A THREE DIMENSIONAL CINEMATOGRAPHICAL ANALYSIS OF THE TECHNIQUES OF INTERNATIONAL AND ENGLISH COUNTY CRICKET FAST BOWLERS

N.P. Stockill and R.M. Bartlett.
Sport and Exercise Research and Development Unit, Crewe+Alsager
College of Higher Education, Alsager. ST7 2HL. U.K.

INTRODUCTION

There has been much debate and controversy over the past two decades as to the most beneficial technique to adopt to release the cricket ball at high speeds without excessively high risks of injury. Traditionally, the Side-On technique, characterised, at back foot contact, by the back foot being parallel to the crease with hips and shoulders pointing down the wicket, has been recommended almost without exception as the correct technique. Recent research has shown that the once scorned Front-On technique may be acceptable when considering certain individuals, and has identified another technique which is prevalent in the game of cricket. This technique is known as the "Mixed" technique and is identified by a Front-On body position at back foot contact followed by a rightward rotation of the shoulders during the delivery stride attempting to adopt a Side-On upper body position. Such a technique is suggested to be potentially dangerous as it "increases the load on the lumbar spine because the body is in a twisted, awkward position." (Elliot and Foster, 1989).

Following from the above, the objectives of this study were:

1). To undertake a detailed analysis of elite and international fast bowlers in a bid to discover if and how the actions of top bowlers vary from the coached Side-On technique;

2). To identify if there is clear evidence of the Front-On and "Mixed" techniques;

3). To determine which of the three techniques is most beneficial for attaining high ball release speeds.

METHODS

Seventeen elite fast and fast medium bowlers (classified as such by Abernethy, 1981) were filmed during the 1991 season at Test and Britannic Assurance County Matches and prearranged open net sessions.

Two phase-locked and event synchronised Photosonics 1PL 16mm cameras operating at 200 Hz were used to film the pre-delivery stride, the delivery stride and the follow through of each of the bowlers. The cameras were set on the boundary edge, one in a position perpendicular to the plane of performance and the other behind the bowler, with optical axes at approximately 110^{o}. A Peak Performance tri-axial calibration frame containing markers of known co-ordinates was filmed prior to performance in a position on the pitch from where the bowler delivers the ball.

One delivery of "good line and length" was analysed at 100 Hz for each of the bowlers using a TDS HR 48 digitising tablet linked to an Acorn Archimedes 440. Real world 3-D co-ordinates were obtained from the two sets of 2-D image co-ordinates using a Direct Linear Transformation 3-D reconstruction algorithm with corrections for linear distortion, based on the algorithm of

Marzan and Karara (1974) and implemented for the Archimedes by Bartlett (1990). Gaussian noise was removed from the 3D data using cross validated quintic splines, based on a program by Woltring (1986).

RESULTS

PARAMETER	BALL RELEASE SPEED ($m.s^{-1}$)	BACK FOOT ANGLE (^{o})	HIP ANGLE (^{o})				SHOULDER ANGLE (^{o})			
KEY MOMENT	Post Release	Back Foot Cont.	Back Foot Cont.	Front Foot Contact	Min.	Ball Release	Back Foot Cont.	Front Foot Contact	Min.	Ball Release
MEAN	37.4	293.9	208.7	225.3	200.6	268.4	227.8	208.8	199.6	290.8
S.D.	1.87	38.0	15.5	10.3	16.4	17.7	17.4	10.0	10.7	15.3

Table 1: The mean ball release speeds, and orientations of back foot, hips and shoulders in relation to the plane of the wicket of the 17 bowlers analysed. (The right hand horizontal is a line drawn through the foot, leading hip or leading shoulder parallel with the pitch).

DISCUSSION

The ball release speeds ($37.4\pm1.87 m.s^{-1}$) were similar to those found in previous studies (Elliot and Foster, 1984; 36.3 ± 1.7 $m.s^{-1}$, n=4), (Burden and Bartlett, 1990; 37.04 ± 1.03 $m.s^{-1}$, n=7). Based on guidelines proposed by Abernethy (1981), 15 of the bowlers were deemed Fast and 2 Fast Medium, and thus warranted inclusion in this study.

The group mean angle of back foot (294 ± 38.0^o) and the angle of shoulders at back foot contact (228 ± 17.4^o), front foot contact (209 ± 10.0^o) and ball release (291 ± 15.3^o) suggest the adoption of a more front-on action compared with the coaching literature but are slightly lower than the results from previous work reported on Australian bowlers (Elliot et al., 1986) and suggest that the Australian bowlers tended to attain a more Front-On position during the delivery stride. This is somewhat surprising as the present study included 6 West Indian bowlers who are traditionally renowned for their excessively Front-On actions.

The classification of bowlers into Side-On, Front-On and "Mixed" categories based on the system used by Foster et al. (1989), where shoulder angle at back foot or front foot contacts of $<190^o$ = Side-On, showed that 2 of the bowlers used a pure Side-On action, 12 used a Front-On action and 3 used a "Mixed" action. Using a slightly less strict criterion (i.e. $<200^o$= Side-On) the results changed somewhat, suggesting that 8 of the bowlers were predominantly Side-On, 6 were Front-

On and 3 were "Mixed".

