

# Swimming in the fast lane

By D. Joseph Hunsaker

Speed in the water is the goal of the world-class swimmers who will journey to Barcelona this summer. Along with all of their efforts in preparing for the experience of a lifetime is the expectation that the Olympic pool will possess all of the qualities needed to maximize these efforts.

What makes water fast? There are seven factors that must exist to maximize the performance of speed swimmers. These factors are not prioritized; however, some are more essential than others.

*Chemical balance.* The pool water must not be chemically aggressive to the degree that it's so irritating to the mucous membranes of the sinus, mouth and eyes (goggles can leak) that the sensation will distract an athlete and affect his or her concentration. Ideally, the water should have a free chlorine level of .5 to 1.0 ppm and a pH of 7.2 to 7.4 with an oxidation reduction potential potential of 750 millivolts.

In some pools, these values are created with a primary or secondary treatment of the water with corona discharge ozone or copper and silver ionization. In the final analysis, pool

water must meet the quality standards of the local jurisdictional health agency.

*Clarity.* Pool water must be clear so that swimmers have excellent underwater vision. Turbid water can be a distraction and is therefore undesirable. Clarity is the result of efficient filtration. Particle sizes greater than 15 microns must be removed from the water through the use of screens, a filter media and finally during oxidation caused by hypochlorous acid or hypobromous acid and/or ozonation. Water must have a turbidity level that does not exceed 0.5 nephelometer – an instrument for measuring cloudiness – turbidity units.

*Temperature.* Swimmers must be comfortable in the water, which means the water temperature should be approximately 78 degrees Fahrenheit (25.5 degrees Celsius). At this temperature, the swimmer's body will not overheat at maximum effort and stress.

At temperatures much below this level, swimmers usually complain of stiffening muscles, and the body will burn more calories to offset the colder skin temperature. At water temperatures above 80 degrees Fahrenheit (26.6 degrees Celsius), swimmers usually feel sluggish and tend to experience an undesirable rise in body temperature during maximum effort.

Controlling water temperature requires an understanding of the medium as a heat sink. Quiescent water will develop a thermocline with a layer of warm water above a colder mass below. With different types of inlet systems – wall or floor - the warm layer will be affected differently. For this reason, sensors for monitoring the temperature of the effective water volume of the race course must be correctly located in the strata where athletes swim.

The monitoring system must also include sensors at other locations in the pool tank and in the recirculation piping system. Such a system must be installed and monitored during swimming meets to determine what set points are required at the thermostat to create the

desired temperature in the swimmer's bounded water environment during the race.

A crowded spectator gallery of 5,000 to 10,000 people can change the dynamics of the air temperature/water temperature relationship. When cooling systems are activated for spectators, pool water temperature and evaporation rates may be impacted. For these reasons, the system should be engineered for best-case water temperature control and then tested during swimming meets to ascertain the effectiveness of controlling water temperature.

*Visibility.* Good underwater visibility is the product of exceptional water clarity and the light level above the swimming pool. FINA stipulates 600 lux at the turning ends, while the NCAA requires 100-foot candles at the water surface over the entire race course. At these light levels and with a white field and black markings on the pool interior, swimmer visibility will be satisfactory.

Water depth will have an effect on the reflective brilliance of the pool interior. The deeper the water, the less light reaches the white reflective surface, which in turn reflects less light. The minimum light levels listed by FINA and the NCAA, in water of minimum championship depths of 2 meters and 7 feet respectively, will provide satisfactory visibility assuming the light sources are correctly located.

Direct illumination from above should be used with fixtures located directly over the water surface. (Indirect lighting using reflective light bounced off the ceiling is not recommended.) With the overhead light source directed perpendicular to the water surface, light will penetrate the water medium and reflect off the white pool interior.

Underwater lights will increase the light level under the water surface, and will also reflect off the white interior. This will create an ideally illuminated medium through which swimmers will race. (It's important to note that the use of underwater robot cameras using a wide-angle lens and propelled along the bottom under the

racingswimmer may be affected by the permanent wall mounted lights. As this technology develops, collateral influences will have to be analyzed.)



