction. For example, organizers of coaching clinics could categorize workshop sessions by attendee skill level and present information with an appropriate balance of verbal and visual information. This list could help a coach update his or her training library or help athletes who do not have a coach find training resources.

## 4.1 Oral Instruction

Oral instruction has been available for humans since language began, preceding written communication by thousands of years. It is the most important tool for coaches to explain technique and give feedback to athletes. It is obvious from the common theories about motor learning that images are important in the instruction of motor and physical skills. However, oral instruction is an irreplaceable part of coaching.

The interchange between coach and athlete is important in the learning process. A beginner athlete can get the general idea of the motion of the throw, but moving to the

advanced level requires a thorough understanding of the segments of the action. Feedback is required in order to make corrections and improvements in the technique and is best delivered orally when the athlete can ask questions and discuss the technique. The most organized method of oral instruction is though coaching clinics or camps. College or elite-level coaches host most clinics for high school and middle school coaches and athletes. They provide information on advanced technique including conditioning, progressions, weight training, nutrition, drills, and solutions to common errors, as well as effective methods for communicating this information to athletes. The coaches-only sessions usually have keynote speakers and technique analysis sessions. The "Learn-by-Doing" camps are host hands-on training sessions where athletes and coaches can view demonstrations and receive personalized or small-group instruction from an experienced staff.

### 4.2 Greek Statues and Art

During the ancient Olympic Games in Greece, the winners of each event were honored with a statue made in their image performing the event in which they competed. There are also images of athletic contests etched on vases, plates and other artifacts that display athletes in action. These images and statues are the earliest form of demonstration. It can be assumed that the winner of each event used the proper form and that the statue could be useful in instruction.

Although the winners were able to choose the material used for their statue and its inscription, these statues were also testaments to the purpose of the Olympics: the tribute to Zeus. The heads of the statues had to be in the likeness of the gods and could not be

made in the image of the actual mortal athlete, unless he accomplished some magnificent feat of heroism. Drees describes an example of an acceptable feat: "An exception was made in the case of triple victors, who were allowed to erect realistic statues [. . .]it was only men whose deeds were so outstanding that they deserved to be immortalized whose features were carved in stone" (105).

Statues of athletic victors are no longer created as they were in ancient Greece, but are predecessors to photography in the capture of the image of athletic form. They complement the written accounts of throwing techniques, but they do not give an entire image of the throw from beginning to end. It would be difficult to replicate the technique of ancient Greek throwers without both the written account and the statues and art of the time. Drees includes photographs of a replica of Myron's Discobolus, a statue of a discus thrower shown in Figure 4.1 and states that the stance of the model is almost identical to the Philostratus's description of discus technique (72-74). Figure 4.2 shows discus throwers on a Greek artifact probably in the beginning of a throw. Note that the statue shows the athlete in a twisting stance, while the artifacts do not. Drees explains: "[. . .] the artists of the sixth and fifth centuries B.C. lacked the technical knowledge which would have enabled them to portray the turn in perspective" (73).

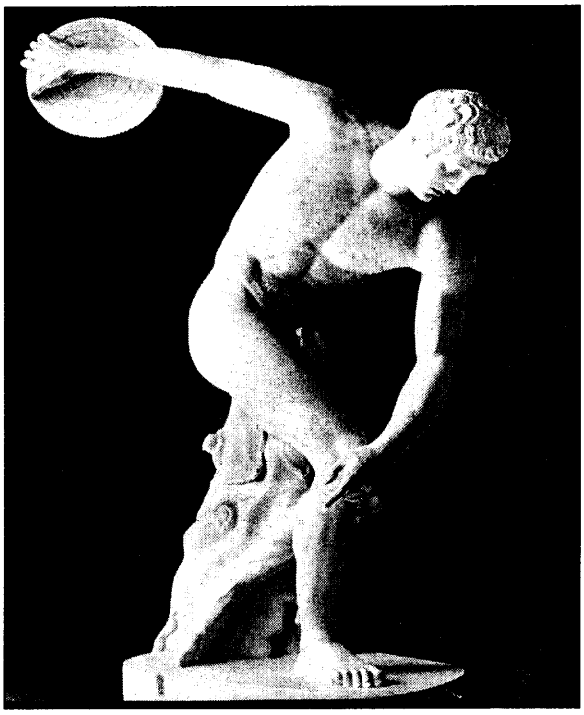


**Figure 4.1** A replica of Myron's Discobolus.
Source: Ludwig Drees, Olympia: Gods, Artists, Athletes (New York, 1967) Plate 15.

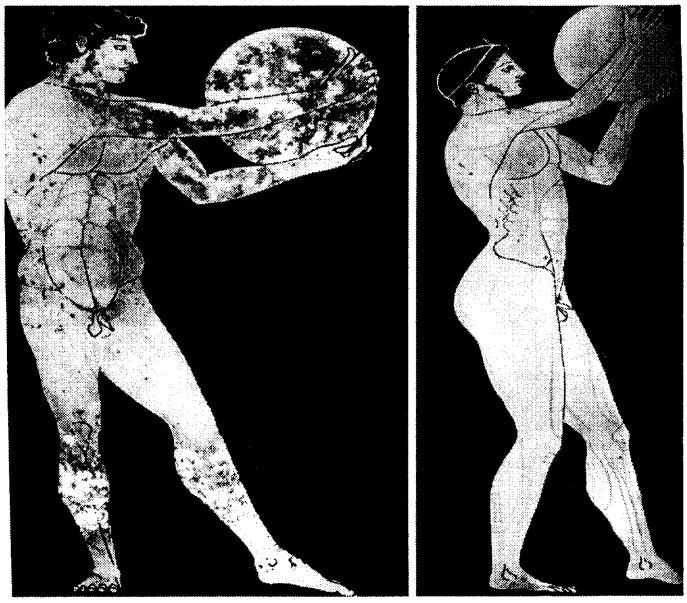


**Figure 4.2** Drawings of ancient Greek discus throwers preparing to throw.
Source: Ludwig Drees, Olympia: Gods, Artists, Athletes (New York, 1967) Plate 17 a/b.

### 4.3 Written Descriptions

Writing has been in existence since the 3rd Millennium B.C., when the Sumerians invented the first known writing system (Ong 84). In relation to the throwing events, the first known written accounts of athletic events was *Gymnasticus* by the sophist, Flavius Philostratus, son of Verus in Greece in the 3rd century A.D. This essay contains information about the original Olympic festivals and the training and competition of the events. Drees presemts Philostratus's description of the technique used in the discus throw:

> *According to Philostratus's account the* balbis *consisted of a raised mound which sloped away to the front. The thrower stood with his right foot stemmed against the mound while his left foot rested on the sloping surface. He then bent his head backwards until he could see the right hand side of his body and threw the discus as if he were lifting an object from the ground, putting the whole force of his body into the movement. (72)*

Over the years, civilizations have become more dependent on writing. Writing allows for the breakdown of techniques into steps, which is more useful to an advanced thrower. Words alone without the assistance of pictures make learning difficult for both advanced and novice throwers. Good written instructional tools, such as books and magazines, balance clear writing with appropriate illustrations.

### 4.4 Drawings and Diagrams

Drawings and diagrams are useful to show basic body position during a throw. They are often used to demonstrate the angles of release, position of the throwing implement during the throw and the application of mathematics and physics to the throw. In some

media, including the book Track & Field for Coach and Contestant written in 1925 by Harry Gill, diagrams showing foot placement in the four throwing events were included to supplement the verbal explanations in the text. (See Figures 4.3 through 4.6)

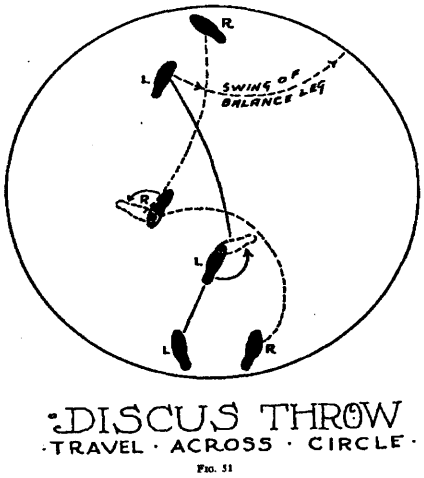



**Figure 4.3** Discus foot placement diagram.
Source: Harry Lovering Gill, Track and Field Athletics for Coach and Contestant (Champaign: Bailey and Himes, 1925) 120.

