EVALUATION OF A SWIM BENCH

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Swim benches are used in dry-land training and for performance diagnosis by most elite swimmers. For the purpose of diagnosis generally the swimmer's mechanical output power is measured. But there are some problems: E. g. the influence of the water resistance and the influence of the legs' power to swimming are not included in a swim bench test. Competitive performances (200 m) and data from swim bench tests (average mechanical output power) of four elite female swimmers (one participant of Olympic finals 2000 and three participants of German championships) over a period of two years were correlated for each swimmer. The results suggest, that swim benches are useful for an individual performance diagnosis if the mechanical output power is acquired.

KEY WORDS: swim bench, performance diagnosis, mechanical output power.

INTRODUCTION: Elite swimmers use swim benches (see Fig. 1) in dry-land training and for the diagnosis of their state of performance. In swim bench tests the swimmer lies on a bench and has paddles in his hands. The paddles are fastened to a roller by a cable. Doing arm strokes the cables are spooled in and spooled out while the forces in the cables and the velocities of the cables are measured. On the basis of these data the mechanical output power of the swimmer's arms can be computed. This leads to the following problems:
The influence of the water resistance, the swimmer' s technique and the influence of the legs' power to swimming are not included in a swim bench test. Further on results of researches of EMGs (Olbrecht/Clarys, 1983; Hermsdorf, 2001) and of the force-velocity-relationship (see Fig. 2), which should be approximately $F \sim v^2$ (see . Gerthsen et al., 1982; Reischle, 1988), suggest that there are great differences between real swimming and "swimming" on a swim bench. But for all that swim benches are used by most elite swimmers. Therefore the purpose of this paper is to evaluate the use of swim benches for performance diagnosis.

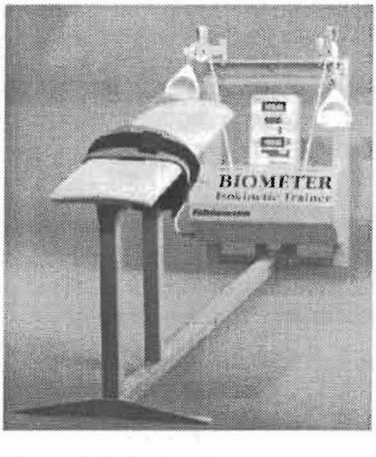

Figure 1: Swim bench.

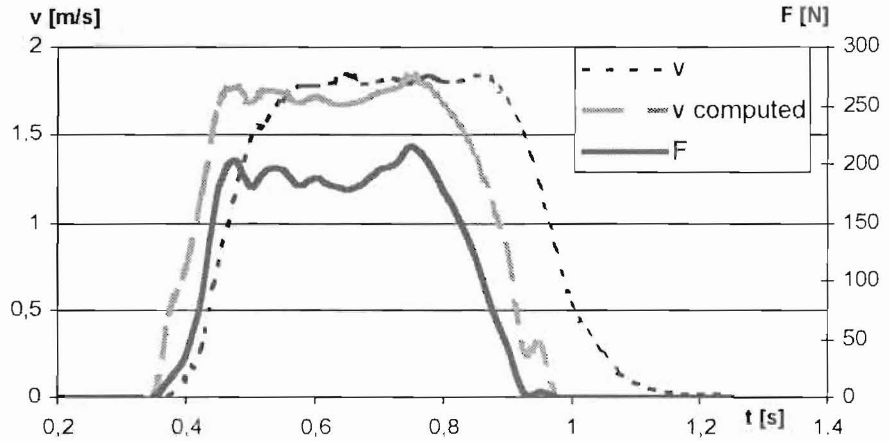

Figure 2: Typical force-velocity-relationship of a crawl stroke on the swim bench: F is the measured force, v the measured velocity and v computed the velocity that should be measured according to the relationship $F \sim v^2$ between force and velocity in water.

