MATCHING TECHNOLOGY TO COACHING NEEDS

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How can a coach accurately diagnose an athlete's faults and adapt skill techniques to take advantage of changing rules or improved equipment? How can a coach help athletes choose safe equipment for use on the field, court, or other sport environment? The answer, the coach must rely upon the principles and methods of biomechanics. When technique plays a major role in the success of the skill, the less a coach can afford to ignore the principles of biomechanics. The biomechanist is concerned. with generating, synthesizing, and organizing data related to sport with an experimental approach. Biomechanists use sophisticated and often very expensive instrumentation to produce this quantitative data. The coach uses the naked eye to provide a qualitative description of a particular sport movement. Both the biomechanist and coach seek to improve performance and reduce chance of injury for the athlete. Excellent research on sport technique is published in refereed journals but not modified to assist the coach in its interpretation. Technique errors in the coaching literature indicate a need to disseminate the research data in a format in which the coach may use to help the athlete. Greater emphasis must be placed on direct application of research results if improvements in an athlete's technique are to be maximized. How can this be achieved?

WORKING TOGETHER

If the biomechanist and coach are going to communicate for the benefit of the performer, a number of concerns must be addressed. First, the biomechanist must be willing to translate the acquired research findings into appropriate terminology for the coach to understand. The biomechanist must become a partner with the coach to help identify flaws in performance and recommend solutions. Miller (1993) suggested the use of computer analysis packages to assist the coach in understanding the basic principles of biomechanics with direct application to a specific sport. Elliott (1989) proposed a model for the teaching of racquet skills based on a biomechanical approach. The model proposed was based on solid experimental research and presented with practical applications.

Secondly, the coach must be willing to learn new and more effective ways for producing successful results. The coach, who understands both basic biomechanics and can analyze movement will be able to better communicate with the biomechanist and athlete. Stothart (1980) reported that 9 out of 10 coaches were seriously deficient in biomechanics knowledge but the coaches recognized that biomechanics had a large role to play in their capacity as a coach. Some coaches felt that application of biomechanics knowledge was a must to good coaching. Lees (1992) proposed a systematic approach of three different models to be used during the research process of the biomechanist which could then be incorporated with the coach and athlete.

Lastly, all parties concerned must use this acquired knowledge for the benefit of the athlete. The biomechanist and coach agree on the importance of understanding the biomechanical principles which underlie performance. The problem lies in how this knowledge is understood and disseminated. The biomechanist may suggest an area to research (Tant, Greene, & Bernhart, 1993); the coach may have requested the information (Greene & Tant, 1992); or a specific underlying mechanism may be\ investigated (Tant, Browder, & Wilkerson, 1991).

For this information to reach the athlete a system of knowledge acquisition, analysis procedures, and communication procedures must be employed.

THE COMPUTER AGE

"The sport research techniques of today will be the practical coaching techniques of tomorrow" (Fraser & Danielson, 1980, 35). Can computers assist the coach during the teaching process of skill technique? Should a high speed video camera and portable VCR be available for every coach to use during a practice and/or game? The answer is yes. Fraser and Danielson identified the computer as the number one coaching tool of the eighties, yet we have made few strides toward integrating this technology on the field or court.

The computer is a versatile tool which could be used to obtain, understand and manage information. In the process of obtaining information, a practical application involves the use of small heart rate monitors to provide coaches and performers with the assessment of physiological responses to training. The development of computerized weight training equipment that can test and record progress and provide immediate feedback to the athlete and coach should lead to improved performances. Immediate and detailed movement analysis can be obtained by a video camera, VCR. and computer system designed to provide feedback to the coach and athlete within hours, instead of days, or even weeks.

Computer technology is increasing the sophistication of both research tools and coaching tools resulting in information overload.

Understanding the obtained information is equally important for both the biomechanist and coach. Computer-assisted instruction (CAI) or computer assisted learning (CAL) is available in a number of formats. Walton and Kane (1979) developed an interactive computer graphics package for use by the gymnastic and diving coaches at Stanford University. Both coaches participated in testing the package under different skill applications and realized that interactive graphics could help them. The mathematicians commented on a need for an intermediary who understands both the technical aspects of the model and the terminology of the coach. Why must another discipline recognize this fact? Aren't we, as biomechanists, that intermediary between theory and practice? Casolo and Zappa (1992) developed a sport biomechanics simulation system oriented toward teaching and coaching. The performance of certain movements and the affect on whole body motion could be displayed graphically for the learner. Biomechanists must then assume the responsibility for providing instructional modules with analysis packages to assist the coach in understanding the mechanics of specific movements.

