The World Swimming Coaches Association

Newsletter

Vol 11 Issue 1

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A THOUGHT PIECE INTENDED TO PROVOKE OPINIONS AND DISCUSSION.

What Will Improve Swimming In The Underdeveloped Swimming Nations?

By John Leonard

One of the charges of the World Swimming Coaches Association is to assist in improving swimming worldwide. This means in the underdeveloped swimming nations as well as the historically strong swimming nations. So what exactly will help the underdeveloped nations move forward?

First, I am sure we can agree on a couple of things.

A) New, safe, sanitary pools to swim in and access to those pools at no or a reasonable cost. (Teach learn to swim, conduct Age Group and development programs, encourage senior training programs.)

B) A dedicated coaching corps interested in staying home, earning a living and building swimming in their own nation. (Not running off to a developed swimming nation once they have the credentials to do so, tempting as this might be.)

C) Interest in the sport among the population. (Easy to say, not so easy to do, if you have no history in the sport.)

Now to the "hard stuff"…….
Does having an entry or two to the Olympic Games and World Championships help develop swimming in a nation? I'd argue no, just the opposite….this policy simply encourages wealthy people to send their children abroad to existing excellent programs to "prepare them" there for representing their home nation at the Games/WChamps. Who can blame them? We all want the very best of opportunities for our own children.

In fact, it allows FINA to claim "Universality" of the sport…..many nations sending under-prepared, non-qualified, but SELECTED athletes to the Games, so FINA can correctly claim large national numbers of "representatives." Not to put too fine a point on it, an athlete from an African nation is training at a major USA University and living there full time. He travels to London to compete in the Olympic Games, after being "selected" by his nation. Then he travels "home" to the USA and his university. How exactly does that help build swimming in that African nation? Does it create a role model you can see, and touch and learn from? Or is it simply "representative"? of the nation. (As a disclaimer, I am NOT criticizing those who do exactly that, we all wish the best for our children. I am questioning if this actually builds swimming in that nation?

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IF you want to develop a nation's swimming, it seems to me that you must "reward" those athletes and coaches who demonstrate the ability and the willingness to do what it takes to excel at the world level. And of course, that is very difficult. One way of rewarding them and at the same time "moving them forward" is to place them in a developed nation, where they will daily compete with even better athletes and learn to improve further onto the world stage. BUT.

IF that athlete never comes home to train, to teach those following them and provide the swimming role model, idol and example, then the connection between elite reward and expanding the corps of potential future elites is lost. One athlete benefits, but the nation does not move forward.

At the same time, if that elite athlete does come home, the home country must provide what that athlete needs, to train adequately at home in terms of coach, training time, support for living, and all the other things that go into the making of a world class athlete. As Rudyard Kipling put it…**the strength of the wolf is the pack, the strength of the pack is the wolf**.

The wolf (elite athlete) must come home and give his support to his community at home and help them move forward. When he does so, the pack (the home organization and athletes) must realize that the wolf has different and perhaps more extensive needs than those who are not yet at elite level, and do their best to provide those.

Everyone in the "aspiring elite" group must realize their responsibility as they become the elite, to make the necessary sacrifices and contributions to give back.

Finally, there is one other key "missing piece." And that is the proper level of aspiration.

For an underprepared athlete to attend the Olympic Games and compete with no hope of advancing to the semi-finals even, is a very bitter-sweet experience. Happy to be there, but no meaningful chance to advance, leaves a very under-stimulated and un-motivated athlete.

The key then, is to have an appropriate level of competition for each level of athlete from the novice to the Olympian. While the Olympian plays on the Olympic field (pool), and the novice in the local pool, the key to development is to make sure that excellent, "reachable" experiences on a regional level are available where the athlete has a reasonable chance to advance to the finals or even win. This will ensure that all world athletes are motivated by an achievable series of goals.

In many places in the swimming world today, we lack the proper structure to encourage those not-yet-elite, but aspiring athletes, to move to the next level in competition, and thus, inspire them to new and harder levels of training. We would do well to focus on making sure that all our "developing nation" targets have regional competitions that are well-developed, well-funded and fully available to provide a step on the ladder to the level of qualifying for the Olympic Games and World Championships.