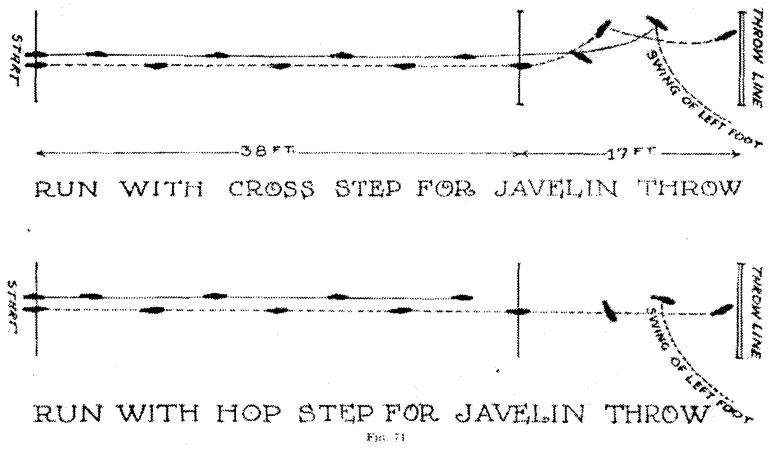



**Figure 4.4** Javelin foot placement diagram.
Source: Harry Lovering Gill, Track and Field Athletics for Coach and Contestant (Champaign: Bailey and Himes, 1925)152.

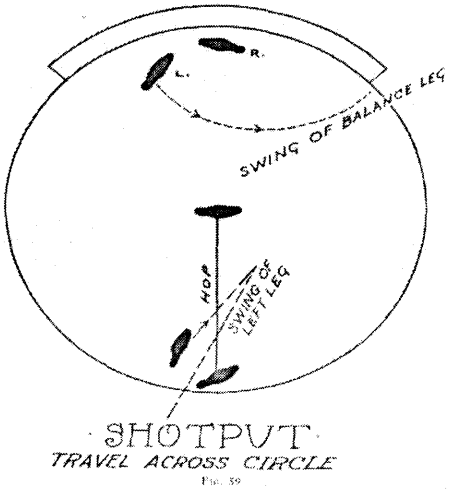



**Figure 4.5** Shot put foot placement diagram.
Source: Harry Lovering Gill, Track and Field Athletics for Coach and Contestant (Champaign: Bailey and Himes, 1925) 132.

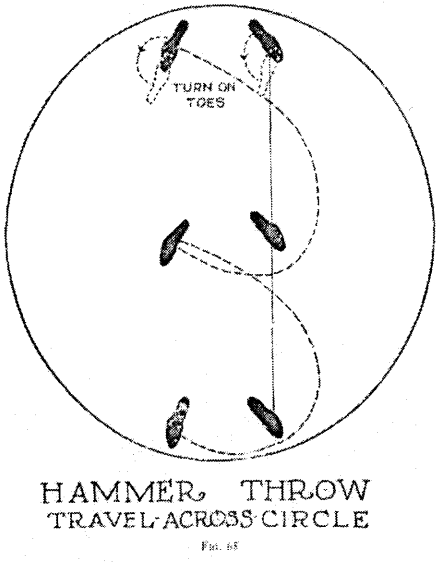
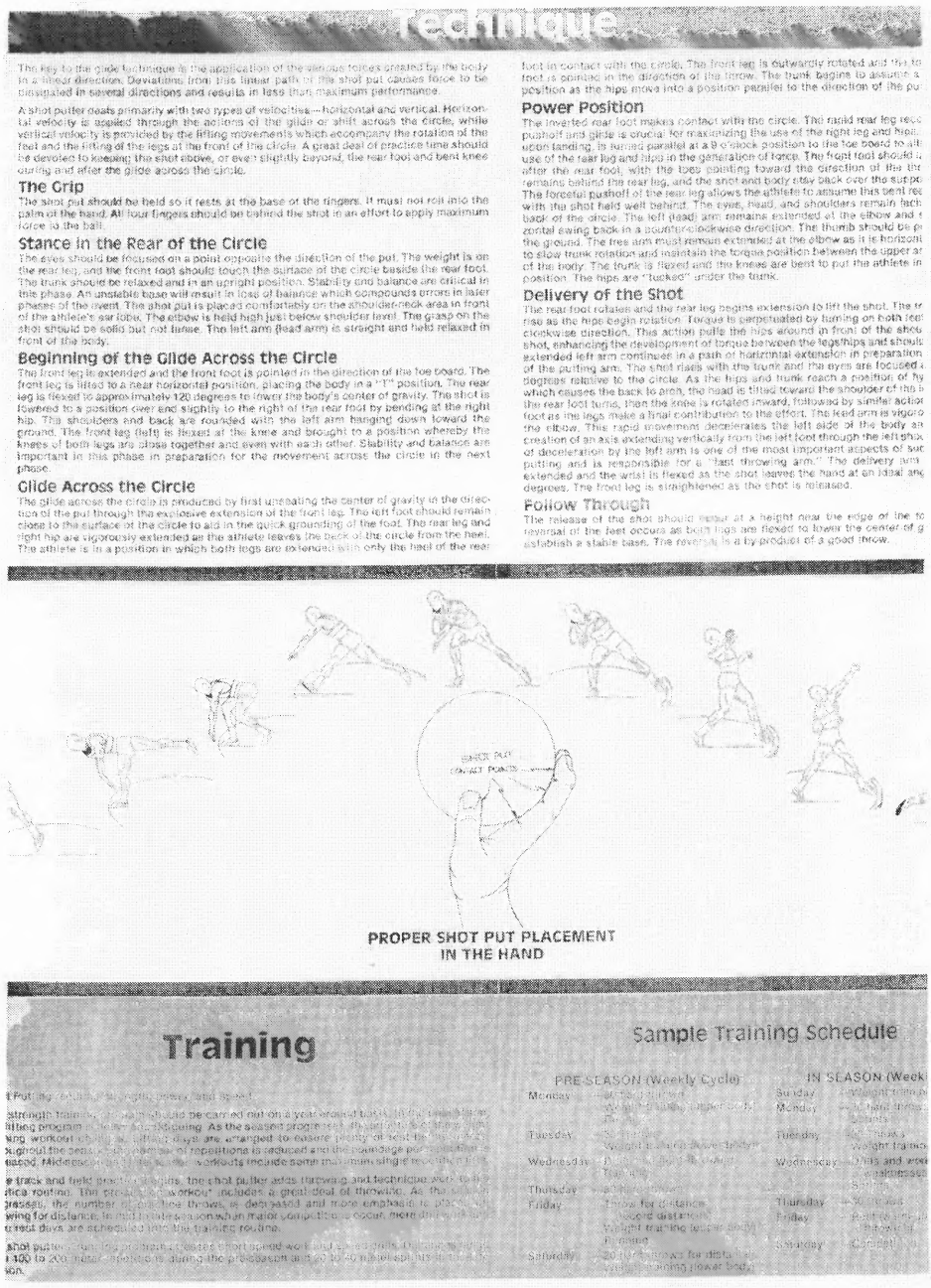



**Figure 4.6** Hammer foot placement diagram.
Source: Harry Lovering Gill, Track and Field Athletics for Coach and Contestant (Champaign: Bailey and Himes, 1925) 140.

Another type of diagram is an informational poster such as those published by Glenn Amundsen and Championship Books and Video Productions. (See Figure 4.7.) These posters contain sketches of key positions during the throw, as well as reference materials. Included in the reference material sections are rules and regulations, technique, sample training schedule, common errors and corrective action and drills.

