TACTICAL APPLICATION OF BIOMECHANICS TO VOLLEYBALL USING INTERACTIVE COMPUTER SOFTWARE

Simon G.S. Coleman
Department of Physical Education, Sport and Leisure Studies, University of Edinburgh, Scotland, UK

KEY WORDS: volleyball, spiking, aerodynamics, fluid dynamics.

INTRODUCTION: Biomechanics of the techniques of volleyball players have been studied in several research papers (Coleman et al, 1993, Huang et al, 1998), but the application of fluid dynamics to the behaviour of volleyballs after spiking impact has only been investigated in one study (Kao et al, 1994). The tactical uses of information on the flight of volleyballs were considered briefly in Kao et al.'s paper, but there were some omissions and errors concerning players' tactical capabilities. It was therefore the aim of this study to design and construct computer software which would allow coaching staff (or their support teams) to make objective decisions about defensive and offensive tactics in volleyball.

METHODS: The software was designed to be simple to use and easily available to coaches. To this end, Microsoft Visual Basic 4 was utilized, as this would only require a small executable program file and the standard Visual Basic library file. The program required equations for Drag and Lift (Magnus) forces, and those from Daish (1972) and Depra (1998) were used. Kao et al. (1994) determined Magnus force empirically in a wind tunnel, and their equation was also supplied as a program option. The program utilized these equations iteratively (rather than solving them analytically) with a time step of 0.005 seconds to calculate ball displacement. Initial input Variables were X, Y and Z coordinates of the ball, its speed ($m.s^{-1}$) and spin rate (rpm). An option was also provided for 0 to 3 blockers (width 0.6m) to assess the difference that this would make to 'hittable' court area. The angles to hit the left and right sidelines at the net were then calculated, and the program iteratively used values between these at a step of 1 degree. The program also calculated to maximum angle below the horizontal (i.e. to avoid the net at 2.43m) and increased this interatively at a step of 0.33 degrees until the ball was hit beyond the court. The X, Y and Z displacements were calculated for each step of angle and time, and when the ball had crossed the net and the Y value was below 0.105m, it was assumed to have hit the floor. The position of the ball (X, Y and Z coordinates) was then shown graphically on a court display. This was repeated for every program step that achieved a ball position that passed over the net (and past the blockers, if selected) and landed within the court boundaries. The final display therefore showed the area able to be hit by the spiker.

RESULTS AND DISCUSSION: In trial testing, this program was found by the coaches to be a very useful tool for assessing offensive and defensive strategies. However, some improvements were suggested. These included objective calculation of the area (m^2) that could be hit, the addition of defensive players, and the use of pre-programmed player rotation information to predict future spikers' capabilities. These are being included in the next version of the software, and should be available in summer 2002.

REFERENCES:

Coleman, S.G.S., Benham, A.S Northcott, S.R. A three-dimensional cinematographical analysis of the volleyball spike. *Journal of Sports Sciences*, **11**, 295-302

Daish, B. The Physics of Ball Games. London, *English Universities Press*, 1972

Depra, P., Brenzikofer, R., Goes, M., Barros, R. Fluid Mechanics Analysis in Volleyball Services. *Proceedings, XVI International Symposium on Biomechanics in Sports* (Eds. H.J. Riehle, M.M. Vieten), Germany, UVK, **1**, 85-88

Huang, C. Liu, G., Sheu T. A 3D Analysis of the Volleyball One-Foot Jump Spike. *Proceedings, XVI International Symposium on Biomechanics in Sports* (Eds. H.J. Riehle, M.M. Vieten), Germany, UVK, **2**, 196-199.

Kao, S.S., Sellens, R.W., Stevenson, J. A. Mathematical Model for the Trajectory of a Spiked Volleyball and Its Coaching Application. *Journal of Applied Biomechanics*, 1994, **10**, 95-109