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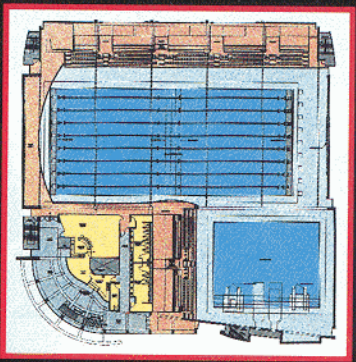
THE MANUAL FOR COACHES & SWIMMERS EVERYWHERE

SWIMMING TECHNIQUE



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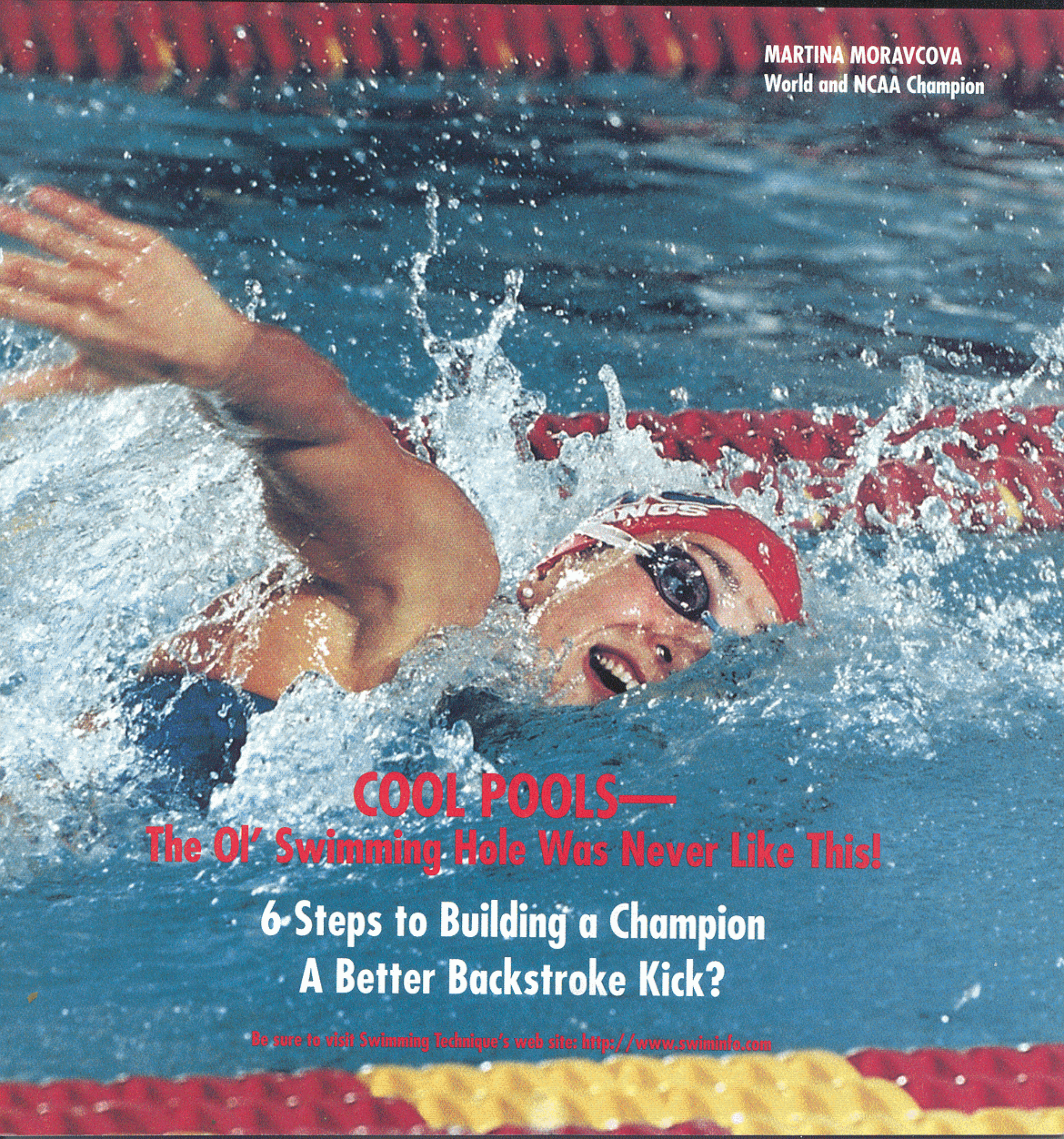
(Cover photo by Peter H. Bick)