Novices have difficulty visualizing all of the steps of the throw in succession. The athlete would have to be experienced in the event to understand the diagrams, which tend to over-simplify the movements required to complete a throwing action. For example, the foot placement diagrams do not show the complex interactions between the feet and the other parts of the body. They also are unable to communicate the rate of speed in which the feet must move in order to complete each phase of the throw.



# Technique

The key to the glide technique is the application of the angular forces created by the body in a linear direction. Deviations from this linear path of the shot put causes force to be dissipated in several directions and results in less than maximum performance.

A shot putter deals primarily with two types of velocities—horizontal and vertical. Horizontal velocity is applied through the actions of the glide or shift across the circle, while vertical velocity is provided by the lifting movements which accompany the rotation of the feet and the lifting of the legs at the front of the circle. A great deal of practice time should be devoted to keeping the shot above, or even slightly beyond, the rear foot and bent knee during and after the glide across the circle.

## The Grip

The shot put should be held so it rests at the base of the fingers. It must not roll into the palm of the hand. All four fingers should be behind the shot in an effort to apply maximum force to the ball.

## Stance in the Rear of the Circle

The eyes should be focused on a point opposite the direction of the put. The weight is on the rear leg, and the front foot should touch the surface of the circle beside the rear foot. The trunk should be relaxed and in an upright position. Stability and balance are critical in this phase. An unstable base will result in loss of balance which compounds errors in later phases of the event. The shot put is placed comfortably on the shoulder/neck area in front of the athlete's ear lobe. The elbow is held high just below shoulder level. The grasp on the shot should be solid but not tense. The left arm (lead arm) is straight and held relaxed in front of the body.

## Beginning of the Glide Across the Circle

The front leg is extended and the front foot is pointed in the direction of the toe board. The front leg is lifted to a near horizontal position, placing the body in a "T" position. The rear leg is flexed to approximately 120 degrees to lower the body's center of gravity. The shot is lowered to a position over and slightly to the right of the rear foot by bending at the right hip. The shoulders and back are rounded with the left arm hanging down toward the ground. The front leg (left) is flexed at the knee and brought to a position whereby the knees of both legs are close together and even with each other. Stability and balance are important in this phase in preparation for the movement across the circle in the next phase.

## Glide Across the Circle

The glide across the circle is conducted by first unreeling the center of gravity in the direction of the put through the explosive extension of the front leg. The right foot should remain close to the surface of the circle to aid in the quick grounding of the foot. The rear leg and right hip are vigorously extended as the athlete leaves the back of the circle from the heel. The athlete is in a position in which both legs are extended with only the ball of the rear foot in contact with the circle. The front leg is outwardly rotated and the toe foot is pointed in the direction of the throw. The trunk begins to assume a position as the hips move into a position parallel to the direction of the put.

## Power Position

The inverted rear foot makes contact with the circle. The rapid rear leg recovery pushoff and glide is crucial for maximizing the use of the right leg and hip. Upon landing, is turned parallel at a 9 o'clock position to the toe board to aid use of the rear leg and hips in the generation of force. The front foot should land after the rear foot, with the toes pointing toward the direction of the throw. remains behind the rear leg, and the shot and body stay back over the support. The forceful pushoff of the rear leg allows the athlete to assume this bent rear with the shot held well behind. The eyes, head, and shoulders remain fixed back of the circle. The left (lead) arm remains extended at the elbow and horizontal swing back in a counterclockwise direction. The thumb should be pointing the ground. The free arm must remain extended at the elbow as it is horizontal to slow trunk rotation and maintain the torque position between the upper and of the body. The trunk is flexed and the knees are bent to put the athlete in position. The hips are "tucked" under the trunk.

## Delivery of the Shot

The rear foot rotates and the rear leg begins extension to lift the shot. The trunk rise as the hips begin rotation. Torque is perpetuated by turning on both feet clockwise direction. This action pulls the hips around in front of the shot. shot, enhancing the development of torque between the legs/hips and shoulders extended left arm continues in a path of horizontal extension in preparation of the putting arm. The shot rises with the trunk and the eyes are focused degrees relative to the circle. As the hips and trunk reach a position of fly which causes the back to arch, the head is tilted toward the shoulder of the the rear foot turns, then the knee is rotated inward, followed by similar action foot as the legs make a final contribution to the effort. The lead arm is vigorously the elbow. This rapid movement decelerates the left side of the body and creation of an axis extending vertically from the left foot through the left shoulder of deceleration by the left arm is one of the most important aspects of successful putting and is responsible for a "fast throwing arm." The delivery arm extended and the wrist is flexed as the shot leaves the hand at an ideal angle degrees. The front leg is straightened as the shot is released.

## Follow Through

The release of the shot should occur at a height near the edge of the toe reversal of the feet occurs as both legs are flexed to lower the center of gravity establish a stable base. The reversal is a by-product of a good throw.



PROPER SHOT PUT PLACEMENT
IN THE HAND

# Training

## Sample Training Schedule

| PRE-SEASON (Weekly Cycle) | | IN SEASON (Weekly |
|---|---|---|
| Monday | [illegible] | Sunday [illegible] |
| | Weight training upper body | Monday [illegible] |
| Tuesday | [illegible] | Tuesday [illegible] |
| | Weight training lower body | |
| Wednesday | [illegible] | Wednesday [illegible] |
| | Training | |
| Thursday | [illegible] | |
| Friday | Throw for distance | Thursday [illegible] |
| | Weight training upper body | Friday [illegible] |
| Saturday | [illegible] | Saturday [illegible] |
| | [illegible] | |

**Figure 4.7** Part of a poster showing technique and tips for the shot put.
Source: Glenn Amundsen, Track & Field Technique Series. Chart #7 Glide Shot Put (Aimes).

### 4.5 Books and Magazines

In around 300 A.D., the codex, an early predecessor of bound books, was created from sheets of vellum sewn together (Fang 6). It is possible that papyrus rolls, clay tablets and parchment were used even earlier to write instructions to athletes. The writings of the Greek sophist, Philostratus, have been discussed earlier in this thesis. The majority of instructional media available today are still books that include a combination of written instructions, pictures and drawings. Books, magazines, and pamphlets comprise the majority of the available instructional media. Although books and articles contain valuable information, it is important to understand the limitations of using only books as a coaching tool. For a novice coach or athlete, attendance at a clinic or consultation with an experienced coach is recommended to supplement the information from books.

The Athletics Journal is a monthly publication that was first published in 1923 as a resource for coaches in high school and college. Much of the information focused on football, wrestling and track and field. One of the earliest modern coaching books on track and field was Track and Field for Coach and Contestant written in 1925 by Harry Gill. It gives instructions on the techniques of that time and includes foot placement diagrams, cited above, and photographs of athletes.

A wide range of writing and presentation styles has been used in books and articles on throwing technique. In general, they teach what to do, how to do it and why the result occurs. Some use elaborate, verbose descriptions while others rely heavily on graphics and images. Technical books, including Basic Track & Field Biomechanics by Tom Ecker and The Mechanics of Athletics by Geoffrey Dyson, use an analytic approach

to explain why the implement behaves the way it does by demonstrating the principles of biomechanics using formulae, calculations and physics. Many journal articles written about the throws within the last ten years are quite scientific and discuss aerodynamic principles of the implements and the theoretical distances than can be attained based on ideal conditions. Some titles include "Optimum Release Angle in the Shot Put" by Nicholas P. Linthorne and "Release Parameters at the Foul Line and the Official Result in Javelin Throwing" by Viitasolo, Mononen and Norvapalo . These articles detail complex topics that are more useful to elite athletes and coaches and the biomechanics research community than to a novice athlete or coach.

The Encyclopedia of Track and Field mixes a reference-style discussion of the biomechanics with a brief history of the events, rules, and a recommended training schedule. Each chapter ends with biographies of the pioneers of the event and a list of world records. Teaching Progressions of the Shot Put, Discus and Javelin by Tony Naclerio, is one of the few books to break down the basic skills required to throw into drills that help the athlete gradually build from novice to advanced skill levels.

