KINEMATIC VARIABLES FOR FORWARD NON-TWISTING PLATFORM DIVES

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INTRODUCTION

Olympic diving utilises both springboard and platform for take-off purposes. This paper will concentrate on platform techniques. Dives from the forward and inward groups were analysed, these being: forward dive with $1^1/_2$ piked somersault (103B), forward dive with $3^1/_2$ piked somersault (107B), inward dive with $1^1/_2$ piked somersault (403B), inward dive with $3^1/_2$ tucked somersault (407C), inward dive with $2^1/_2$ piked somersault (405B), with the aim of establishing the most important kinematic variables.

For purposes of analysis a dive can be seen to consist of five phases: approach, contact, take-off, flight and entry. The most critical point of the dive is the take-off, as this sets the angular and linear momentum required to complete the dive, as well as the flight trajectory. However, the take-off momentum is dependent upon the momentum created during the approach and contact phases.

This paper will concentrate upon the approach through to take-off phases of the dive, aiming to establish the kinematic variables necessary for the performance of an effective take-off, though it must be realised that what will be affective for one diver will not be so for another, due to factors such as body type, segment length, and strength of the individual.

METHODS

Biomechanical analysis requires a scientific approach involving technical data collection and reduction methods. The development and testing of biomechanical methodologies is unnecessary as the principles and procedures to be used in this study have already been established and used in previous investigations. Miller (1974), Hamill (1986), Sanders (1988).

DATA COLLECTION

The set-up of equipment for data collection followed the principles established in other research. The literature shows that, due to the speed of the dive take-off, it is necessary to film at a higher speed than that of normal video camera, in order to obtain an accurate temporal base for the digitised data.

In filming the divers at the 1993 European Championships in Sheffield, a Sony Rotary Shutter Camera was used filming in N.T.S.C. format, enabling a frame rate of 60Hz. To eliminate error due to parallax, the camera was positioned perpendicular to the plane of motion by setting it to view the side and front edge of the 10m platform, in alignment with a surveyor's pole positioned at the opposite side of the pool. (Surveying procedures were used to achieve alignment.) A spirit level on the tripod ensured that the camera was level.

DATA REDUCTION

Major kinematic and kinetic variables were established using software developed by Crowe P. & Taylor S.W. (1989) Analysis of the film data was by means of digitisation. The digitization procedure produced a 14 segment body model (Dempster 1955), which has the advantage over the 7 segment model in that it does not assume symmetry within the movement, and takes each segment separately. From this digitized data, and supporting algorithms, kinematic and kinetic variables were derived for analysis and comparison. The video data was digitised using a T.D.S. graphics tablet and digitise controller in conjunction with a G.E.S. video projector. Co-ordinates are transformed using an I.B.M. PS/2 computer. The data was smoothed using a cubic spline for displacement and velocity data, and a quintic spline for acceleration data.

RESULTS

Variables were imported into a spreadsheet programme (Quatro Pro) to enable data to be shown in graphical form, and also into a statistical package (S.P.S.S.) to enable statistical analysis.

Table 1 shows the variables which have significant differences between the forward dives for both the men and women.

TABLE 1	MEN		WOMEN	
VARIABLE	P VALUE		P VALUE	
Contact whole body angular momentum about the C.M.	0.0207	*	0.0118	*
Take off vertical velocity	0.0005	**	0.0002	**
Take off whole body angular momentum about the C.M.	0.0002	**	0.0000	**
Take off head, trunk and arm angular momentum about the C.M.	0.0003	**	0.0003	**
Take off head and trunk angular momentum about the C.M.	0.0003	**	0.0008	**
Take off arm angular momentum about the C.M.	0.0019	**	0.0201	**
Take off hip angle	0.0028	**	0.0012	**
Take off shoulder angle	0.0029	**	0.0221	**

** Significant at the 99% level. * Significant at the 95% level.

Table 2 shows the variables which have significant differences between the inward dives.

TABLE 2	MEN		WOMEN	
VARIABLE	P VALUE		P VALUE	
Take off vertical velocity	0.0005	**	0.0001	**
Take off horizontal acceleration	0.0451	**	0.0042	**
Take off horizontal force	0.0381	*	0.0033	**
Take off resultant velocity	0.0042	**	0.0050	**
Take off whole body angular momentum about the C.M.	0.0004	**	0.0337	*

** Significant at the 99% level. * Significant at the 95% level.

The vertical velocity results for both the forward dives and the inward dives showed significant differences at the 99% level. Differences in vertical velocity have major affects upon the take-off of the dive. Figures 1 and 2 show the average vertical velocities for the men and the women for the forward dives.

