Excerpts

Apply biomechanics to improve techniques

This is an excerpt from Biomechanics of Sport and Exercise With Web Resource and MaxTRAQ 2D Educational Software Access, Third Edition by Peter McGinnis.

Technique Improvement

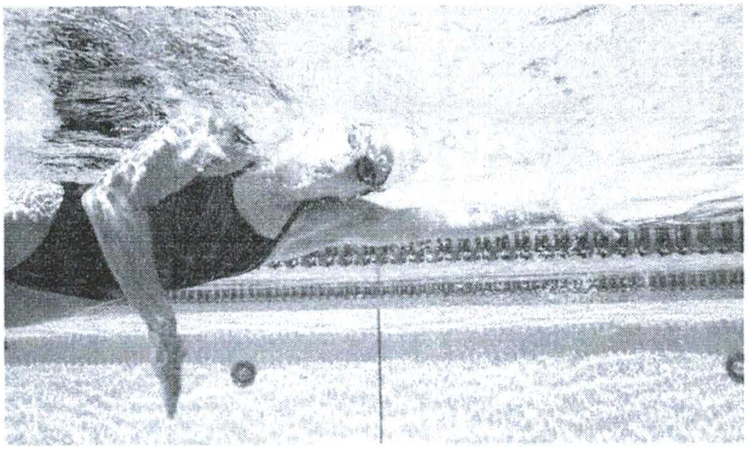
The most common method for improving performance in many sports is to improve an athlete's technique. This is highlighted here as one motivation for studying biomechanics, and it is probably what you thought of when asked how a biomechanist goes about trying to improve an athlete's performance.

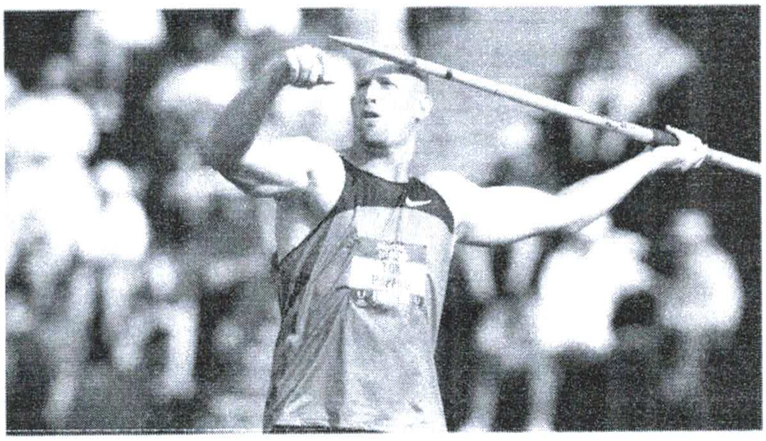
The application of biomechanics to improve technique may occur in two ways: Teachers and coaches may use their knowledge of mechanics to correct actions of a student or athlete in order to improve the execution of a skill, or a biomechanics researcher may discover a new and more effective technique for performing a sport skill. In the first instance, teachers and coaches use qualitative biomechanical analysis methods in their everyday teaching and coaching to effect changes in technique. In the second instance, a biomechanics researcher uses quantitative biomechanical analysis methods to discover new techniques, which then must be communicated to the teachers and coaches who will implement them.

Let's look at a simple example of the first case. As a coach, suppose you observe that your gymnast is having difficulty completing a double somersault in the floor exercise. You might suggest three things to the gymnast to help her successfully complete the stunt: (1) jump higher, (2) tuck tighter, and (3) swing her arms more vigorously before takeoff. These suggestions may all result in improved performance and are based on biomechanical principles. Jumping higher will give the gymnast more time in the air to complete the somersault. Tucking tighter will cause the gymnast to rotate faster due to conservation of angular momentum. Swinging the arms more vigorously before takeoff will generate more angular momentum, thus also causing the gymnast to rotate faster. In general, this is the most common type of situation in which biomechanics has an effect on the outcome of a skill. Coaches and teachers use biomechanics to determine what actions may improve performance.

The second general situation in which biomechanics contributes to improved performance through improved technique occurs when biomechanics researchers develop new and more effective techniques. Despite the common belief that new and revolutionary techniques are regularly developed by biomechanists, such developments are rare. Perhaps the reason is that biomechanics as a discipline is a relatively new science. The much more common outcome of biomechanics research is the discovery of small refinements in technique. One example of biomechanics research that did greatly affect the technique and performances in a sport occurred in swimming in the late '60s and early '70s. Research done by Ronald Brown and James "Doc" Counsilman (1971) indicated that the lift forces acting on the hand as it moved through the water were much more important in propelling a swimmer through the water than previously thought. This research indicated that rather than pulling the hand in a straight line backward through the water to produce a propulsive drag force, the swimmer should move the hand back and forth in a sweeping action as it is pulled backward to produce propulsive lift forces as well as propulsive drag forces (see figure I.2). This technique is now taught by swimming teachers and coaches throughout the world.