### 4.6 Photograph Sequences

Modern photography was invented in 1826 when Joseph Nicépce used chemicals to create a photographic image on a pewter plate (Fang 70). Photography was used in the mid 1800s to record history. Matthew Brady's photographs of the Civil War were important to American Culture because showed the public the reality of war (Fang 73). Today, photographs are the most common and least expensive method for capturing images.

There are several ways that photographs have been used in athletic training to illustrate athletic progression through techniques. Flip books place individual photos in a sequence and place them on separate pages. (See Figure 4.8.) The reader can rapidly flip the pages in order to see the motion in action or view each page individually to examine the position of the model at key points during the throw. These books also provide commentary on the errors made by the expert model.

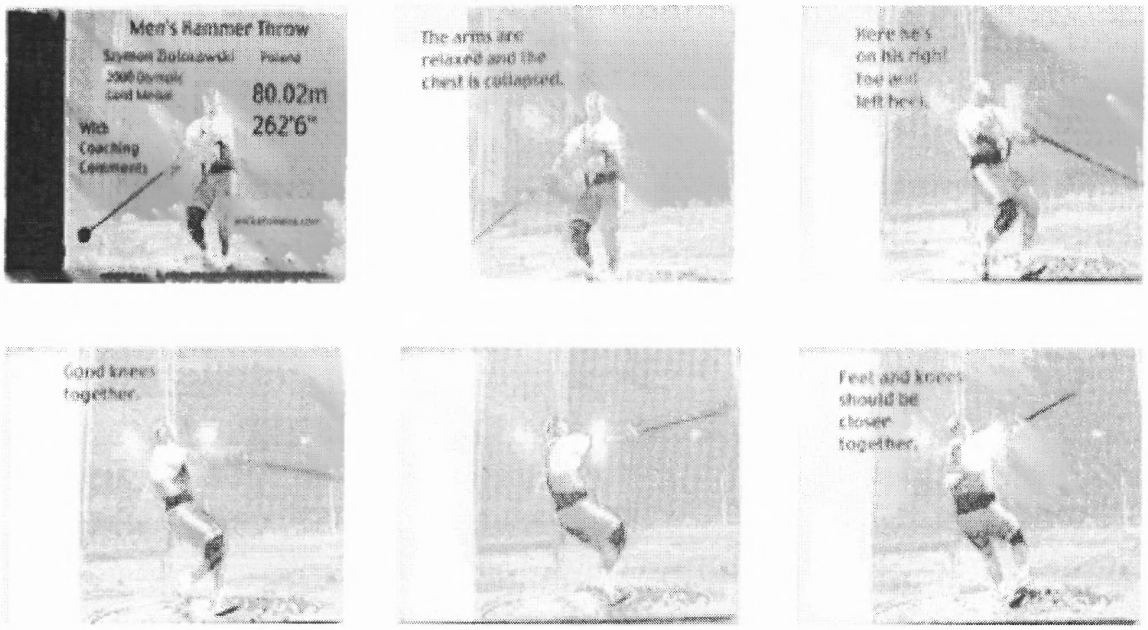



**Figure 4.8** Pages from a hammer throw flip book.
Source: Men's Hammer Throw (Burton, 2002).

Photography is used in several ways in instructional media. Still images show a throw by an actual athlete. The picture shows the position of the implement, as well as the body position of the thrower, at a particular stage in the throw. Photo sequences are often included in books to show the progression of a throw from start to finish. (See Figure 4.9.) In many cases, a record throw is used as the source for the photo sequence.

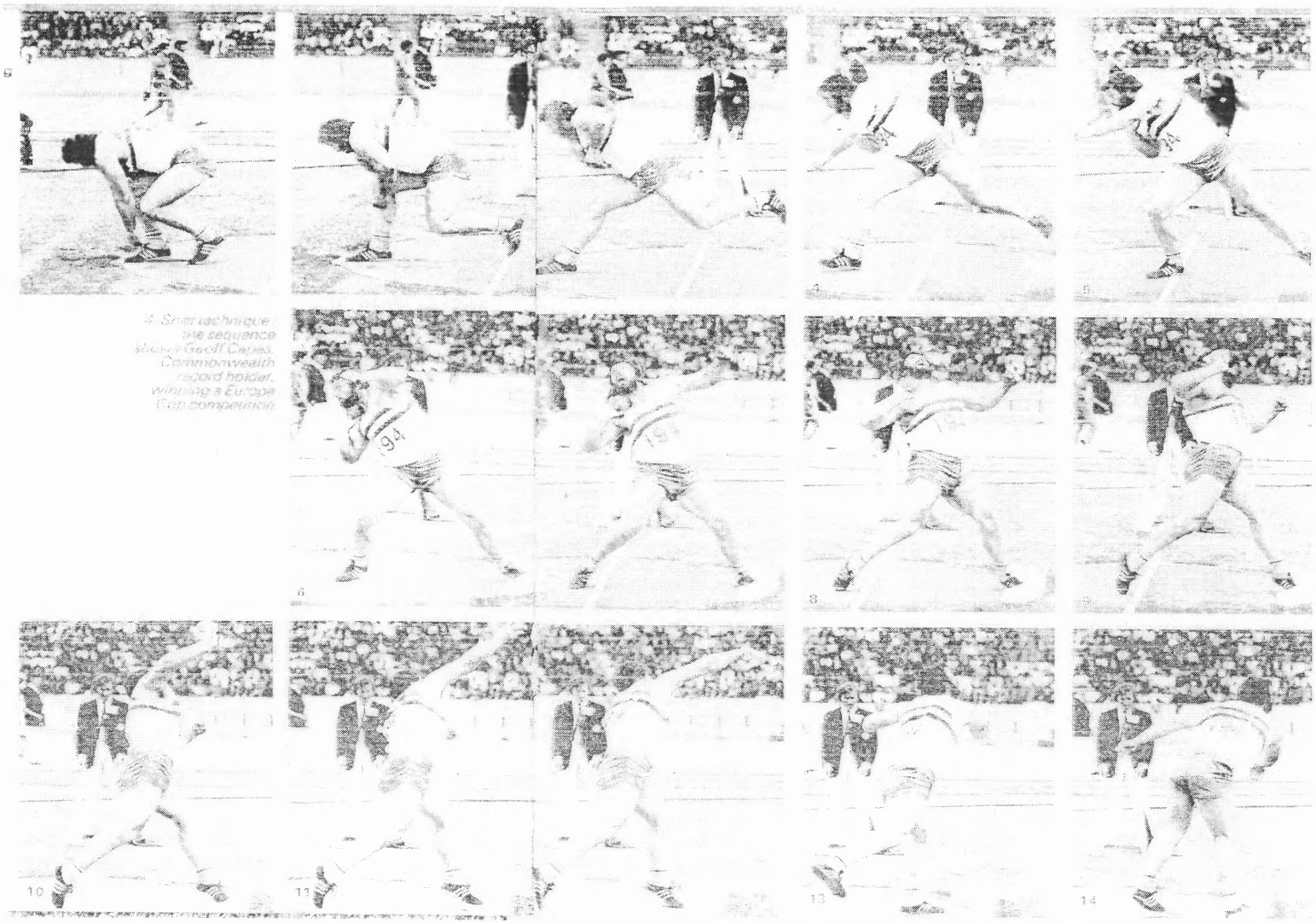



**Figure 4.9** Shot put photograph sequence of Geoff Capes.
Source: Howard Payne, Athletics: Throwing (London: Pelham, 1976) 16-17.