Athletes will train harder and achieve more when we are able to place the full and properly realized goals in front of them, where they are seen as "achievable."

All of us involved in world swimming should be working to realize this expectation of our swimmers. After all, "a Rising Tide lifts ALL the Boats".

All the Best, John Leonard

Coach Representation on the FINA Bureau….VOTE WITH THE FINA PRESIDENT!

By John Leonard, American Swimming Coaches Association and World Swimming Coaches Association Executive Director.

The FINA Bureau Meeting of January 27-28 in Frankfurt, Germany, saw a remarkable shift in opinion on the topic above…..being the inclusion of a Professional Coach on the FINA Bureau in it's coming iterations, with voice but no vote.

The measure, proposed by USA-Swimming and other federations, lost by a vote of 17-4…BUT, voting with the four, was the FINA PRESIDENT Julio Maglione.

This vote simply means that the Bureau will recommend that this motion not be adopted by the FINA Congress in it's meetings on the FINA Constitution, this July in Shanghai. As we saw with the swimsuit rules, sometimes, when the cause is good, the Federations will NOT support the Bureau recommendations, but instead, vote for the right result.

And surely in a sport dominated by professional athletes and coached by professional coaches, the input from one of those professional coaches cannot be anything but a wonderful assistance to the volunteers of the FINA Bureau.

(One should note that the same FINA Bureau, at the same meeting, approved a measure to include the selected chair of the FINA Athletes Commission, as a member of the new Bureau, with voice but no vote. Why is an athlete approved, but a coach not?)

This leaves all of us, as professional coaches in the powerful position of urging our Federations to VOTE WITH THE FINA PRESIDENT in July, and add a professional coach to the Bureau, alongside the athlete.

A more important principle also arises here…..neither athletes nor coaches need their representative selected by the FINA Bureau. Athletes and Coaches are fully mature enough to VOTE for their representatives on the ATHLETES and COACHES Committees. My hope is that a number of nations will seek to amend the measure on the floor of the Congress to an ELECTION, rather than a SELECTION of representatives of the most important parts of our sport…our athletes and our coaches. Please, let's make it so!

Let us work from now through July, to persuade our respective national federations to VOTE WITH THE FINA PRESIDENT and put a coach on the FINA Bureau.

Nothing is more important to the future success of our sport. •

InCredible. Really.

By John Leonard

A review by ACES (Association of Chief Executives for Sport) supplied to USA-Swimming reports that exactly ZERO are the number of people serving on the governing boards of directors for their international Federation, who are ATHLETES or COACHES. At the end of this short article, I'll list all the federations who responded.

No athletes. No coaches. What conclusions can we draw from this?

1) International Federations operate as paternalistic organizations where anyone except the "suits" (sport politicians) are not welcome.
2) Professional athletes in all sports, are "done to, and for" by amateurs who reside in the old thinking of the 19th century that only "gentlemen" run sport.
3) Professional coaches are not considered worthy to help govern the sports in which they spend their entire lives.

Someone told me recently that clearly it was a "bad idea" to have athletes and coaches on governing bodies. This same person is a ranking sport politician not only in his own federation, but in the international federation. What flawed logic. ("It's never been so, so clearly it SHOULD never be so.")

In reality, this is the strongest possible indictment of the CREDIBILITY of International Sports Federations to govern their sport. Making them, quite literally, IN-Credible.

As proof of the absurdity of this conclusion, I point to USA-Swimming and to Australian Swimming….the two most successful sports teams in the history of Olympic Sport, in terms of medals won, records set, etc. (we'll dismiss the old drug cheating East German regime from consideration, shall we?)

Both organizations have both athletes and coaches embedded permanently in the highest levels of decision making in their organization….quite successfully it would appear. While I cannot speak authoritatively on the history of Australian Swimming, it is correct that USA-Swimming has had athletes and coaches on it's Board of Directors since it's inception in 1979. It works for the two most successful Olympic organizations on the planet, but wouldn't work for International Federations? Please.

And please, remember that we're talking "Serving on the governing boards…" not the eyewash of "athletes commissions" and some others that the IOC put in place to blunt valid criticism, and then roundly ignore.