METHODS: Competitive performances (200 m) and data from swim bench tests (average mechanical output power, swim bench: BIOMETER ISOKINETIC TRAINER, Fahnemann, Germany) of four elite female swimmers (one participant of Olympic finals 2000 and three participants of German championships) over a period of two years were correlated for each swimmer providing a constant period of three days between the swim bench exercise and the competition. The swim bench tests took two minutes each according to the competition time for 200 m of about two minutes. The resistance of the swim bench was set on level 5, that corresponds approximately to the resistance of water in swimming according to the swimmers' feelings. The swimmers did butterfly arm strokes at their own stroke frequency. The velocity and the force of the arm strokes were measured (National Instruments A/D converter, software LabView, scan rate 40 Hz) and used to calculate the average of the mechanical power for the two minutes. For each swimmer the Pearson correlation coefficient was calculated from the averages of her mechanical power of the two-minute swim bench tests and her competition times (200 m).

RESULTS: Table 1 shows the Pearson correlation coefficients of the four swimmers. The negative correlation coefficients indicate a higher mechanical output power leads to less swimming time in competition.

Table 1 The swimmers' Pearson correlation coefficients between the averages of her mechanical power of the two-minute swim bench tests and her 200m competition times. The swimmer S4 was the participant in the Olympic finals 2000. "n.s" means not significant on a five percent level, "s" means significant on a five percent level.

swimmer	*style in competition*	*number of pairs of variables test competition*	*Pearson correlation coefficient*	*significance*
S1	freestyle	4	-0.807	9.7% (n.s.)
S2	freestyle	5	-0.981	0.2% (s.)
S3	dolphin butterfly	6	-0.625	9.2% (n.s.)
S4	individual medley	12	-0.610	1.8% (s.)

Fig. 3 shows the course of the competitions and the course of the mechanical output power in the swim bench tests for the swimmer S4. We can see that the two courses are passably similar (correlation coefficient 0.610).

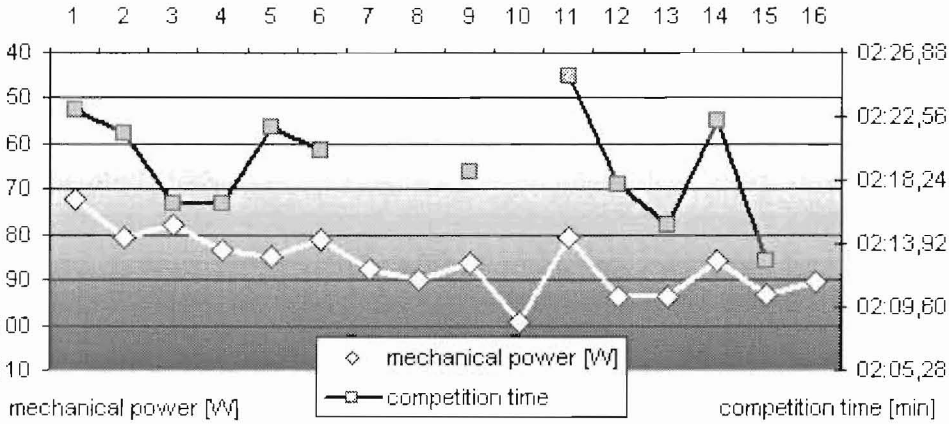

Figure 3: The times in competitions and the averages of the mechanical output power in the swim bench tests over a period of about 18 months. The style in competition was individual medley. All swim bench tests are drawn in even if there was no competition three days later.

DISCUSSION AND CONCLUSION: An interpretation of the correlation coefficients in Table 1 is problematic, because the number of pairs of variables test/competition is very small for the swimmers S1, S2 and S3. Thus the correlation for S2 is nearly -1 and significant but one more pair test/competition with unfavourable values can change the correlation coefficient and the significance dramatically. To get information about the influence of one more or less pair of variables test/competition and to verify at least the negative correlation between mechanical power in the swim bench test and the competition time the following procedure was done:
For each swimmer her correlation coefficients were computed leaving out one pair of the variables test/competition. I. e. for S1 four correlation coefficients were computed using three of the four pairs, for S2 five correlation coefficients were computed using four of the five pairs, for S3 six correlation coefficients were computed using five of the six pairs and for S4 12 correlation coefficients were computed using 11 of the 12 pairs. All these correlation coefficients were negative and their values were in a range of -0.50 up to -0.99.
Thus we can conclude that swim benches are useful for an individual performance diagnosis if the mean mechanical output power of a time period corresponding to the competition time is acquired.

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