### 4.7 Television, Video and Computers

In 1923, Vladimir Zworykin gave a television system demonstration. He later led a team at RCA, which was assembled by David Sarnoff, that gradually improved on the design of the device . RCA unveiled television broadcasting to the public at the 1939 World's Fair (Fang 155-156). Ampex introduced the first commercially practical video recorder in 1956. In 1975, Sony introduced the Betamax format and JVC introduced the VHS (Video Home System) format for video recorders. Eventually, the VHS format became the standard for video recorders (Fang 177). Television and video have become an institution in American society and sports culture. In relation to track and field coaching, television is usually used in conjunction with videotape. There are many professionally produced videotapes made by coaching experts that demonstrate correct techniques. Several tapes incorporate the science and physics involved in the throw or show movement of the thrower or the implement independently. Coaches also record and analyze athletes' performance in competition or practice.

Cinematography is the study of human performance through the use of motion picture film (Northrip, Logan and McKinney 222). Basic cinematographic analysis does not involve mathematical calculations: the instructor or coach views the images and is able to determine areas that need improvement. Intermediate cinematographic analysis involves mathematic computations and is a precise method for evaluating aspects of the throw that cannot be calculated by sight alone, such as velocity and angles of release.

The use of film is beneficial for both novices and experienced throwers. When watching a film of an expert model, video allows the beginning thrower to understand the general idea of how to throw. The athlete can rewind and review the tape or film as

many times as is necessary. A more advanced thrower can compare his or her throw with the model on the video and stop the tape at various points to see optimal positions of arms, legs and torso, as well as the angle of release.

Video is also beneficial for reviewing competition or practice. The coach analyzes the athlete's performance and gives feedback as they both watch the video. The advantage of taping during competition is that the coach can compare the distance thrown with the technique to determine the most effective method for that athlete. This is better for advanced throwers who are able to understand and process detailed feedback and make adjustments in practice. Novice throwers can view their performance in relation to the model and use the mental practice technique to compare their overall performance with that of the model discussed earlier.

Coaches can enhance their skills by learning how to detect errors without using video, a technique that Northrip, Logan and McKinney describe as non-cinematographic analysis (222) and Naclerio calls "shutter eye" (personal interview). This ability takes time to develop because the coach has to look for patterns over time, not just errors in a few performances, that allows him or her to provide more immediate feedback on performance.

Dartfish, a Swiss software company, makes a product that allows coaches to transfer standard videos to their computers from a video camera, VCR, DVD player or television. Users can play up to four videos at once, use slow-motion, zoom and close-up modes, add lines and curves straight to the video, superimpose clips, add commentaries, titles and notes. The software also offers functionality that allows the coach to calculate the athlete's actual angle of release and body position during the throw (Dartfish).

### 4.8 The Internet and Web Pages

The internet, originally called ARPAnet, was designed by Larry Roberts in 1963 as a way to transfer messages safely. During the Cold War, the military funded research that would make messages difficult to intercept because they travel through unpredictable paths through a network of cities (Negroponte 234). Although the use of the internet has increased dramatically in the last decade, it has not yet become an effective coaching tool. The information on most web pages provides references to books, coaching clinics, and articles, but the internet as a direct tool for coaching at any skill level is not widely used.

Some web sites provide video demonstrations of throwing technique. However, these video clips are usually large in file size and slow to download over dialup internet connections. One example is the Hot Circle Coaching web site, which includes links to text articles, video clips and pictures of the discus throw. These resources could be useful to an experienced athlete or coach, but a novice thrower would have difficulty knowing where to begin. One disadvantage of hypertext and multimedia is that if the information is not organized intuitively, it is difficult to follow the logic and progress effectively through the web site.

An advantage of web pages as a coaching resource is that they are dynamic sources of current information if they are well-managed and kept up-to-date. Although books are widely available and have been the dominant source of coaching information, the information is static and must be updated and reprinted in order to remain current. It is easy and more cost-effective to update a web page than to publish a revised edition or a new book.

# CHAPTER 5

# MULTIMEDIA AND COACHING

All of the media discussed in Chapter 4 have advantages that should be considered in an effective multimedia tool. In this chapter, additional variables have been added to the list associated with effective coaching that was introduced in Chapter 2. In addition to technique, science, expert models and learning process, I have added the following variables that are associated with an effective coaching tool: interactivity, usability and cost. Each of these variables will be explained in Section 5.2.

## 5.1 A Brief History of Multimedia

The word multimedia simply means a combination of more than one medium used to communicate information. The Massachusetts Institute of Technology's Architecture Machine Group officially coined the term in 1976. The group, led by Nicholas Negroponte, used video and computer software to create a training tool for the military (Negroponte 66-67). However, the concept of multimedia began in 1945 with the publication of an article titled "As We May Think" by Dr. Vannevar Bush in the July edition of the Atlantic Monthly. Bush was president of the Carnegie Institution of Washington scientific research organization from 1939 to 1955. His article urges post World War II scientists to focus their efforts on managing the sum of human knowledge

instead of fighting. He predicted that men would be able to create tools that can provide near instant access to massive amounts of information in a variety of formats:

> *Consider a future device for individual use, which is a sort of mechanized private file and library. It needs a name, and to coin one at random, "memex" will do. A memex is a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory [. . .] All our steps in creating or absorbing material of the record proceed through one of the senses - the tactile when we touch keys, the oral when we speak or listen, the visual when we read. Is it not possible that some day the path may be established more directly? (Bush 106-107)*

Multimedia is a combination of new and traditional media and is not necessarily a computer program or internet application. "In a sense, it is a repackaging of the traditional elements of instruction [. . .] multimedia development is within the grasp of every educator who has access to a computer and desires to expand his or her repertoire of instructional strategies" (McKethan and Turner 25).

Technically, a book with illustrations or a poster with written descriptions can be considered multimedia because they combine writing with pictures. A well-developed multimedia tool is an effective solution for athletes at the novice, intermediate and advanced levels. A beginner can use this tool to learn the event and a more advanced athlete can use multimedia as a guide to improvement.

The use of information technology is important because it allows scientists to apply principles of motor learning to form the foundation for new tools and techniques that allow the athlete to receive immediate feedback:

> *When the athlete can compare internally the expected optimum performance with the actual movement outcome, the probability of learning increases [. . .] For general purposes of motor learning, the impact of basic external feedback and collateral technologies – from simple video movies to complex simulators – are of major importance and should be seriously considered in the normal practice scheme. (Lieberman,* et al. *767)*

Multimedia tools do not have to be complex but they should be used regularly in practice so athletes can learn how to use the tools more effectively as they build on existing knowledge.

### 5.2 Creating an Effective Tool

The following seven predictor variables are associated with an effective multimedia coaching tool for the throws: technique, science, expert models, learning process, interactivity, usability and cost. Figure 5.1 is built on the variables associated with effective coaching discussed in Chapter 2. These variables are important in a quality coaching program that can be applied to a multimedia product. Tony Naclerio, college and Olympic coach for the throws in 1996 and Mark Mirabelli, High School Coach and creator of the only Multimedia CDs for the throws, provide insight to this association as described below.