It is evident from Table 1 that the bowlers analysed tended to rotate the shoulders away from the batsman by 28±13.2^{o} between back foot and front foot contacts. All but one of the bowlers (shoulder angle at back foot contact of 193^{o}) rotated the shoulders away from the batsman, thus decreasing the angle of the shoulders and, in theory, adopting a more advantageous position in terms of maximising the contribution of the shoulders to the ball release speed. Although only 3 bowlers rotated the shoulders in excess of 40^{o}, (the angle which Elliot and Foster (1989) used to define the "Mixed" technique), there are nevertheless a number of bowlers who approach that figure (4 were in the range of 34-38^{o}). It may be suggested that it is inadvisable to state an absolute figure which is applicable to all bowlers. It may also not be wise to view the shoulders with disregard for the angle of the hips, as the hips may be rotating away from the batsman to the same degree as the shoulders, thus reducing the risk of lower back damage. The analysis of hip/shoulder separation angles may provide more conclusive and informative results than simply viewing shoulder angle alone.

Pearson Product Moment Correlations performed between ball release speed and the kinematic parameters shown in Table 1 did not reveal any significant results suggesting that the type of action used (Side-On, Front-On or "Mixed") is not, in itself, a valid predictor of the speed at which the ball will be released. Run up speed was found to be positively correlated ($r=0.55$, $p<0.05$) with ball release speed, though due to the limited (8m^{3}) calibration volume utilised, producing unusually high approach speeds (6.81m.s^{-1}), these results must be treated with caution. Possibly due to these inaccuracies no relationship was found between run up speed and the angle of the back foot, hips or shoulders at back foot contact.

Significant relationships were found between the angle of back foot and the hips at back foot ($r=0.73$, $p<0.05$) and front foot contacts ($r=0.60$, $p<0.05$), and also between the angle of the back foot and the shoulders at back foot contact ($r=0.51$, $p<0.05$). These findings are consistent with previous work which has suggested that the attainment of a side-on position, as measured by shoulder angle, is largely dependent upon the angle of the back foot at back contact. Bradman (1958) supports this suggesting that "errors which occur at back foot contact cannot be compensated for later in the action". However, in light of the large degree of rightward shoulder rotation evident in the bowlers analysed, it may be suggested that such a statement is in fact inaccurate and maybe ought to read "Errors which occur at back foot contact should not as opposed to cannot be compensated for later in the action". From a coaching perspective this finding suggests implications in terms of the importance placed on correct placement of the back foot, and the subsequent choice of the correct type of technique (Side-On or Front-On) that is coached for individual bowlers.

CONCLUSIONS

The results are consistent with previous findings (Foster et al., 1989) and show that there are three distinct Fast Bowling techniques used in First Class Cricket.

There is a tendency for bowlers to adopt a more front-on technique (shoulder angle at back foot contact=228^{o}) compared to the "Classical" technique, as taught in the coaching manuals. It is possible that this difference and the relatively high incidence of the "Mixed" technique are due

to poor coaching, a lack of understanding of effective and safe techniques, or possibly due to the fact that the guidelines set out in the majority of cricket texts are not only inaccurate but are impractical.

The determination of the effect upon ball release speed of the orientation of the back foot, hips and shoulders proved inconclusive and suggest a need for further investigation.

Further investigation into the relationships between ball release speed, technique and injury, similar to Foster et al.'s (1986) study, but with reference to the angle of the hips and hip/shoulder separation is also required.

REFERENCES

Abernethy, B. (1981) Mechanics of skill in cricket batting. *Australian Journal of Sports Medicine* 13, 3-10.

Bartlett, R.M. (1990) The definition, design, implementation and use of a comprehensive sports biomechanics software package for the Acorn Archimedes 440 microcomputer. Communications to the XIII International Symposium of Biomechanics in Sports, Prague.

Bradman, Sir D. (1958) *The Art of Cricket*, Hodder and Stoughton, London.

Burden, A.M., and Bartlett, R.M. (1990) A kinematic comparison between elite fast bowlers and college fast-medium bowlers. Proceedings of the Sports Biomechanics Section of BASS, 15.

Elliot, B.C., and Foster, D.H. (1984) A biomechanical analysis of the front-on and side-on fast bowling techniques. *Journal of Human Movement Studies*, 10, 83-94.

Elliot, B.C, Foster, D.H., Gray, S. (1986) Biomechanical and physical factors influencing fast bowling. *Australian Journal of Science and medicine in Sport*, 18, 16-21

Elliot, B. and Foster, D. (1989) Fast bowling technique. In: Elliot, B.C., Foster, D. and Blanksby, B.A. (Eds), Send The Stumps Flying, The Science of Fast Bowling, University of Western Australia Press, Perth.

Foster, D., John, D., Elliot, B., Ackland, T. and Fitch, K. (1989) Back injuries to fast bowlers in cricket: a prospective study. *British Journal of Sports Medicine*, 23, No.3.

Marzan, G.T. and Karara, H.M. (1975) A computer programme for the direct linear transformation solution of the collinearity condition, and some applications of it. In: *Close Range Photogrammetric Systems*, Falls Church, American Society of Photogrammetry, 420-76.

Woltring, H.J. (1986) A Fortran package for generalised cross validatory spline smoothing and differentiation. *Advances in Engineering Software*, 8, 104-113.