BIOMECHANICAL SERVICES AT THE AUSTRALIAN INSTITUTE OF SPORT

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The Australian Institute of Sport was established by the Australian Federal Government in 1980 to assist in the preparation of Australia's elite athletes. Within several months of the A.I.S.'s establishment a sport science division was formed which comprised of a physiology, biomechanics, sports psychology, sports medicine and sports physiotherapy department. Although each of these departments began with only a single member of staff, they gradually grew to the extent that the biomechanics department now consists of 16 of which 5 are classified as biomechanist scientists, 1 as a strength development scientist, 5 as technical officers, 2 as research support staff, 2 as research assistants and 1 as an administrative assistant. The primary objective of each department was originally to support the coaches in those sports that had athletes on scholarship at the A.I.S., as well as the coaches in sports that attended the A.I.S. on a short term basis (generally about a week) as part of the national training camp program. Originally the A.I.S. had only 8 sports which were centralised in Canberra. They were Track & Field Athletics, Swimming, Gymnastics, Basketball, Netball, Soccer, Weightlifting and Tennis. Within ten years of the A.I.S.'s formation Rowing and Road Cycling had been added as centralised sports in Canberra while Weightlifting had dropped out and Track and Field Athletics had become a decentralised sport with various disciplines in a number of cities. A number of sports had also joined the A.I.S. as decentralised units in major centers around Australia.

Field Hockev was an addition to the A.I.S. program in Perth. Track Cycling and Cricket in Adelaide, Golf and Weightlifting in Melbourne, Rhythmic Gymnastics and Volleyball in Sydney, Squash and Diving in Brisbane and Canoe-Kayaking on the Gold Coast. Just recently four new sports have been added to the A.I.S. program. Softball, Baseball and Rugby Union are additions which do not have a fixed location and Mountain Bike Riding was added as another centralised sport in Canberra. Some of the A.I.S. Sports could be regarded as comprising the nucleus of the national team while others formed more a developmental program. Each of the states also developed their own Institute or Academy of Sport with sport science and medicine departments of varying capabilities. The state academies were funded by the state governments and their major function was to develop sport at the state level.

Originally the A.I.S. Biomechanics Department serviced all the centralised sport programs and National Training Camp programs that were conducted at the Canberra Campus with equal priority. The biomechanical service to the decentralised sports was contracted to the state academies or to nearby university biomechanics programs. During the first five years of the A.I.S. no service was provided to the National Sporting Bodies. As A.I.S. sports were compelled to draw closer to their national sporting bodies, the A.I.S. developed policy to service the national bodies of seven targeted sports with sport science and medical support. Originally, the A.I.S. biomechanics Department attempted to provide a general biomechanical service to all programs that were eligible. When the seven targeted sports were finalised, A.I.S. biomechanics became more selective for whom servicing was provided to achieve improved benefits to clients. When the Olympic Games were awarded to Sydney, the federal government announced increased funding to the Olympic sports to the extent of one million dollars per week up until the year 2000. A proportion of this funding was ear marked for sport science and medicine servicing. At this time the A.I.S. biomechanics department focussed its service on the national bodies of five sports that it could achieve the most significant benefits. To do this effectively each of the five biomechanists accepted the responsibility to work with the national body of one of these Olympic sports as well as the A.I.S. sport responsibilities previously held. The 5 Olympic National Sporting bodies that were chosen included Swimming, Cycling, Rowing, Track and Field Athletics and Canoe/Kayaking.

The success of biomechanical servicing at the A.I.S. comes from the close relationship the biomechanist has with the coach. The biomechanist attempts to provide answers to the coach from questions that arise from the sport. Most of the questions are athlete specific rather than deal with the sport generally. To do this effectively the biomechanist must attain a specialisation within the sport. The coach and biomechanist must have a good working relationship where neither dominates the relationship and where the focus of attention is placed upon improving athletic performance. The biomechanical parameters which are measured to gain insight into athletic performance are presented to the coach and athlete in a form that both can readily understand and identify with. The biomechanical information is provided to the coach in as close to immediate feedback as is possible. The basic function of A.I.S. Biomechanics is in its servicing nature rather than in research. Applied research only occurs when attempting to answer a question posed by generality in the sport. In the servicing of the sport, the major responsibility of the biomechanist is to ensure that the biomechanical parameters that are focussed upon are measured in an effective manner and the information so gained is provided in an easily interpretable form.

