THE STUDY OF THE OPTIMAL EXCHANGE TECHNIQUE IN 4X100M RELAY

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The objective of this study was to determine the baton passing distance i.e. the distance between the 'go' mark and start line of acceleration zone for three baton passes. The motion was video filmed (50Hz) during a local athletic meet. Selected video materials were processed using a kinematic system to calculate the centre of gravity (C.G.) of the runners. A plot of C.G. velocity against different distance ranges of 0m to 40m and 70m to 100m for each runner was made. Based on the plots, the 'go' mark for three exchange sessions could be established. The results of the study established that the distance from the start line of the outgoing runner to the 'go' mark selected by the runners was usually much shorter than the optimal distance.

KEY WORDS: 4x100m relay, kinematic, go mark

INTRODUCTION: The 4x100m relay is the event in track and field that requires teamwork. The baton has to be passed at high speed within a 20m passing zone. Strategy and the proper use of the 10 meters acceleration zone are crucial in the outcome of a sprint relay. Four athletes must work together in harmony in order to achieve optimum results. In the 4x100m relay, minor errors in baton passing can have a significant affect on the overall performance. Establishing the 'go' mark is one of the key factors for the runners. If the baton passing distance is too short, the outgoing runner does not have enough time to accelerate to achieve a sufficiently high velocity that is similar to that of the incoming runner. Therefore, the incoming runner may have to decelerate to keep the velocity similar to the outgoing runner. Consequently, a discrepancy in velocity during the baton passing causes a reduction in the speed of athletes. If the baton passing distance between athletes is too far and the final velocity of the outgoing runner too fast, the baton pass would not occur. Alternatively, the baton passing may occur outside the passing zone resulting in disqualification (Schmolinsky, 1992). The objective of this study was to establish the specific baton passing distance i.e. the distance between the 'go' mark and start line of the acceleration zone for each baton passing.

METHODS: The average age of the four runners was 22.5 years. The best times for the four runners in a 100m sprint were 10.89s, 10.81s, 10.54s and 10.46s. Four video cameras (50Hz) were used to capture the performance during individual 100m sprint and a 4x100m relay during a local athletic meet. During the individual 100m event, the video capture range was divided into four regions 1) 0-25m, 2) 20-45m, 3) 65-85m and 4) 80-100m. Video information on the baton passing during the 4x100m relay was obtained. Video materials were processed by a Peak Performance System to calculate the velocity of the centre of gravity (C.G.) of the runners. A plot of C.G velocity against different distance ranges of 0 to 40m and 70m to 100m for each runner was made. The velocity of the incoming runner at the finish line was determined from the 70m-100m-profile plot. This velocity was used to determine the distance of the "go" mark from the start line of the outgoing runner by looking at the corresponding distance of the incoming runner in the 0-40m-profile plot of the incoming runner. A comparison of the performance of the runner during the individual event and the 4x100m relay was done to determine the exact distance of the start for the outgoing runners.

RESULTS AND DISCUSSION: Figures 1 and 2 are typical examples of velocity profiles for an individual runner at two different distances.

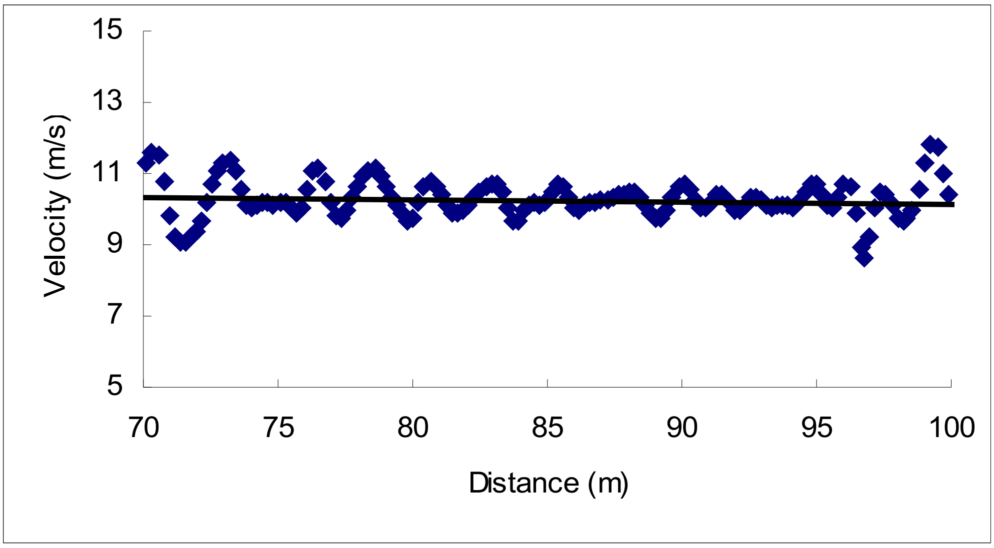

Figure 1 - Typical velocity distance profile between the distance of 70m and 100m ($p<0.05$).