Once the information is obtained and understood it is imperative that it is managed within the sport setting. Testing, training, and performance information must be managed through the use of databases. Pataki (1988) described the United States Olympic Training Management System as a cooperative effort between sport scientists, coaches and athletes. A computerized network was being developed, with help from many experts, to determine the correct training model for peaking at the appropriate time for maximum performance of an athlete. The teams in the National Football League, National Basketball Association, and Major League Baseball make use of analysis systems and management systems to study and keep statistics on each team.

Computers can be programmed to the individual coach, player, team, and/or researcher's needs. The use of computer technology and analysis procedures will enhance the performance of the athlete. Every coach should realize the importance and advantages of increased knowledge about computer technology and how this technology will assist in the improvement of sport performance.

The use of this technology is also important in the design of equipment to assist in an athlete's motion and/or decrease the chance for injury.

EQUIPMENT DESIGN

Research studies in the areas of rowing. golf and swimming indicate the role biomechanics research has played in the development of equipment and application to the coaching environment. Klavora (1979) discussed the development of the Environmental Data Acquisition System (EDAS) stroke analyzer by two Norwegian engineers, Moetsue and Pope. The EDAS system consisted of: a) special oarlocks equipped with pressure sensors and goniometers; b) accelerometer and data recorder placed inside the boat; and c) a mini computer, monitor, and printer. Data from this equipment and video recordings would provide a good base for analysis of a crew. Ten years later, Smith and Spinks (1989) developed an on-water data collection system to provide immediate feedback to the coach to determine flaws in force production of the rower. The new technology of force transducers, signal conditioners, telemetry equipment, a laptop computer, and video were used to simultaneously collect oar force, angle and velocity data for two rowers. The results were then presented graphically to the coach immediately after the performance. Both systems could provide immediate feedback of the kinetic and kinematic parameters of the rower at each stage of development.

High technology golf innovations have evolved primarily from a company started 31 years ago by Karsten Solheim (1989). Today, the Ping line of golf clubs in the best-selling single brand in the world. New club designs are being developed with the use a 3-D laser digitizing system and computer software. As the design of the club is refined the average golfer will also see improvements in skill. Braham (1992) highlighted a variety of new innovations to assistthe golfer during practice time. The Putter Trainer and Swing Trainer are equipped with sensors in the grip to emit vibrations when the the club is taken off line, lifted abruptly, or is not smooth and straight. The PowerShift Module are foot pads with force transducers inserted in the golfer's shoes which sends a beep into headphones to reinforce correct weight shift. The Medicus Practice is a hinged shaft which breaks alignment with improper swing plane position, timing, tempo, or weight shift. All of these equipment aids have alluded to the fact of immediate feedback to the performer and/or coach but very little research has been documented as to the effectiveness of these devices. On the other hand, research in the area of swimming has led to effective changes in stroke mechanics.

Schleihauf (1984) developed a method for estimating propulsive forces from measures of hand and arm velocities, directions and angles of attack. Three-dimensional analysis has provided a wealth of information on stroke parameters however, getting precise measurments underwater is very difficult and immediate feedback to the coach may be limited. Costill, Lee, and D'Acquisto (1987) developed the video-velocity meter to enable coaches to benefit from the combination of computer technology and video. A swimmer is attached to a line which is controlled by a generator. As the swimmer moves down the pool the tension is recorded in a computer to represent velocity. Video images are recorded and the velocity graphs are overlayed on the computer monitor. The information is made available to the swimmer immediately after leaving the pool. Both the coach and athlete are then able to use the data to determine flaws in the stroke. Persyn, Tilborgh, Daly, Colman, Vijvinkel, and Verhetsel (1988) developed an user-friendly software package to measure hydromechanical, kinanthropometric, physiological, and other data for use in the evaluation of swimmers.

Data were collected on 600 elite swimmers from various countries to validate this program. Feedback can be provided immediately to the performer and coach.

CONCLUSIONS

Research may precede the development of a product or technique change, however. past history indicates otherwise. Innovative designs of high-technology instrumentation and computers are being developed for use on the field, court, and in and on the water. The biomechanist, coach, and performer must work together to use the expert systems being developed today. As mentioned previously, computers will be the number one coaching tool of the future. The coach must be willing to become educated on the use of computers, basic biomechanics, and analysis procedures. The biomechanist must be willing to provide the education for the coach, possibly through CAI/CAL. The ultimate winner will be the athlete. An elite athlete in motion is art to the eyes. The Special Olympian displays athletic ability in its raw form. In the future we must ask the right question for the benefit of improved performance and decrease in injury of the athlete. The question can be generated from the biomechanist, the coach, and/or the athlete. All performers will benefit from the cooperative efforts of science and practice.

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