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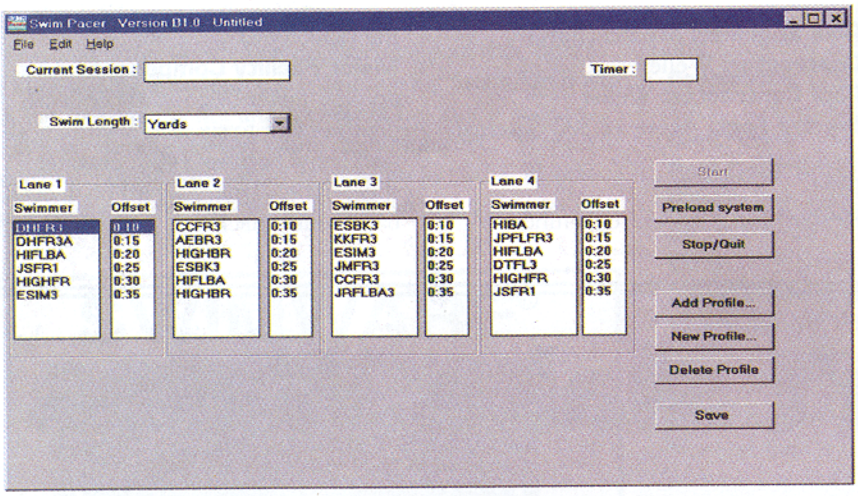
Pace Lights and Swim Performance

Swimmers can train more efficiently and attain better results in competition when using an underwater pacing light system.

By Budd Termin, Dave Pendergast, John Zaharkin and Michael Zaharkin

Pacing Lights Training Main Program Screen



The screen, at left, depicts the training files, loaded and ready to execute a training session. Each swimmer has a separate file. Up to six swimmers can be programmed in each lane for a total of 24. The offset column indicates the send-off interval between each swimmer. In this case, the swimmers leave five seconds apart.

Swimming performance is defined as the time required to cover a specific distance. This can also be expressed as velocity. Achieving a velocity while swimming is dependent upon the number of strokes taken per minute (stroke rate) and the distance the body travels per stroke.

In pioneering work, Al Craig and his co-workers demonstrated a characteristic relationship (curve) for each competitive stroke, relating velocity to stroke rate (Craig, 1979). They also showed that faster swimmers achieve a greater distance per stroke, and, at higher velocities, can shorten the distance per stroke. Therefore, they can sustain higher stroke rates for a specific distance with faster times (Craig, 1985).

More recently, we have shown that the distance per stroke, degree of shortening and stroke rates during competition can be improved by a specialized training system (Kame 1990 and Termin 1998). This training system uses the stroke rate velocity curve and high velocity training to improve both mechanics and metabolic power.

Swimmers can sense and control their stroke rates very well. However, their "sense" of velocity is neither accurate nor reliable. The implication is that swimmers cannot judge the effects of changing stroke mechanics on velocity. Therefore, training splits often are not precisely performed, particularly in a fatigued state.

The result of these two factors results in training velocities below that which is desired. This can prevent any training program from achieving "optimal" improvement.

Purpose

We have designed, built and tested a system that paces swimmers at predetermined speeds and can be programmed to run training intervals for an entire team during training sessions. This system allows the swimmers to alter their mechanics and immediately determine if the changes increased or decreased their speed. It also allows the swimmers to complete an entire training session at the exact stroke rate and velocity determined by the coach.

The system allows the coach to "teach" or, as it is referred to here at Buffalo, "dial in" the techniques and evaluate the swimmer's progress during specific sessions and over the season. This provides the coach with a systematic method of administering and checking the stroke rates, velocity, rest intervals or interval times. This system can be used long or short course (see

Fig. 1) and can manage six swimmers per lane for up to four lanes.

The microprocessors that control the lights are programmable by using a standard computer. Data for swimming distance, time, rest intervals, each interval and the number of intervals are entered for each individual swimmer. Six swimmers can be programmed for each of four lanes. These data are then downloaded to the four microprocessors that control the light system.

This process is repeated for the number of repeats that are programmed. Once this has been completed, the next segment of the training is started (next line on the menu). The microprocessors are programmed to require proper turn techniques for the laps where turns are required. The light pacing system is flexible enough to accommodate being programmed for any training program or, in our case, the UB program (Kame 1996).