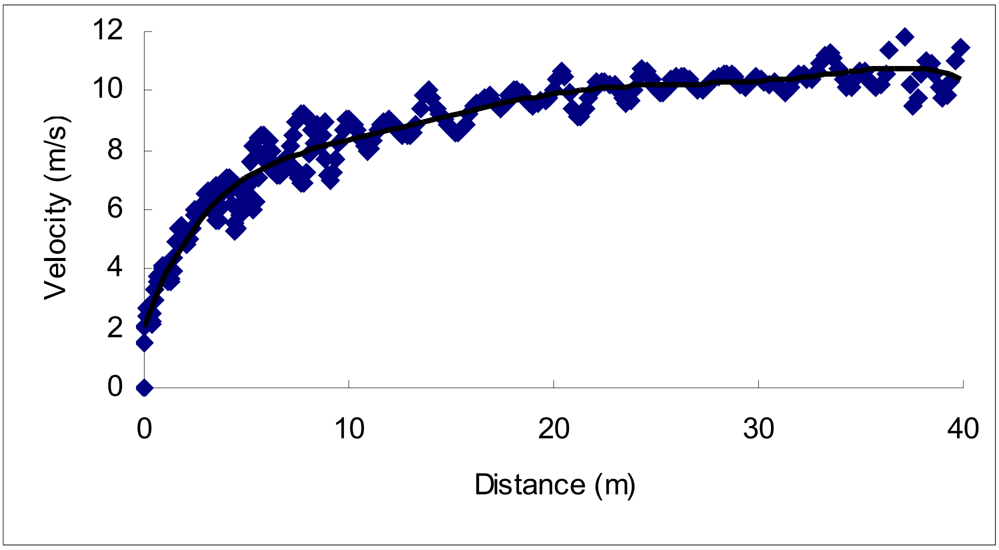

Figure 2 - Typical velocity distance profile between the distance of 0m and 40m.

Plot Figure 2 before Figure 1 given the 0-40m then 70-100m (and relabel)

Table 1 shows some of the parameters in three different exchange sessions. These included, the distance of the “go” mark and the start line of the acceleration zone of the outgoing runner; the distance finished by the outgoing runner at the point of baton exchange; the distance of the incoming runner between the “go” mark and the point of baton exchange; the time the outgoing runner left the start line to the point of exchange; the distance between the necks of the two runners at the moment of baton exchange and the velocity of the runner at the moment of baton exchange.

The calculation of the above parameters was based on the following assumptions: 1) The velocity of both athletes were the same at baton exchange. The velocity should be the speed of the outgoing runner at the finish line in their individual 100m sprint; 2) At baton exchange, the arms of the runners should be straight and horizontal.

If the velocity of the incoming runner was larger than the outgoing runner, during baton exchange, the distance between the runners could be closed. Although this may guarantee the success of exchange, some time may be wasted. On the other hand, if the velocity of the incoming runner was smaller than the outgoing runner during baton exchange, this may lead to time loss and even failure of exchange. The optimal exchange would occur if the incoming and outgoing athletes maintained the same velocity at exchange.

Table 1 Kinematic Parameters During Exchange

	First exchange	Second exchange	Third exchange
Distance of "go" mark and the start line of the acceleration zone of the outgoing runner (m)	9.47	9.70	9.19
Distance finished by the outgoing runner at the point of baton exchange (m)	14.82	13.25	19.12
Distance of the incoming runner between the "go" mark and the point of baton exchange (m)	22.69	21.30	26.66
Time of the outgoing runner leaving the start line to the point of exchange (s)	2.32	2.20	2.72
Distance between the necks of the two runners at baton exchange (m)	1.60	1.65	1.65
Velocity of the runner at baton exchange (m/s)	9.62	9.68	9.80

In a local athletic meet, the distance from the start line of the outgoing runner to the "go" mark was found to be in the range of 7.5m to 8.5m for the Hong Kong relay team. During the baton exchange, the velocity of the incoming runner was larger than the outgoing runner therefore, the distance between the two runners during the exchange was much smaller than the calculated distance. As a result, there was a loss of time during the exchange. The "go" distance of the runners was modified according to the information provided. The result time of Hong Kong relay team at the next meet was reduced from 41.34s to 40.28s. According to the literature, an ideal exchange technique in 4x100m relay would produce a race time reduction of 2.5s better than the total individual time of four runners (Schmolinsky, 1992). In the example of the Hong Kong relay team, the time reduction was improved from 1.36s to 2.42s.

From the data generated by this study, it has been determined that the optimal velocity of exchange was not the highest velocity during the exchange. This was contrary to the advice given by Walker (1982).

CONCLUSION: Generally, the establishment of a "go" mark for the runner is based on experience. However, that experience was sometimes misleading, as the distance from the start line of the outgoing runner to the "go" mark usually was too short, which lead to a loss of time. Based on the velocity profile plots of the runners in individual 100m sprints, the optimal three distances were found to be 9.47m, 9.70m, and 9.19m. Applying this data to the Hong Kong relay team resulted in a time reduction that was improved from 1.36s to 2.42s. This corresponded to an improvement from 41.34s to 40.28s, which could be significant in competition.

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