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Biomechanical assessment of athletic performance

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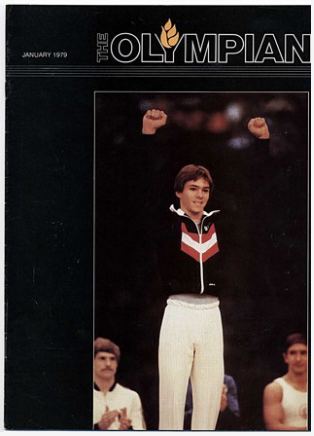

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The article "Performance profile of woman runner. Biomechanical assessment of athletic performance" by Gideon Ariel and Irving Dardik, discusses the use of technology and biomechanics in enhancing athletic performance. The authors highlight the importance of computers in analyzing complex sports techniques, surpassing the limits of human observation and intuition. However, they emphasize that human judgment, particularly from coaches, remains crucial. The article also discusses the use of high-speed cinematography and computer analysis to study the physics and mechanical engineering principles of body movements during sports. The authors point out that the application of science to athletic performance has led to countries with smaller populations, like Eastern Europe and Cuba, dominating certain sports. The article concludes by discussing the establishment of the U.S. Olympic Sports Medicine Committee in 1977 and its role in using biomechanics to improve the performance of U.S. Olympic teams. The sports analyzed in the study include long-distance and sprint running, kayaking, weightlifting, and diving.

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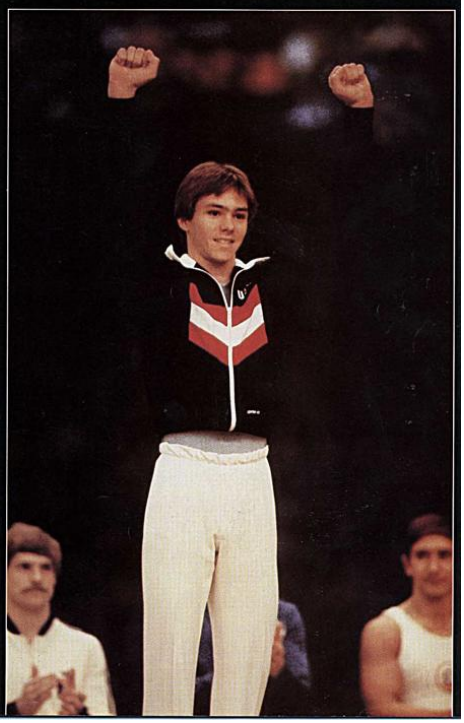
Below find a reprint of the 3 relevant pages of the article "Biomechanical assessment of athletic performance" in "The Olympian":

JANUARY 1979

THE OLYMPIAN



SPORTS MEDICINE

Biomechanical assessment of athletic performance

by Gideon Ariel, Ph.D. Chairman, Division of Biomechanics and Computer Sciences, United States Olympic Sports Medicine Committee and Irving Dardik, M.D., F.A.C.S., Chairman, United States Olympic Sports Medicine Committee

(The first of two parts)

Introduction

All aspects of society are greatly affected by increasingly rapid advancements in science and technology. Computers have become indispensable in finance, industry and government, providing precise analyses of complex problems that would otherwise require enormous expenditures of time and energy to solve. The strength of these electronic wizards is in their ability to follow instructions exactly, remember everything and perform calculations in thousandths of a second. With increasing international interest in competitive athletics, recreation and fitness, it was inevitable that computers would be used for the analysis of sports techniques.

They allow us to surpass the limits of what the human eye can see and intuition deduce. Human judgment however, is still critically important. As in business and industry, where decisions are based ultimately upon an executive's experience and interpretive ability, the coach is and will continue to be the ultimate decision-maker in athletic training. The computer should be regarded as a tool, however complex, which must be skillfully used by people in order to achieve a desired end.

Biomechanical analysis generally begins with high speed cinematography which allows careful scrutiny of even the fastest of human movements. The films are traced and resulting data stored in a computer which analyzes the workings of the body according to the principles of physics and mechanical engineering. Tables and graphs are generated which give a precise profile of what actually occurs during the execution of a skill. The researcher then carefully examines this output in order to determine which patterns are most important in distinguishing championship performances.