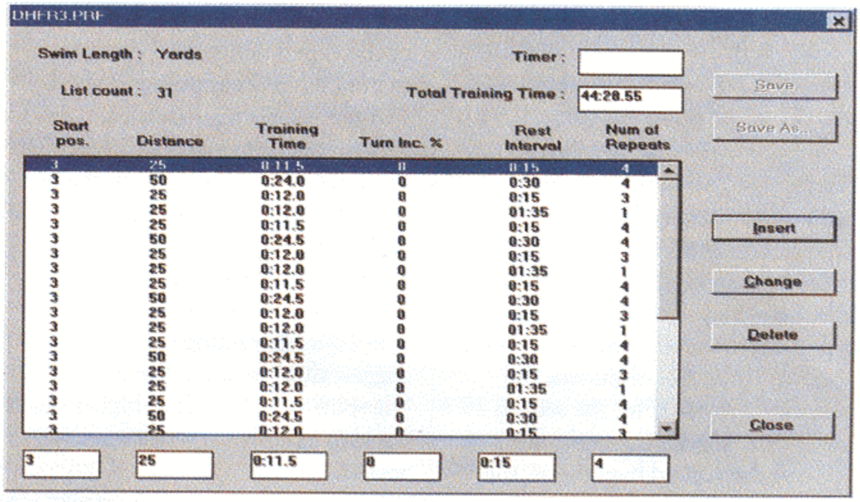
Experiment

It was our hypothesis that swimmers during training would swim at a speed slower than desired by the coach and that they would change their stroke so they could "feel" the water, which would occur during increased drag (decreased speed). If this were true, we hypothesized that by pacing the swimmers at precise speeds during training, the improvement from training would be greater.

The screen, at right, represents an individual training file. The program is flexible enough that any training matrix can be programmed. The number of repeats, preferred training distance and the amount of rest is infinite. The logic behind this configuration is to give the coach the ability to individualize a training program in order to optimize the training. The program also calculates the total training time of the practice.

Once the program is started, each of the six swimmers in each lane is started with a countdown light tree. The swimmers are then paced by the series of flashing lights at the pre-set speed over the distance of the interval that was programmed. After the swimmers complete the interval, they are allowed the prescribed rest interval, and the light tree begins the next repeat.

Pacing Lights Training Individual Training File


DHFR3.PRF

Swim Length : Yards — Timer :

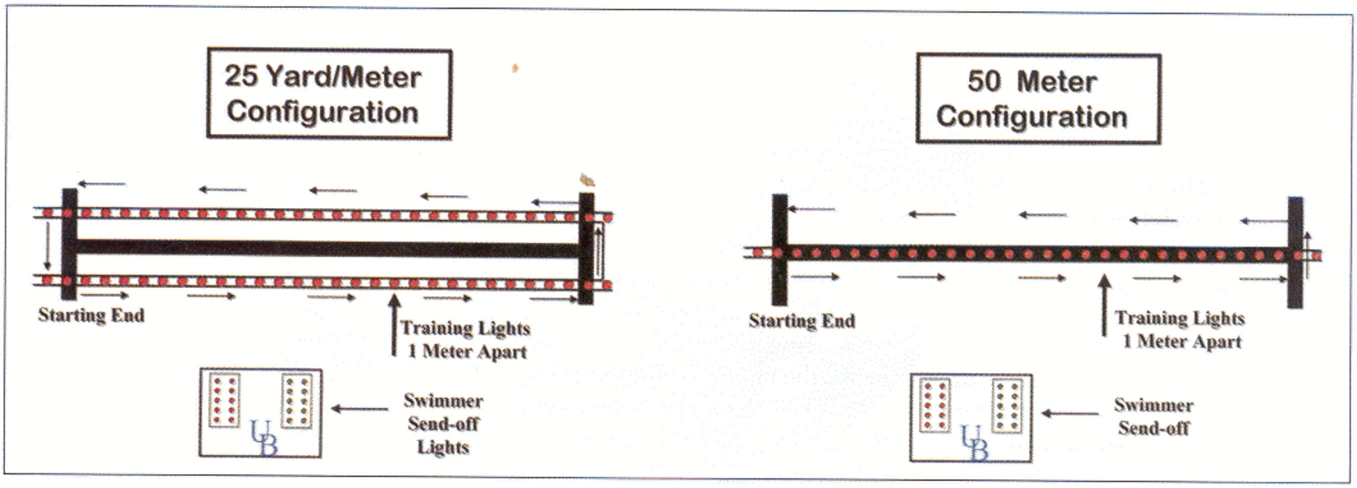
List count : 31 — Total Training Time : 44:28.55

Start pos.	Distance	Training Time	Turn Inc. %	Rest Interval	Num of Repeats
3	25	0:11.5	0	0:15	4
3	50	0:24.0	0	0:30	4
3	25	0:12.0	0	0:15	3
3	25	0:12.0	0	01:35	1
3	25	0:11.5	0	0:15	4
3	50	0:24.5	0	0:30	4
3	25	0:12.0	0	0:15	3
3	25	0:12.0	0	01:35	1
3	25	0:11.5	0	0:15	4
3	50	0:24.5	0	0:30	4
3	25	0:12.0	0	0:15	3
3	25	0:12.0	0	01:35	1
3	25	0:11.5	0	0:15	4
3	50	0:24.5	0	0:30	4
3	25	0:12.0	0	0:15	3
3	25	0:12.0	0	01:35	1
3	25	0:11.5	0	0:15	4
3	50	0:24.5	0	0:30	4
3	25	0:12.0	0	0:15	3

| 3 | 25 | 0:11.5 | 0 | 0:15 | 4 |

Save — Save As... — Insert — Change — Delete — Close

Fig. 1. (below) Configurations of the underwater light pacing system for 25 yards (left panel) and 50 meters (right panel). The dark solid lines are the stripes on the pool bottom. The circles represent the individual pacing lights (one meter apart). The arrows indicate the direction of swimming.



