A BIOMECHANICAL INVESTIGATION OF THE SWIMMING START

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INTRODUCTION

The purpose of this paper is to present the investigation of two different problems. The questions were: 1) what factors influence the performance of a swim start? and 2) how can we teach the optimal start? In the second part of this paper we have used Heusner's theory (1959) with measurements and the teaching methods.

METHODOLOGY

For the calculations and preliminary investigations, we used some simple and well-known equations and formulas. The bases of our calculations were the theoretical facts and several practical experiences.

We used the following basic equation:

$$s = \frac{\sin 2\alpha * v_o^2}{2g} + v_o * \cos\alpha \; X \; \sqrt{2/g \; X \; (h + (\sin^2\alpha * v_o^2 \backslash 2g))}$$

During this study we calculated and/or approximated the following:

1. We used the classic equations of mechanics and kinetics in all intervals.
2. We did not calculate the air resistance because the investigated times and speeds were low.
3. We calculated the position of center of gravity (CG) from start to water entry.
4. We used real data (e.g. the start position of CG).
5. We considered the horizontal speed component as constant during the whole start. This was calculated from the start speed.
6. The vertical speed of jumping (during the measurement of CG rising) was correlated, this is equal to the speed of start in swimming.

We generated all other equations from these formulae. Our "book" consists of these data and how the coach can use it. We calculated the horizontal and vertical speed component of water entry but we have not detailed this method.

The coaches can calculate the optimal parameters (values) of start from the measured values. They can optimize a swimmer's start using only the following "instruments": paper, pen, tables of correlating values and measuring tape. The method consists of the following steps :

1. Measure the height of CG.
2. In Table 1, find the correlated speed value of measured value.
3. Look up the adequate table of speed (Table 2 and Figure 1.).
4. Calculate the starting height from the height of starting-block and the height of CG.
5. Measure the distance of the dive and find angle of start in these tables.

If this value is not in the optimal interval, we must correct the technique.

Table 1. Section A.

s (cm)	v_o (m/s)	s (cm)	v_o (m/s)	s (cm)	v_o (m/s)	s (cm)	v_o (m/s)
1	0.4	51	3.1	101	4.4	151	5.4
2	0.6	52	3.1	102	4.4	152	5.4
3	0.7	53	3.2	103	4.4	153	5.4
4	0.8	54	3.2	104	4.5	154	5.4
5	0.9	55	3.2	105	4.5	155	5.5
6	1.0	56	3.3	106	4.5	156	5.5
7	1.1	57	3.3	107	4.5	157	5.5
8	1.2	58	3.3	108	4.6	158	5.5
9	1.3	59	3.4	109	4.6	159	5.5
10	1.4	60	3.4	110	4.6	160	5.6
11	1.4	61	3.4	111	4.6	161	5.6

Table 2. Section B.

h>	100	110	120	130	140	150	160	170	180
8'	95	99	103	107	111	115	118	122	125
9'	95	100	104	108	112	115	119	122	126
10'	96	100	104	108	112	116	119	123	126
11'	96	100	105	108	112	116	120	123	126
12'	97	101	105	109	113	116	120	123	127

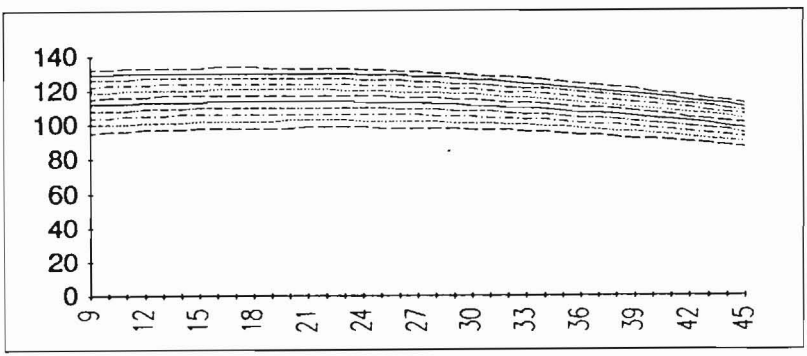

Figure 1. Section B.

RESULTS

The results are the referential curves (nomograms) of correlations between different angle of release, speed of release and height of CG. They are not verified with long theoretical deduction. We hope that practice will prove them to be true or not.

From our calculations we can establish the following:

1. The correlation between the height of start and optimal angle is reversed.
2. If the speed is rising the optimal angle is rising and will correlate to 45°.
3. The correlation between the speed and the dimension of interval of optimal angles is reversed.

DISCUSSION

Several researchers have investigated the technique of swimming (Toussaint et al., 1991) and simple jumping (Pandy and Zajac, 1991) but none have used a similar model to the one proposed here. Thus we could compare our results only with those of Heusner (1959). We found the interval of the start angle to be between 5-22°, and the optimal angle was 13° in that study. We found that this value depends on factors such as speed, the position of CG, etc.

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