Figure 1

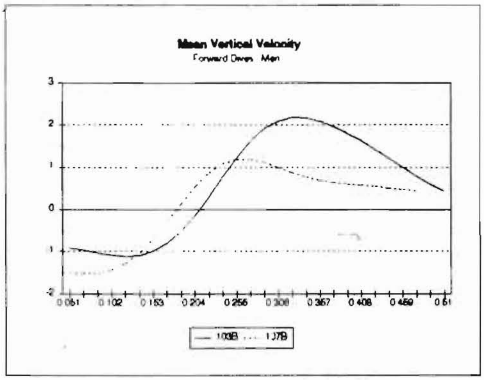
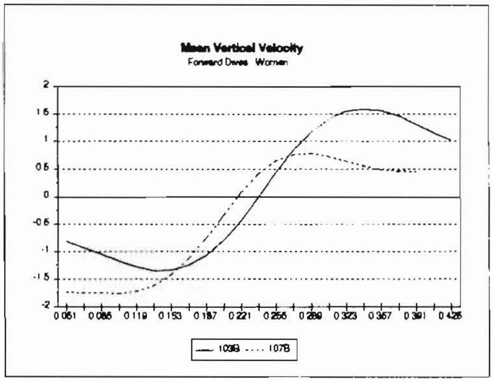


Figure 2



Figures 3 and 4 show the average vertical velocities for the men and the women for the inward dives.

Figure 3

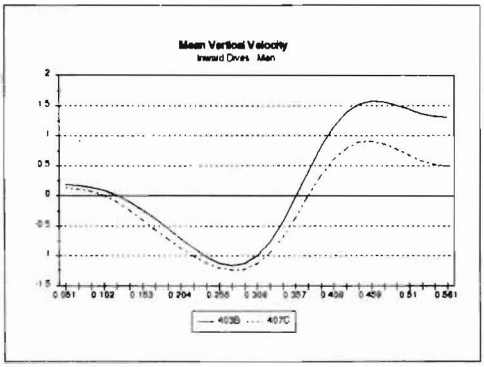
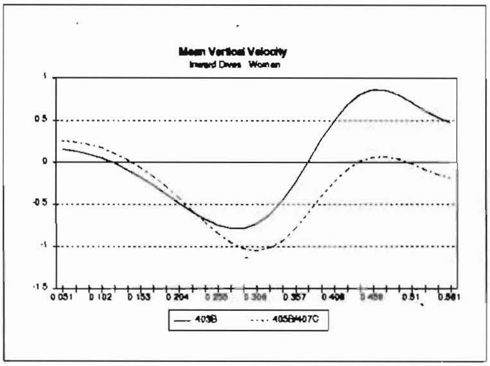


Figure 4



CONCLUSION

The differences in contact and take-off values for both the forward and inward dives, as shown in figures 1 and 2, are explained by the different rotational requirements of the dives. Differences in angular momentum values at contact of the forward dives are due to the increased forward lean of the diver because of the need for greater angular momentum in the forward $3^1/_2$ piked dive. This dive shows larger mean angular momentum values at contact. The forward $3^1/_2$ piked dive also has larger mean take-off angular momentum values, for both the men and the women. The inward $3^1/_2$ tucked dive and the inward $2^1/_2$ piked dives show greater take-off angular momentum values due to the increased rotation. Hamill (1986) supports this, stating that angular momentum increased with each increase in somersault rotation.

Take-off vertical velocity is a major factor relating to the number of somersault rotations, decreasing as the rotational requirement increases. Both the forward and inward $1^1/_2$ dives have significantly higher take-off values, and therefore show greater height in the performance of these dives. Sanders (1988) support this finding.

> "With each somersault increment, an increasing quantity of strain energy is converted to kinetic energy of rotation, and less is available for kinetic energy of translation. This leads to a reduced vertical velocity at take-off."

The forward dives show more significant differences common to both the men and women, than the inward dives. The forward dives have a more complex take-off due to the utilisation of an approach run, which cannot be used for the inward dives, therefore a higher proportion of significant differences may be expected.

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