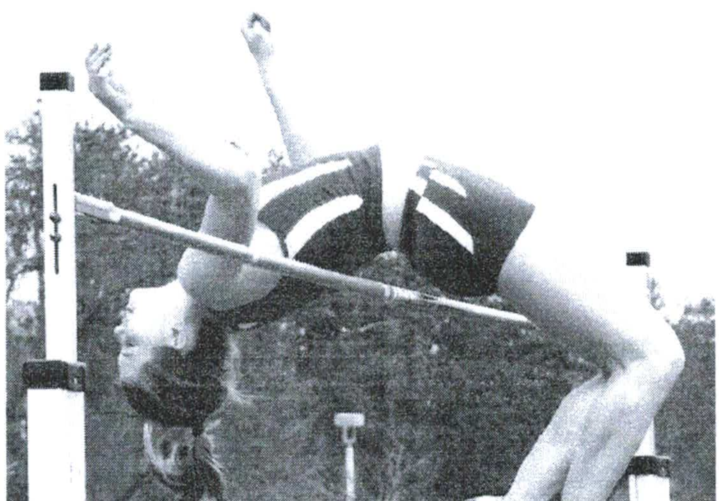
Other examples of sports in which dramatic changes in technique produced dramatic improvement in performance include javelin throwing, high jumping, and cross-country skiing. In 1956, before the Summer Olympic Games in Melbourne, Felix Erasquin, a 48-year-old retired discus thrower from the Basque region of Spain, experimented with an unconventional way of throwing the javelin. Erasquin had experience in barra vasca, a traditional Basque sport that involved throwing an iron bar called a palanka. A turn was used to throw the palanka, and Erasquin incorporated this turn in his innovative javelin throwing technique. Rather than throwing using the conventional technique—over the shoulder with one hand from a run—Erasquin held the javelin with his right hand just behind the grip. The tip of the javelin pointed down to his right, and the tail was behind his back and pointed upward. During the run-up, Erasquin spun around like a discus thrower and slung the javelin from his right hand, which guided the implement. To reduce the frictional forces acting on the javelin as it slid through his hand, it had been dunked in soapy water to make it slippery. The outstanding results achieved by Erasquin and others with this technique attracted international attention. Several throwers using this "revolutionary" technique recorded throws that were more than 10 m beyond the existing javelin world record. Officials at the International Amateur Athletic Federation (IAAF), the governing body for track and field, became so alarmed that they altered the rules for the event, and this unconventional technique became illegal (see figure I.3). None of the records set with the Spanish technique were recognized as official world records.





In 1968, most world-class high jumpers used the straddle technique (figure I.4a). But at the Olympics in Mexico City, the gold medalist in the high jump used a technique few had ever seen. Dick Fosbury, an American from Oregon State University, used a back layout technique to jump 7 ft 4 1/4 in. (2.24 m). The technique became known as the Fosbury Flop (figure I.4b). Its advantages over the straddle technique were its faster approach run and its ease of learning. No biomechanics researcher had developed this technique. Fosbury achieved success with it in high school and continued using and jumping higher with it despite its dramatic differences from the conventional straddle technique. His successes led others to adopt it, and now all world-class high jumpers use the Fosbury Flop.

a



b

In the late '70s, Bill Koch, an American cross-country skier, began experimenting with a new skating technique he had observed marathon skiers using in Europe. The technique he experimented with was much different from the traditional diagonal stride skiing technique in which cross-country skiers moved their skis parallel to each other in set tracks. In the 1976 Olympic Games in Innsbruck, Austria, Koch surprised the world by winning a silver medal in the 30K cross-country skiing event. More surprising were his performances in the 1982 to 1983 season, when he became the first American ever to win the World Cup. Koch used the skating technique in achieving this title. By the mid-1980s, the skating technique was used by virtually all elite Nordic ski racers. Beginning with the 1992 Winter Olympics, there were separate competitions for traditional (diagonal stride) and freestyle (skating) cross-country skiing.

With the exception of the swimming example, these examples of new and dramatically different techniques leading to improved performances all happened without the apparent assistance of biomechanics. Maybe this is evidence of the skill of teachers, coaches, and athletes. Through repeated observation, trial and error, and possibly some application of mechanical principles, they have successfully developed excellent techniques for performing skills in most sports without the assistance of biomechanical researchers. But perhaps these improved techniques would have been developed sooner if more teachers and coaches had a working knowledge of biomechanics.

Read more from *Biomechanics of Sport and Exercise With Web Resource and MaxTRAQ 2D Educational Software Access, Third Edition* by Peter McGinnis.