SOUTH EAST ASIAN (SEA) GAMES BIOMECHANICS PROJECT

Wei Xie, Chuang Teh Kong, Singapore Sports Council, Singapore,
Annette J. Raynor, Nanyang Technological University, Singapore, Singapore

INTRODUCTION: The 19th South East Asian Games (SEA Games) were held in Jakarta, Indonesia in October 1997 and presented an ideal opportunity for much needed kinematic data to be collected from the track and field athletes representing the ten South East Asian countries.

This project was a collaborative effort between the Singapore Sports Council and the Indonesian Olympic Committee (KONI) and was the first biomechanical research project conducted during the SEA Games. The purpose of the project was:

- to initiate biomechanical data collection at the SEA Games and thus establish biomechanical parameters for athletes in South East Asian countries
- to provide coaches and athletes with quantitative information on techniques currently being used
- to allow the comparison of critical biomechanical parameters of South East Asian athletes with world class athletes

The research team was divided into two groups: one group focused on the finals of the men's throwing events, specifically the hammer throw, discus and javelin, and the second group focused on the final of the men's and women's triple jump, 100 m sprints and 110 m hurdles. While in Jakarta, data from selected events was digitized and analyzed with a preliminary report presented to members of the KONI biomechanics research group. Further analysis was completed after the Games.

METHODS AND PROCEDURES: The major problems that were anticipated for a practical research project of this nature included obtaining access to the field for video recording, transport of equipment, equipment failure and the unstable power supply of Indonesia. In preparation for the data collection in Jakarta, pilot testing was conducted at the Nike 59th Singapore Open Championships (1997) using 12 volt batteries and modified uninterrupted power supply (UPS) systems. In Jakarta a meeting with officials of the Indonesian Olympic Committee and a site visit prior to data collection also helped to minimize the potential problems of such a project. During the SEA Games two- and three-dimensional video data was collected at 50 and 200 fields/sec and a shutter speed of 1/1000 second using two Peak Motus motion analysis systems - a fixed camera system and a Pan and Tilt system.

- A fixed three-camera system was used to record the men's hammer throw (50 fields/sec) and discus (200 fields/sec). The cameras were placed at the right, back and front left side of the thrower to allow the collection of 3-dimensional data (Figure 1).
- A fixed two-camera system operating at 50 fields/sec was used to perform a 3-dimensional analysis of the men's javelin. The cameras were placed at the front-right and back-right sides of the thrower (Figure 2).

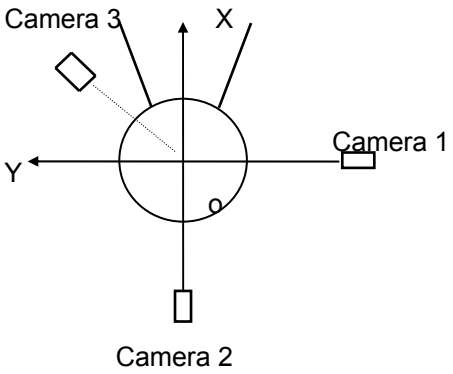

Figure 1. Camera placement for hammer throw and discus.

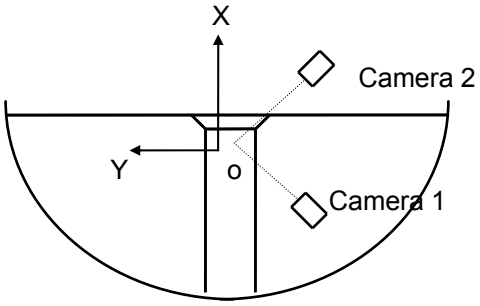

Figure 2. Camera placement for javelin

- Three cameras operating at 50 fields/sec were used to collect 2-dimensional and 3-dimensional data for the triple jump (Figure 3). This included a two-camera Pan and Tilt system (Cameras 2 and 3) with Camera One placed in line with the take-off board to allow a 2-dimensional analysis of the takeoff.
- Five cameras operating at 50 fields/sec were used for the 100 m sprints and 110 m hurdles (Figure 4), with the same camera position maintained for both events and all camera positions being relative to the 100 m start line. Cameras One and Two were fixed cameras positioned at the 20 m mark, with Camera One focusing on the start line and Camera Two focusing on the 20 m mark. Cameras Three and Four were part of the Pan and Tilt system and were placed at the 51.0 and 69.0 m mark respectively, with the final fixed camera placed at the 85 m mark of the track.