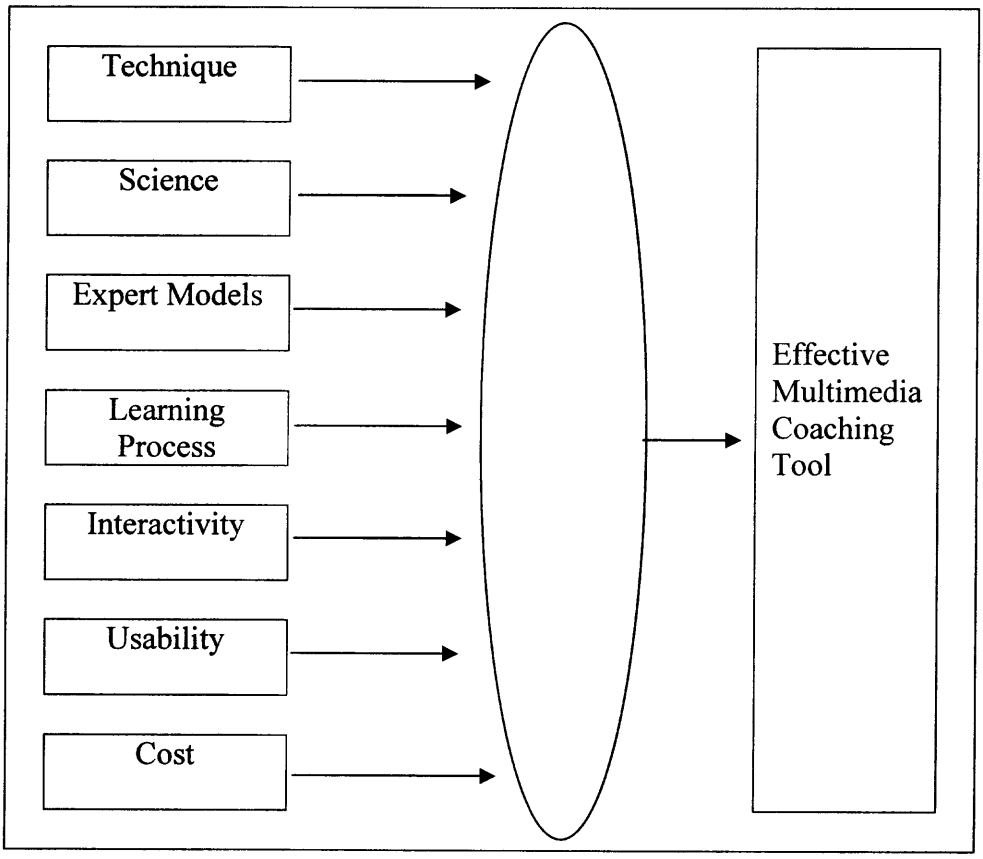



**Figure 5.1** Predictor variables associated with effective multimedia coaching tools.

### 5.2.1 Technique

The foundation for any athletic skill is the understanding of sound technique to achieve optimal results, farthest throw possible. Proper technique is also a major factor in the safety of the athletes and spectators. Size, strength and speed alone do not guarantee success in the throws. The forces exerted by the athlete in the process of the throw can cause serious injury to the arms, legs and especially the back if not properly managed. Spectators or officials can be injured if the implement is not released in the proper position, causing it to fly outside of the landing zone.

Many high school throwers either do not have a coach or their coach is not well versed in advanced and intermediate technique. Learning proper technique early in the athletic career is important to optimal performance as well as to maintain a safe throwing environment. Mirabelli created the multimedia CD series because he realized the lack of knowledge of high school coaches about the events. "They had no idea how to coach," (personal interview).

### 5.2.2 Science

The throwing events require complex interactions between the limbs and trunk of the body, the science of kinesis or biomechanics. The implement and the athlete are also affected by principles of physics. It is important that a coach understands the relationship between technique and science in order to minimize the physical limitations of the athletes and allow them to use their energy efficiently.

The coach and athlete should understand the effect of physics on the throwing events. However, it is not necessary to go into the details of physics and biomechanics. The coach should understand enough about the science of the throws to relate the principles to the events but need not be too specific. "I always use all of the laws of physics, but you don't want to break into science versus athleticism. But you have to show them that it's important to stay within the laws of physics" (Naclerio, personal interview).

### 5.2.3 Expert Models

Many videos and photo sequences use a personal-best or world-record-setting throw of an elite athlete as a model. Usually the throw is broken up into steps in which the best aspects of the throw are highlighted.

Using the performances of expert models is valuable to a limit. By watching a world-record or Olympic winning performance, athletes can get a good idea of the optimum throw. However, as Naclerio states, many of the elite athletes have strength levels that are unrealistic for high school and most college athletes to achieve. Some throwers can bench press and squat two to three times more weight than the average high school or college athlete and can compensate for mistakes in technique with their strength.

> *I was just looking at film from the Athens games of the women's shot. A lot of these girls were technically very unsound, but the ball was going 58, 59, 60 [feet]. And the commentator was saying that 'she is one of the stronger Russian girls and I understand she has a 400 lb bench.' So that will certainly negate some technique with a 9 lb ball. (personal interview)*

Both Naclerio and Mirabelli note that with a beginning or intermediate athlete the drills that allow the body to memorize the positions and movement help to build good technique. A student that does not have a good technical base is likely to focus too heavily on imitating the model instead of adjusting to his or her own abilities.

### 5.2.4 Learning Process

According to accepted theories of motor learning discussed in Chapter 3, there are different ways of instructing beginning and advanced athletes. However, visual aids are the most effective learning tools. The expert models mentioned above are good for showing the overall motion, but step-by-step instructions build the foundation for good technique and a solid understanding of the event.

Since coaches need to understand the events before they can teach their athletes, most coaching tools focus on the coach, but athletes can learn from them as well.

Mirabelli found that clinics for coaches are dull if only speakers talk for hours without any visual aids.(Mirabelli personal interview) The presentation of visual information is the most effective way to teach the throws. Students who do not have a coach could teach themselves how to throw by studying video and imitating the movements that they see. It is feasible because the actions are imitatable, but if watching the video is all that they are doing, then it is not adequate. Athletes should make contact with a coach either by attending camps or sending video of their performance to a coach for critique.

The most acclaimed books and videos show more than frame-by-frame analysis of throws from elite athletes. Drills and stretches develop speed, balance, flexibility and strength. Mirabelli's CD shows still shots with audio descriptions and video explaining how to perform the drills and stretches and why they are important in the training routine as shown in Figure 5.2 (Mirabelli Basic Javelin Throwing CD).

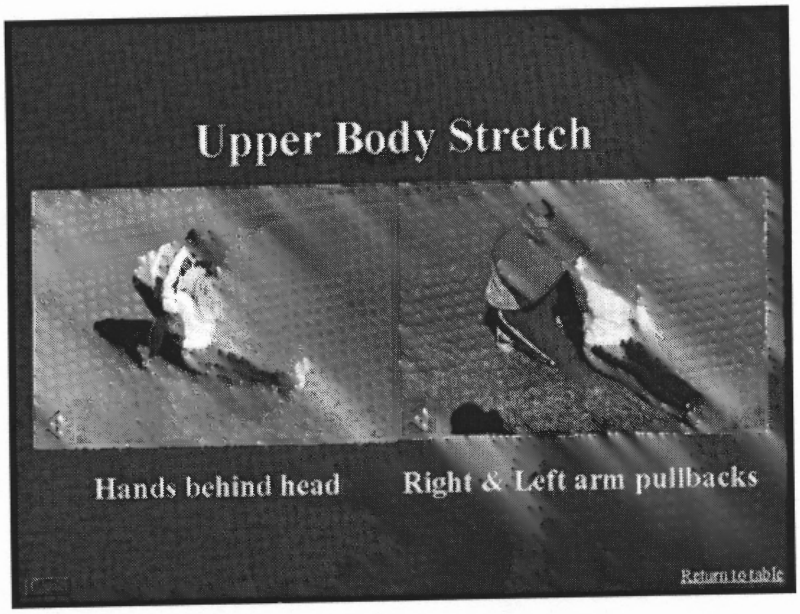



**Figure 5.2** Stretching demonstration with audio commentary.
Source: Mark Mirabelli, Basic Javelin Throwing (2003).

Figure 5.3 shows a slide from Basic Javelin Throwing that includes visual and verbal information to explain the final eight steps of the javelin throw. This technique is in line with Lawther's statement that a combination of words and pictures are effective for learners at all levels.