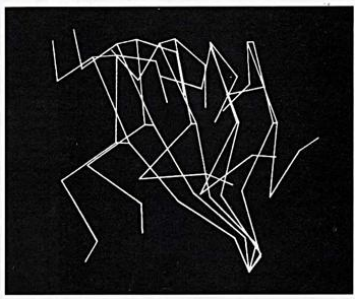
The success of East Germany in the last Olympic Games made very clear what organized effort could accomplish by pooling national resources to achieve athletic excellence. With victory in international sports competition as a national priority, the best young talent was methodically sought out and facilities making intensive training possible made available to them. Science was recruited and extensively employed in the development and improvement of training techniques, with many people engaged in sports research at Institutes.

The establishment of Olympic Training Centers in the United States shows an acknowledgement that winning will not result only from the dedication of individual athletes. A national effort is needed. The national resources exist — talented young athletes, dedicated coaches, brainpower, technology and monetary wealth. The welding of these into a unified program can only lead to success.

Biomechanics is a science still in its adolescence, with many discoveries yet to be made. Hand analysis of high speed films is a slow and tedious process, and it is only recently that the computer has been harnessed to make the process more efficient, thereby expanding its practicality. Development of this technology in the United States has meant that many complex analyses can be executed in a relatively short time.

In the past, athletic achievement depended mainly on the individual's talent although skill was often enhanced or ruined by existing facilities and equipment. Athletes with superior genetic compositions who successfully interacted with the available facilities dominated the list of world records. Continual improvement of equipment and techniques have complimented raw talent. However, with the advent of new measurement tools and knowledge in the field of sport sciences, athletic achievement has attained a new dimension. Countries such as those of Eastern Europe and Cuba, which have relatively small populations, have achieved a spectacular level of success in some athletic events which had previously been dominated by the Western world and current evidence suggests the likelihood of this trend continuing into the 1980's.

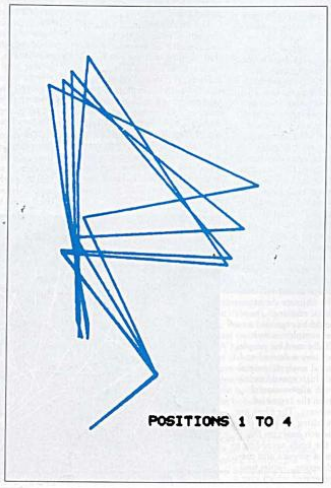
Such domination stems, in part, from the application of science to the realm of athletic performance. Modern coaches utilize physiological, biomechanical, psychological and nutritional means to optimize the human body in various



Performance profile of woman runner.

events. Since the human body obeys the same physical laws as all other earthly objects, the laws of motion govern its performance. In order to throw, run, or jump, physical laws must be obeyed. It is impossible to throw the shot 66 feet if the shot velocity and the angle of release do not attain certain values. These values do not differ for different athletes since for each particular shot velocity there is one specific optimal angle. For the jumper to leap 26 feet, it is necessary to produce certain forces on the ground in order to propel the body with a specific reaction force at a particular angle. This force is unique, and it is impossible to cover the same distance with only a fraction of the force since gravitational forces act uniformly regardless of the jumper. The concept to be emphasized is that all bodies, athletes, implements, or machines are affected by and must adhere to the laws of motion.

The science which deals with motion of the body and the forces produced is the field of biomechanics. During 1977 the United States Olympic Committee established the U.S. Olympic Sports Medicine Committee. The purpose of the present paper is to report some of the results obtained by the Biomechanical Subcommittee of the United States Olympic Sports Medicine Committee for use as a base line in future development of the United States Olympic teams.



Performance profile of 145kg snatch.

Method

The biomechanical research relied primarily on data obtained from high speed cinematography, force platforms, and specialized transducers for measuring body motion and forces. The analysis of the data consisted of kinematic data including a description of the motion in terms of displacement, velocities, and acceleration of body segments and kinetic data consisting of the measurement of forces, moments of force, and center of gravity analysis. The specific analytic method is described elsewhere.

Data acquisition at the U.S. Olympic Training Centers at Squaw Valley and Colorado Springs was guided by questions posed by coaches and athletes of various sport groups. The analyses varied depending upon both the particular sport and the guidance sought by the participants. In some cases the data was collected during National and International competitions rather than at the training sites to afford evaluation of the sport's superior competitors. Numerous findings resulted from these studies, however, the reporting of all the information exceeds the scope of this paper and it will, therefore, be restricted to only general information concerning the selected sports analyzed. The sports analyzed included:

1. Long distance and sprint running
2. Kayak
3. Weightlifting
4. Diving

To be continued in next issue