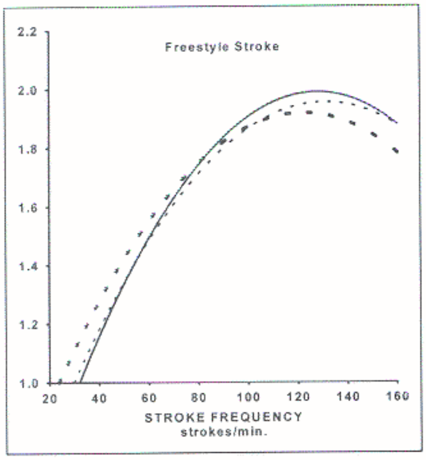


Fig. 2. The average maximal velocities that could be swum for 10 meters are plotted as a function of freestyle stroke frequency for pre-training (— —), post-training/no lights (- -) and post-training/with lights (——).

To test the first hypothesis, the UB team was instructed to swim two 25-yard segments at constant speed (80 percent of their maximum speed) and stroke frequency. The pacing lights for the first lap paced the swimmers. Then, unbeknownst to the swimmers, the lights were turned off for the second 25 yards, while velocity was measured.

To test the second hypothesis, the UB swimmers trained from January to March with the training program that was developed at the university (Termin 1990). One year, the swimmers did not use the pacing light system; the following year, they did use the pacing light system.

The training program involved repeats of 25- or 50-yard distances with 15- to 30-second rest intervals at 80 to 120 strokes per minute (velocities of 95 to 100 percent of maximum) for one hour. The data for the velocity and stroke rate relationship were collected prior to (January) and after (March) the training period (see Fig. 2, Craig 1978).

The data were normalized to percent improvements from January to March for each year and expressed as absolute values using the January data from the first year.

The men's Division I team participated in this study. The team was comprised of 11 freestylers, four backstrokers, three butterflyers and two breaststrokers (age = 20 ± 1 year, height = 182 ± 18 cm., weight = 75.4 ± 5.3 kg., VO_2 = 4.85 ± 0.45 l/min). Only the freestylers were used in the data analysis, as there were sufficient numbers to apply statistics.

An analysis of variance for repeated measures was used to compare the data for velocity at selected stroke frequencies over the range of frequencies studied when using the lights compared to not using the lights.

Results

Each swimmer completed all aspects of the experiments. The velocity of swimming in the training intervals without the pacing lights was 0.4m/sec slower (two percent) on average than the velocity when they were trained more consistently by using the pacing light system.

These data demonstrate that swimmers do not maintain the desired speed during training splits. They also suggest that clamping the speed during the splits would result in higher quality sessions and, thus, greater improvement.

The data for the velocity-stroke rate curves (pre-training, post-training/no lights and post-training/with lights) are shown in Fig. 2.

The swimmers trained between 80 to 120 strokes per minute. There were no significant differences in the velocities for given stroke rates among the three data sets below the range of stroke frequencies used in the training. The velocities over the range of stroke frequencies used in training for the post-training with lights data were significantly higher than pre-training and post-training no lights velocities.

The improvement in the light-trained group averaged four percent, while using the same training without lights, the improvement was two percent. Thus, the improvement using the lights is twice the same training without the pacing lights.

The improved maximum swimming speed carried over into the improvements in meet performances at all distances. The difference in improvement training with the lights compared with the same training without the lights could potentially decrease times by 65-hundredths of a second for every 50 meters swum.

Conclusion

Our study demonstrated that swimmers cannot control their training velocities within splits, and, in fact,

These data demonstrate that swimmers do not maintain the desired speed during training splits. They also suggest that clamping the speed during the splits would result in higher quality sessions and, thus, greater improvement.

they swim slower than directed by the coach.

This under-performance can be corrected by pacing the swimmers, using the underwater pacing light system that we have developed. This improved training increased maximum velocity and meet performance twofold over training without velocity pacing.

Although we could not analyze the data statistically due to the small number of swimmers in the other three strokes, similar improvements were seen in the breaststrokers, backstrokers and butterflyers.

About the Authors

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