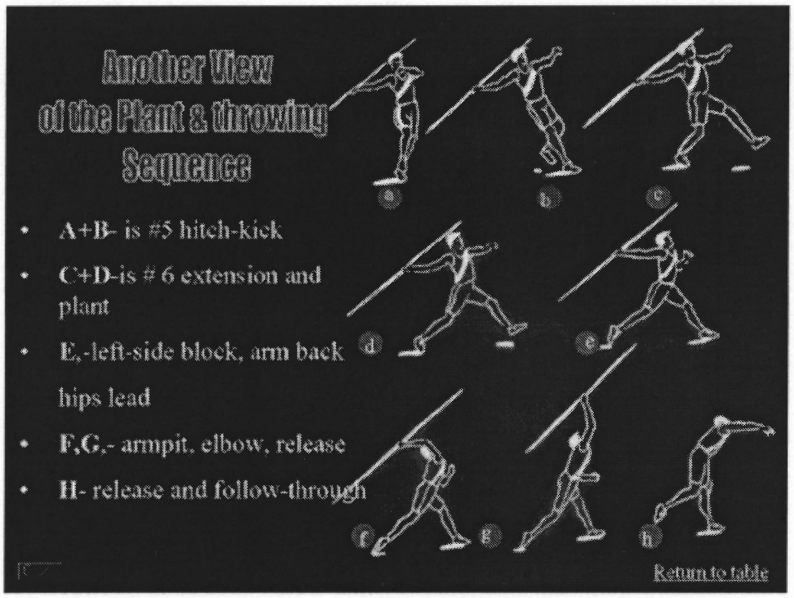



**Figure 5.3** Drawing sequence showing the final eight steps in the javelin throw.
Source: Mark Mirabelli, Basic Javelin Throwing (2003).

### 5.2.5 Interactivity

Motor learning theories state that feedback is an important aspect in the instruction of physical skills. While there is no replacement for a live coach, a good tool will allow the coach or self-taught athlete to reference relevant information. Users should be able to learn how to detect errors and use the tool to make adjustments in practice. Mirabelli's CD allows users to play back video and audio and navigate to information that they need to improve performance. Since the CD is a PowerPoint presentation, it does not offer much interactivity in this case.

### 5.2.6 Usability

Most people, even those with advanced computer skills, expect to have information presented as clearly as possible. Ease of navigation and clear presentation of information are important aspects of usability. Mirabelli's CD opens with instructions on how to use the product. Figure 5.4 shows the table of contents of the Basic Javelin Throwing CD. Each topic is represented by a hyperlink that will take the user directly to the material. Many people who use computers are familiar with PowerPoint software and this product does not require that the user perform complicated operations. The CD opens automatically so the user does not have to navigate their computer to find the file that starts the presentation.

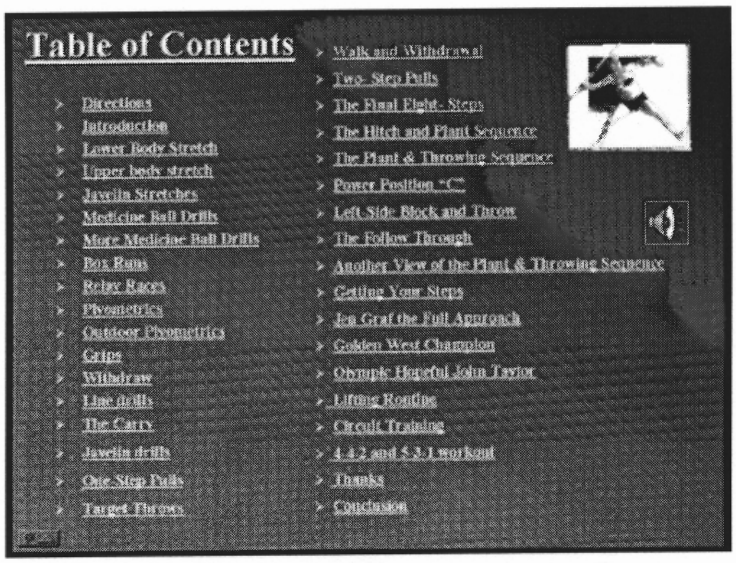



**Figure 5.4** Table of Contents from Basic Javelin Throwing.
Source: Mark Mirabelli, Basic Javelin Throwing , (2003).

### 5.2.7 Cost

In the United States, Track and field is considered a non-revenue sport and usually is not a top priority for athletic directors. The financial resources available for track teams are proportional to the amount of revenue that they bring into the school's athletic organization, so funding for training materials and equipment is limited. New technology must be cost-effective and compatible with the program's available resources. Most books, videos and the multimedia CD are in the similar price range. If prices are too high, the program will not pay, but if the cost is too low, people will think that the quality will be inferior to comparable media. Cost is also a concern for athletes that compete past their college years and are paying their own costs for training and competition.

## 5.3 Current Coaching Tools

The use of multimedia tools in the instruction of throwing events is at a similar level as the internet. One of the few multimedia tools currently available commercially, the Basic Javelin Throwing CD, was created by high school coach Mark Mirabelli. It combines video, written commentary and sound in a PowerPoint presentation on a CD. Products for the shot put and discus are also available.

Multimedia tools such as this are beneficial to novices as well as advanced throwers. Beginning athletes who do not have access to a coach are able to see and hear instructions, in a more effective format than books alone. An advanced athlete is able to navigate through the CD to find information specific to his or her needs. Multimedia CDs are a better option than web sites viewed over the internet for several reasons. The first is that many people still use their telephone lines to dialup to their internet service

instead of a high-speed connection such as DSL or cable modem. The potential for having large files for video and sound would make downloading information time-consuming. The second reason is that the CD is portable and can be used on a computer without an internet connection. A coach could use a laptop and a projector to instruct athletes on location or loan the CD to athletes to study at home.

# CHAPTER 6

# CONCLUSIONS

Of all the instructional media used in coaching the throwing events of track and field, multimedia tools such as CDs and DVDs have the greatest potential for growth and development. Traditional media, including books, have reached their potential for innovation and improvements in usability and interactivity. Multimedia tools are not a replacement for live coaching, but they are a good way to help coaches learn the event in order to properly instruct their athletes.

According to the theories of motor learning, it is clear that visual presentation of information is the most effective in instruction of physical skills. Videotape is the most effective way to show the entire throwing action. In recent years, the technology for including video clips in CDs and DVDs via computer has greatly advanced. The number of personal computers in homes and schools has increased as the prices have gone down.

Multimedia instruction tools combine the advantages of different instructional methods to provide the best solution to the coach and athlete. According to experienced coaches, the more visual the medium is, the more effective it is, especially on the high-school level and for novice coaches.

DVDs are becoming popular for data storage because they have more storage space than CDs: Mark Mirabelli states that in the next version of his tool, he will use DVDs because he will be able to store more video clips (personal interview). Currently, the capacity for a DVD is between 4.7 GB and 17 GB, many times more than the 700MB

available on CDs. Based on the variables introduced in Chapter 5 – technique, science, expert models, learning process, interactivity, usability and cost – I have made the following recommendations for future multimedia coaching tools.

**Technique:** Positions and common errors should be emphasized to help guide novice coaches. *Flash* software allows the developer to place text, images and arrows over the video. This will help the coach develop the ability to quickly detect mistakes during a live throw without having to refer to a video tape of the athlete's performance.

The inclusion of drills and weight training routines, such as those included in Mirabelli's CD and Naclerio's Teaching Progressions of the Shot Put, Discus & Javelin, are important in building the strength and agility required to execute the proper technique. These elements should also be included in a multimedia CD.

If the CD will be used as a reference as well as a coaching tool, it should also include rules of each event, legal sizes and weights of the implements and safety considerations. The United States of America Track and Field Organization (USATF) publishes rules of the sport each year that could be included as a PDF file in a reference section or the CD could have links to the USATF web site.

**Science:** Although it is important to teach the relationship between science and athletics, it is not necessary to overwhelm the user with technical information. The scientific information could be included in a reference section with basic discussions about forces and aerodynamics as they relate to the throwing events. This information can be presented graphically with diagrams and short animations. This section could also discuss the adjustments that tall and short, heavy and light and left-handed athletes need to make in order to be successful.

**Expert Models:** Expert models show the overall motion of the throws, but should be used sparingly. The world-class athletes are often several times stronger than the average high school or college athlete due to much more intense workouts and access to performance-enhancing substances, legal and illegal. These athletes can make mistakes that they overcome with pure strength.