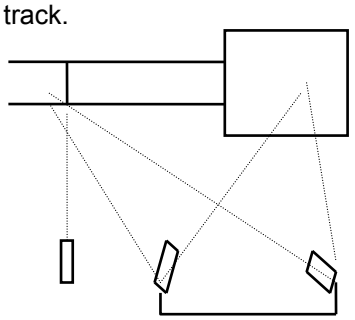

Figure 3. Camera placement for triple jump.

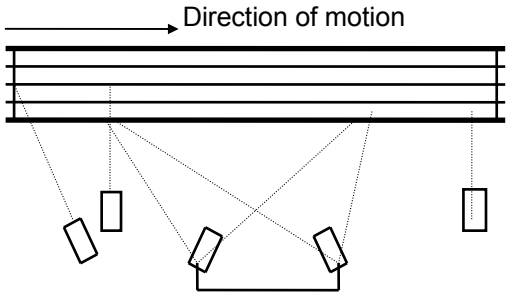

Figure 4. Camera placement for 100 m sprint and 110 m hurdles.

RESULTS AND DISCUSSION: As an example of the data collected, the results from the Gold medallist and the fourth placed athlete in the men's hammer throw

final are presented below and compared with data from the 1991 World Championships in Tokyo**.** The position of the hammer, velocity and angle of projection (with respect to the horizontal) were measured at the point of release, with results presented in Table 1. The reference origin was the center of the throwing circle with X representing the anterior-posterior direction, Y the medio-lateral and Z vertical.

Table 1. Release conditions of selected hammer throwers.

	1997 SEA Games 1st	1997 SEA Games 4th	1991 World Champs 1st *	1991 World Champs 2nd *
Distance thrown (m)	58.00	51.33	81.70	80.94
Point of release - X (m)	0.85	0.78	1.24	1.14
Point of release - Y (m)	-1.58	-1.77	-1.65	-1.71
Point of release - Z (m)	1.62	1.86	1.72	1.66
Release velocity – X (m/s)	17.7	17.1	22.2	20.9
Release velocity – Y (m/s)	0.7	-4.2	4.1	2.9
Release velocity – Z (m/s)	15.4	14.4	18.3	19.6
Resultant velocity (m/s)	23.4	22.8	29.1	28.8
Angle of projection (deg)	41	39	39	43

* - Results taken from Ueya (1992).

Significant differences in the position of release and the velocity of release can be observed when comparing the SEA Games and world class throwers. At the point of release, the release velocity and subsequently the resultant velocity is considerably less for the SEA Games throwers analyzed, with the velocity of release being a critical factor in the distance attained for all projectiles.
For the six throws of the SEA Games gold medallist, the distances ranged from 53.22 m to 58.00 m, which are all in excess of the best throw recorded by the fourth placed SEA Games athlete. The position of the hammer at the point of release ranged from 0.75-0.88 m (X), -2.02-(-1.58) m (Y) and 1.62-1.90 m (Z) for the gold medallist with the point of release for the fourth-placed athlete being within this range. However, both the resultant velocity (22.8 m/s) and the angle of projection (39 degrees) used by the fourth-placed athlete were outside the respective ranges for the gold medallist, namely, 23.3-24.3 m/s and 41.0-44.2 degrees.

With respect to the technique currently being used by world class athletes and those participating in the SEA Games, many of the world class athletes are now using a four-turn technique (Bartonietz & Borgström, 1995), compared with the

three-turn technique used by the SEA Games throwers. With all else being equal, a major consequence of this differing technique would be the amount of angular velocity that could be generated during the preliminary swing(s) and the turns**.** As such, it is suggested that the three-turn technique currently employed by the SEA Games athletes may be limiting the angular velocity developed, the resultant linear velocity at release and thus the distance that is achieved.

CONCLUSIONS: When comparing the fourth- and first-placed throwers at the SEA Games, or the SEA Games gold medallists with world class throwers, the biggest difference is the release velocity. The release velocity developed by an athlete is affected by his strength, power and technique, with an obvious difference between the SEA Games and world class athletes being the chosen technique. The use of the four-turn technique as used by the world class throwers may allow the SEA Games athlete to develop additional angular velocity; however, the overall technique must not be compromised in the process. If the athlete fails to get the body into a position such that he can make optimal use of the various muscle groups involved, the additional angular velocity developed through the fourth turn may in fact be detrimental to the throw.

REFERENCES:

Ueya, K. (1992). The Men's Throwing Events. *New Studies in Athletics* **7**(1), 57-65.

Bartonietz, K., Borgström, A. (1995). The Throwing Events at the World Championships in Athletics 1995, Göteborg - Technique of the World's Best Athletes, Part 1: Shot Put and Hammer Throw. *New Studies in Athletics* **10**(4), 43-63.