The choice of light fixtures should be based upon several considerations. Metal halide is not often selected for overhead fixtures, while quartz lamps are preferred for underwater lights. These products produce a white light that is preferred for competition. Designers and owners have experimented with high-pressure sodium, but the light spectrum creates some objectionable effects in the form of reflected glare on the water and a diminished degree of visibility below the surface.

*Subsurface turbulence.* It's thought that subsurface turbulence can inhibit the forward motion of a swimmer. This turbulence can be

caused by water currents from the pool's recirculation system. These currents seem to vary depending upon the type and location of the inlets. Currents that are the result of circulation flow can be a problem if they exist in the racecourse.

Of greater concern is the theory of rebound turbulence – created by swimmers stroking at the surface – which reaches the bottom of the tank and then rebounds to the surface so it interferes with the forward progress of swimmers. If of sufficient energy and water mass, this turbulence can affect the catch of the swimmer's hands and the propulsion created by the feet.

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To date, there have been no empirical studies conducted to identify the amount and nature of the rebound turbulence that occurs when swimmers race in a pool, or what influence various pool depths have on that turbulence. The minimum depths stipulated for championship competition, especially for the Olympics and World Cup, are sufficient to minimize any subsurface turbulence that will negatively affect the swimmers at the surface above.

*Surface turbulence.* The effect of the water surface on forward progress has been recognized for centuries by people who have struggled to paddle a canoe or row a boat through choppy water. Swimmers have long been aware of the difficulty of swimming through rough water as compared to a smooth, flat surface.

It was the basic understanding that led to the development of floating lane dividers and subsequently to the wave quelling designs that are used today. Floating lane lines absorb

wave energy created in each lane by swimmers and contain any energy that is not absorbed within the lane. The primary benefit of contemporary lane lines is that they isolate the turbulence in one lane and prevent it from crossing into adjacent lanes.

To a lesser degree, surface turbulence created inside the lane by the swimmer must be dissipated. The speed of the swimmer is not impeded by the residual surface turbulence until he or she swims back through the medium. As a result, the swimmer experiences greater impedance the first third of each length, with the exception of the first length. Conversely, the least impedance occurs in the last third of each length, when the surface has experienced the longest period of time from the last surface agitation.

This phenomenon affects short-course races differently than long-course races. Because of the shorter time frame, the water is "rougher" for the duration of a multilength race in a short course than it is in a long course. It's difficult to apply a factor to the difference because other influences impact the issue, such as the number of turns and push-offs, and the possible rest or stimulation the turns provide the swimmer.

*Psychological influence.* Psychological impact is a subjective variable that influences all athletes in a positive or negative way at the start of a race. While a swimmer's mental attitude is most affected by his or her coach, plus the swimmer's preparation for the event, there are things that natatorium designers can do to influence the excitement and adrenalin level of the athletes. First, architects should be educated about the experience of the competitors. This includes identifying psychological impact points, including the locker room environment, the first entry into the natatorium, the warm-up routine, the rubdown, and the sounds and smells he or she experiences as more athletes arrive.

As the time of the event draws closer, there are special individual behavior patterns that each competitor will carry out. This usually includes

a period of time for seclusion, meditation and concentration. Privacy may be an empty room, a corner under the stands or simply a towel over the head.



Time itself is a stimulant, so the awareness and communication of time is important. Clocks should be synchronized and located throughout the natatorium, locker rooms and support spaces.

For Olympic and world-class competition, a ready room must be provided. The location, design and appearance of this room can be a factor in motivating swimmers, as is the time spent in the room before the athletes are led out to their stations on deck before moving to the starting blocks.

These microstimuli affect an athlete as he or she progresses to the emotional and physical climax of the race, but there are also macrostimuli created by the scale of the facility, the spectators who become a part of the experience and the pre- and post-race ceremonies. The total pageantry of a world-class championship will have an impact on the athletes – sometimes for the better in some cases for the worse.

If all of the environmental stimuli conditions come together to help produce record-breaking times, and even more important, personal-best times for those who do not win, the pool will be known as a “fast pool.” Such recognition, based upon performance, is the goal of competitive pool designers.