Time for a Change. InCredible.

The sports represented in the survey: Badminton, Biathlon, Bowling, Equestrian, Fencing, Field Hockey, Hockey, Lacrosse, Luge, Masters Swimming, Rugby, Sailing, Shooting, Soccer, Softball, Swimming, Synchro Swimming, Table Tennis, Volleyball, Water Polo, Water Ski, Wrestling. •

ROME, 2009 Reflections.

By John Leonard, WSCA Executive Director

Two major things came to me in Rome.

First, the FINA Bureau was not going to fix the greatest crisis in our sport's history. They had botched the suit issue on three other occasions when they reviewed it. They botched it because they depend on one source of information, the Executive Director of FINA, and look no further than that for good ideas and to understand the needs of the sport. And for a very, very long time, the Executive Director "got it wrong." First, he didn't understand the seriousness of the situation, and how it would distort and destroy the very fabric of the sport, and when he did, he would not just "bite the bullet" and do what needed to be done.

Ancient wisdom tells us that you can't cross a chasm in two jumps. The Bureau in all its wisdom, led by its Executive Director, kept talking about doing the chasm jump in three steps. Each step just plunged them further into the abyss.

So COACHES took control in the FINA Congress in Rome and first, by a vote of 113 to Zero, the Technical Congress voted to put the word "swimsuits" into Rule 10.7, which meant the door was open for FINA to control and eliminate the problems. That was Thursday.

On Friday, COACHES took control once again and offered the resolution with the specifics that solved the problem... all textiles in the suits and textiles only, no zippers, and a limit of suit profile to knees to navel for men and knees to shoulders for women. This the day after nine coaches from seven leading countries met with the FINA Executive Director to try to explain what was needed. Most of it fell on deaf ears. We kept hearing how we had to take the needs of the manufacturers into account.

This while the sport was in chaos outside the meeting doors and in the underpinning of the ancient building adjacent to the pool, a scene like the gladiators of ancient Rome was unfolding as hundreds of swimmers pushed, shoved and waved their athlete badges to try to score one of the newest and most popular pieces of plastic in which to swim. This was not the sport we loved. This was a cross of circus and farce. The Bureau and Executive Director apparently could not see this.....or didn't care.

That vote had some opposition, because 6 people did not understand the meaning of the English word, TEXTILE, so they voted against it. The other 168 delegates in the room were not content to leave this to the Bureau to muck up once again, and voted into place the coaches preferred rule (stated above.)

On both days, the President of FINA and the Executive Director spoke AGAINST the motion on the floor to solve the swimsuit problem. Talk about wildly out of touch with reality.....

And of course, in the typical FINA way, the rest of the Bureau sat on their hands at the bidding of the President and Executive Director. Not an independent thought among them, nor the moral courage to express it, if it existed.

To their credit and to be fair, the Bureau the next week did not try to overturn the overwhelming view of the Congress. Nice of them.

This led me to my second thought.

In the last twenty years, we've had three major issues in our sport:

1. The doping crisis. (still on-going?)
2. The world meet schedule issue. (coherent meet schedule that does not require doping to compete fairly and well.)
3. The Swimsuit Debacle.

In each case, the Bureau has not ever really reacted or acted, much less showed leadership. The President, the Executive Director may or may not have been paying attention. In each case, they were very late to the table to discuss the issues and in each case, had to be forced to hear the views of those who actually knew something about the topic.

On the first, Coaches and Media and to some extent, athletes, eventually FORCED the FINA Bureau to take its head out of the sand and support anti-doping efforts. Ask yourself, if coaches had been quiet, where would we be on anti-doping today?

On the second, it took the threat of coaches withholding their athletes from FINA World Championships (Specifically the short course meets) before the Executive Director finally came to the Coaches and sought a solution...years after he was first told this was an issue.

On the third, Coaches had to force new rules through the 2009 Congress, because the Bureau and Executive STILL had not done anything to resolve this process prior to the Rome event. We had to do this OVER THE OBJECTIONS of the FINA President and Executive Director. When specifically asked by a member of the Coaches Commission if he cared to hear the Commissions views on the swimwear issue, the Executive Director responded with a simple

ROME, 2009 Reflections.