Both the coach and biomechanist share responsibility in the interpretation of this information for the benefit of the athlete. The remainder of this presentation shall demonstrate the function of A.I.S. biomechanics and focus attention upon the biomechanical services provided to the National Sporting Organisations in Track and Field Athletics, Cycling, Rowing and Swimming.

Services to the sport of cycling include ergonomic assessment to optimise power output and reduce aerodynamic drag. Assessment for aerodynamic drag includes looking at the anthropometry of the cyclist, particularly segment lengths, and adjustments to the cycle to suit the anatomy of the rider. In particular, the optimal position of the back and arms are resolved. The information used in this assessment has been developed from wind tunnel testing. Screening of pedalling techniques is performed to identify inefficiencies that may reduce power output or may produce injury. Screening to identify mechanisms of injury are conducted in collaboration with physiotherapists. Athletes are filmed during time trial racing so that heart rate, pedalling cadence and velocity may be overlayed in the video image. The kinetics of pedalling technique are evaluated to obtain efficiency throughout the pedal stroke by using a feedback system of the force vector. In mountain bike riding the position of the center of gravity of the cyclist with respect to the cycle frame is examined in climbing. In regard to equipment development, a carbon fibre cycle frame has been developed which has been optimised for aerodynamic drag, weight and stiffness. The frame has been developed so that it may be individually designed for each rider. All the adjustments that are available in a steel frame cycle are accommodated in the carbon fibre frame. Similar development has occurred in handle bar and front fork design. A data logger has been developed which monitors heart rate, cadence, velocity and gear ratio. Resolution to every wheel revolution and distance to 0.5 metres has been obtained. Specialist software has been developed to diagnose optimisation in gear ratios. An inexpensive telemetry system has been developed to transmit the above information to the coach travelling along side the cyclist.

In Track and Field Athletics, kinetic and kinematic analyses within the A.I.S. Biomechanics laboratory provides immediate feedback for athletes attending event camps in Canberra. Such analyses is available for the long jump, hurdles, triple jump, high jump, sprint start and pole vault. Field testing based on purely kinematic analyses is available on all of the above events as well as the shot put. Such analyses provides information to the coach when the analysis occurs away from Canberra. This servicing is performed at the national championships and Grand Prix competition.

For the sport of Rowing, a telemetry based system provides immediate feedback on intrastroke velocity, distance travelled and acceleration of the shell. Heart rate as well as forces on the oar and oar angles are monitored for each oarsman in an eight. Parameters that are provided by the system include the maximum and minimum boat velocity produced for each stroke. Wasted catch, wasted finish, work per stroke and propulsive work per stroke is produced for each oarsman. Implementation of the above is designed to assist the coach identify optimum positioning of the oarsman in the boat and the rigging required for each athlete to optimise performance. In the laboratory, ergometer assessment is designed to simulate on water rowing. Parameters which include work output, power output and shape of the force curve are designed to identify inefficiencies in performance. This is used by the coach in a format whereby the oarsman performs while watching a video screen on which is overlayed the force profile of his or her performance.

In swimming, competition analysis is performed at three major championships per year. Here the coaches are provided with start time, finish time, turn times and stroke lengths, stroke frequencies, velocities and efficiency indices in free swimming. This is performed for each swimmer in A and B finals in all events. In addition, graphical output is produced to represent the above information. In the future it is hoped to produce this information for heats as well as finals. Analysis is also performed in training camps to provided more detailed information concerning technique in starts, turns, finishes and for free swimming. The competition analysis is designed to highlight a swimmer's deficiencies in competition and the technique analysis is designed to further analyse the problem so that the coach may rectify it. In the near future it is hoped to build an under water video tracking system which may be used to obtain good quality 2D video footage during competition, good quality split image video during training, enhancements in the system for technique analysis, and a method by which 3D kinematic data can be gained on swimmers to assist in injury reduction. At the present time most of the analysis of technique utilise kinematic information. Greater use will be made of kinetic data in future technique assessment.