Experts should be used to show the overall motion and the positive aspects of the athlete's technique. The product should also point out the errors in the throw, as the flip books note (Men's Hammer Throw). The users of the product should be encouraged to study the technique and drills instead of simply imitating the models.

**Learning Process:** The product should match the motor learning studies which show that people learn physical skills more effectively when there is some type of visual demonstration. The developer of the ideal multimedia coaching tool should take learning theory research into consideration.

Information about the throws should be clearly organized in ascending order of complexity so that advanced throwers can quickly browse the contents and go to the topic that they need. Teaching Progressions takes the reader through the development of skills through drills and conditioning exercises (Naclerio, Teaching Progressions). A multimedia coaching tool should also organize the information as a series of progressive lessons. This structure allows novice coaches to manage the lessons so they can stay as many steps ahead of their athletes as necessary as they build their own knowledge of the sport. Quizzes can test whether the user understands the topic or if further review is needed.

**Interactivity:** Advanced and novice coaches and athletes have different needs and need to focus on different areas. The multimedia product could indicate which topics are focused more for the early stages of learning. The advanced users could browse these topics and use them as a reference.

Interactivity includes quizzes and tests that can be created through the Flash software. Developers could incorporate tests that measure understanding of technique and safety measures. Athletes could also have their performances taped and transferred to a DVD or CD where they can analyze their technique.

Within the new multimedia teaching tool would be hyperlinks that take users to websites such as the USA Track and Field or International Amateur Athletic Foundation, where there are additional resources, such as track meet schedules, training research and development plans for the sport.

If the user is an athlete without a coach, the product should include notify the user that these tools are not a substitution for interaction with a coach. Information about how to find coaching clinics or camps in the area and recommendations about how to approach a local coach should also be available.

**Usability:** Usability is important for people who are apprehensive about computers. Developers should not assume that the user has knowledge of the material or advanced computer skills, but should not insult advanced users. The organization of material is important to the usability of the product. Topics should be organized into chapters and sections similar to books. Ease of navigation through the CD is important and should be intuitive. There should also be a help section for those who need

assistance using the product. The addition of an index or search feature would be beneficial to users as well.

Mirabelli's CD uses video that is embedded in a PowerPoint presentation. The instructions for video playback are located in the first slide of the presentation. To start the video, the user clicks on the frame containing the video object. To stop or pause, the user clicks on the video again. There are no playback controls for the audio. A developer can improve usability and interactivity by placing easily recognized playback buttons wherever video and audio are present.

Currently, Mirabelli's instructional CD is available only on the Windows platform because it uses Microsoft PowerPoint software for Windows. The use of software tools including Macromedia Flash, Java and HTML, allows for cross-platform compatibility.

**Cost:** Pricing of the product should be in line with existing books and CDs. However, the developer must take the cost of production into consideration. The cost of a blank CD is less than 20 cents and the cost of a blank DVD is less than one dollar. Although the cost of the media is low, the time of the developers and producers is high. The hourly rate for Flash developers can reach over $100 per hour depending on the skill level of the developer and complexity of the project. A video camera and editing software are also needed for integration into the product.

Such are the present recommendations. The next level of multimedia instruction is the evaluation of actual performance via video recording and computer analysis. The MultiMedia Analysis of Sport Skills (MASS) program combines text, video, images and analysis of performance. This tool would allow users to view a skill being performed via video and still images. Written detailed descriptions of the skills are also available. It

also includes a test window which rates the student's learning of the skill and provides immediate feedback.

One of the recent developments in the world of computer-aided sports analysis is a project conducted by Dr. George K. Hung of the Rutgers University Biomedical Engineering department. He has created a computer system that monitors hand and eye movements of golf putting which could be applied to the throwing events in track and field as well as other sports where there is a complex relationship between positions of limbs. He states that golf instructors and professionals teach that there should be little or no eye and head movement during the putting action. "Head position is also important because it allows for maintenance of stability of the visual environment. If the head moves during the stroke, this can lead to misalignment and a missed putt" (Hung 76).

In the throwing events, head position is also important. The example of Dr. Hung's research is relevant to this topic because although the golf swing is not identical to the hammer throw, for example, there are certain aspects that are relevant. In the hammer throw, it is important that the athlete's back remain straight, especially in the initial stages of the throw, to ensure the proper balance as well as limb position. If the head moves out of ideal position, the spine and limbs will follow (and vice versa).

The eye and head movement monitor could be used in the throws to determine if the athlete is beginning the motion of the throw properly. Errors at the start of the throw will perpetuate during the entire action. Hammer throwers can make between two and four rotations depending on their ability. Incorrect technique at the start of the motion will carry through a possible four rotations and put the athlete off balance. Such poor technique is particularly dangerous in this event: Of all of the throwing events, the

hammer travels at the highest speed and has the greatest potential for injury to the athlete and bystander. This apparatus can be an effective tool for teaching beginning and intermediate throwers about the interaction and relationship between head position and proper technique.

Virtual reality is also a possibility for future instructional tools. It has been used as a tool in athletics training since the 1970s, but has not yet been applied to multimedia tools for the throws. Many of the products available in virtual reality apply to a computer-generated simulation that replicates an outdoor environment. For example, Fitcentric offers products for fitness clubs that allows patrons who use exercise bicycles to view a virtual riding course complete with hills that correspond to an increase or decrease in resistance based on the incline of the hill. These programs provide an illusory escape from the gym environment rather than offer feedback to athletic performance (Fitcentric).

Biomedical and biomechanics research is used not only to improve performance, but to identify common causes and potential prevention of injuries. Modern scientists use principles of physics, kinetics, and mathematics to analyze sports techniques. Since the 1970s, researchers have used mathematical analyses to study athlete performance.

There is much opportunity for technical communicators to develop multimedia instructional tools for track and field throwing events. Not many coaches or companies are creating teaching tools or combining video with other media online or on CD. Those who have experience with the latest software tools – and who are good at organizing information – can create effective teaching tools in track and field instruction.

## APPENDIX: SEMI-STRUCTURED INTERVIEW QUESTIONS

The following pages list the interview questions relating to the variables associated with effective coaching and multimedia tools.

Tony Naclerio, 1996 Olympic Coach for the throws and Assistant Coach at Rutgers University.

| | |
|---|---|
| Technique | How is technique associated with safety for the athlete and spectator?<br>Do you find that many coaches have difficulty understanding and teaching advanced technique? |
| Science | How important is the understanding of the physics and science (1) for the coach and (2) for the athlete?<br>What are some of the physical limitations that athletes need to overcome in each of the throwing events? How can technique help offset these limitations? |
| Expert Models | How important are expert models and examples?<br>Are there disadvantages to depending heavily on videos of experts performances? |
| Learning Process | What are the differences between instructing beginning and advanced athletes?<br>What aspects of good coaching are missing from most books and videos that would be a good fit for a multimedia CD?<br>Do you see the use of CDs as a reference tool or a primary coaching tool?<br>How likely is it that athletes can teach themselves how to throw using books, video and multimedia? Why or why not? |
| Interactivity | How important is interactivity and feedback in the coaching process? |
| Usability | Are most coaching tools focused more towards teaching the coach or teaching the athlete?<br>How user-friendly are the current coaching tools? Can the usability be improved? |
| Cost | How does cost influence the use of coaching tools? |

Mark Mirabelli, High School Coach and Creator of the Javelin, Shot Put and Discus CDs.

| | |
|---|---|
| Usability | What feedback have you received from the CDs? |
| Cost | How does cost influence the use of coaching tools? |
| Learning Process | Are there any other coaches or companies that you are aware of that have created multimedia coaching tools? |
| | Why did you decide to create a multimedia CD? |
| | What aspects of good coaching are missing from most books and videos that would be a good fit for a multimedia CD? |
| | What, if anything would you change about the CDs? |
| | How likely is it that athletes can teach themselves how to throw using books, video and multimedia? Why or why not? |
| Interactivity | How important is interactivity and feedback in the coaching process? |

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