"NO." He gets kudos for brevity of expression. And he deserves something else for communication skills with his coaches commission.

We still don't have video replay for fair judging because the Bureau and its ED decided at the last minute that they didn't want it. We are now the last major sport on earth to deny the best officiating tool on the planet...instant replay. One is left to ask, WHY? The officials committee, which should know best, has entirely endorsed it, tested it, supported it. But still we officiate with no option to review. Fair competion for all?

Are we a professional sport? Some of us would like to think so, including some remarkable modern athletes.

If so, we are a professional sport being run by well-meaning but completely inept amateurs.

Its time to think seriously of an alternative to the way FINA is Presently Run and that alternative must include far more prominent roles for the professionals and technical people who have solved or attempted to solve our major problems over the past two decades.

We need to remake FINA as an "athlete centered, professionally led, and administratively supported" organization.

At present, one could make the argument that we are "Bureau centered, amateurly led, and administratively ill-informed". In the next WSCA newsletter, I'll provide some ideas on how FINA could rebuild itself for the century ahead.

John Leonard

Why Competitive Swimmers Need Explosive Power

By Grif Fig

This article focuses on how an increase in power can help swimming performance in swimming. When examining swim races many different instances exist in which a swimmer would benefit from having more explosive power. The components of the race we will focus on in this article are the start, turn, and pull of the stroke. The biomechanics of the start and turn (the push off) are very similar to the Squat and Romanian Dead Lift (RDL) which incorporates the use of the same muscle groups (hamstrings, gluts, and quadriceps). Specifically, increasing power in the lower body and pulling (lats, posterior deltoids) muscle groups would provide a huge benefit in swimming since they are the muscle groups that are in dominant in the sport. Components of the race, such as starts, turns, breakouts, the kick, and the pull of the stroke can benefit from a training program that provides an improvement in power production.

Before we go any further let's define exactly what power is. Power is defined as:

Power = Force x velocity
or
Power = Work/time

Simply put, power is a perfect blend of speed and strength or more work in a given time period. Either one of these mathematical expressions can be directly applied to any race.

If two people have the same amount of strength and one can apply that strength faster than the other, which is better off? Of course the individual who can apply his strength faster has a clear cut advantage; the individual would have greater power output. Let's examine the different ways to train for explosive power and how it can help improve different components of a race.

Swimmers need to take advantage of every start and turn during a race. Having a start and turn that are superior to the competition provides a distinct advantage, particularly for sprinters. Training the gluts, hamstrings, hip flexors, and quadriceps explosively will increase the amount of power one is able to generate off the start and turn, as well as increasing total kicking power. This is evident since these muscle groups are being used during these movements. The muscle groups are key in producing power off the start and the turn, which are the only two portions of the race in which a swimmer is able to produce force off a solid base (the starting block and the wall) and take advantage of ground reaction forces. We have a variety of methods to train the legs for power at the Institute of Human Performance (IHP). One example is the Box Jump. This is a great exercise for enhancing power in the legs. You may progress your athletes through this exercise by increasing the size of the box and for swimmers that are advanced in this exercise you may start adding resistance to the jumps through the use of dumbbells or a weighted vest.

The pulling muscles (lats, posterior deltoids, etc.) are used during upper body propulsion in swimming. The breaststroke pullout provides a good

example of how training the pulling muscles of the upper body can assist in an increase in propulsion. The pullout is the first movement during breaststroke when the swimmer is coming off the start or turn. While underwater you are allowed to pull your hands all the way down from the overhead position and extend the elbows until the hands go down past the hips one time off of every wall. This is one of the most explosive pulling actions you will see in a swim race. It is an element of a race that is very crucial to performance. Since it is the first movement off each start and turn it is a factor in developing maximum speed quickly. A swimmer with weak pullouts is basically playing catch-up after every turn. This leaves little chance to beat someone of equal swimming ability, but who has a better pullout.

Including pulling power exercises in a swimmer's strength training program will teach these muscles to generate force at a faster rate, thus, increasing the athlete's total pulling power. Increasing a swimmers pulling power will assist his ability to create more propulsion during each stroke cycle. This will not only allow a swimmer to increase his speed but also will assist in maintaining proper body position and alignment in the water. This applies to all four strokes, regardless of the difference in different stroking patterns.

One of my favorite ways to train for more powerful breaststroke pullouts is the Overhead Medicine Ball Toss (OMBT), which replicates the breaststroke pullout closely. The two movements are very similar. This exercise may be utilized in two ways. You may perform this exercise with the goal of completing as many reps as possible in a certain time period (i.e., work/time) when working on power endurance. The OMBT can also be performed with the focus on generating as much force as possible (i.e., Force x Velocity) during each repetition when working on raw power development.

The following is an example of a power development training session focusing on the lower body. The workout consists of 3, 4 exercise circuits, with the red letter indicating a new circuit. A 45 second rest period is taken between the first (the strength exercise) and second (the power exercise) exercise of each circuit. The movement of the 1st exercise should be no slower than a 2:1 concentric:eccentric ratio. The 2nd exercise should always be fast and explosive. The 3rd and 4th exercises are functional and core exercises.

Next is an example of power endurance workout, where the focus is to hold on to power for a longer duration. The 45 second rest period is eliminated to improve power endurance. This particular workout is focused on the pulling muscles.

These are just a few examples of the many training programs and exercise that can be used to increase power in the major muscle groups used in swimming.

While building strength may benefit the swimmer, adding exercises that focus on speed as well is more specific to the demands of the sport. These exercises have been integrated into all of our swimmers' strength training programs and we have seen tremendous time improvements during this time period. If you have any more questions regarding this topic you may contact me at Grif@ihpfit.com. •

BB Squat	3 x 5
Box Jumps	3 x 5
Band Swims	3 x 20
Stability Ball Rollouts	3 x 12
RDL	3 x 5
Reverse Scoop Toss	3 x 5
T-Stability Push – ups	3 x 10
Stability Ball Log Rolls	3 x 10
Lunges	3 x 5
Split Jumps	3 x 5
Recline Rope Pulls	3 x 10
Body Blade	3 x 30 seconds

Free Motion Rows	3 x 5
Explosive Rope Pulls	3 x 5
Triple Threat	3 x 10
Hyperextensions	3 x 10
Free Motion Lat Pull	3 x 5
MB Slams	3 x 5
Hands on Medicine Ball P – up	3 x 10
Reverse Hyperextensions	3 x 10
Bent Over DB Row	3 x 5
Explosive Band Swim	3 x 5
Stability Ball Pike	3 x 10
Prone Bosu Streamline Position	3 x 30s

Swimming arcs and curves.

By Lewis J O McGill, PhD

Introduction

The aim of every competitive swimmer is to travel the prescribed distance in the shortest possible time. If the time taken is less than their opponents' they will be declared the winner of the race. This paper grew from my observations of swimmers when standing at the end of a lane in the capacity of Inspector of Turns (IOT). It has been common to see swimmers track along a path which deviated from the centre line. Some swim near the lane line which seems to mimic their training path. Others swim towards the lane line, make a correction only to swim near the opposite line. A few swimmers have been seen making several changes in one lap. Although I have not kept figures, there have been enough incidents to take my attention. This phenomenon occurs across the age groups and it is not just the younger swimmers who are learning who follow this pattern. However, it is much less prevalent in the more elite older swimmers.

The hypothesis: when a swimmer moves away from the centre line, this increases the distance to be travelled. In turn, the increase in distance correlates to an increase in the time taken if the average speed is kept constant. The corollary: swimmers can learn to understand their stroke and develop an awareness of the feeling associated with swimming in a straight line along the centre of the lane, and conversely know when they deviate from the shortest possible (allowed) distance.

Swimming close to the lane line can be used as a race tactic. It is possible for a swimmer to draft on the bow wave created by the swimmer in the next lane. The magnitude of the effect depends on the mass and speed of the other swimmer. This case will not be considered in this paper, but it would be interesting to collect data to ascertain whether the additional distance travelled using the drafting strategy is countered by the gain in speed.

Swimmers must be aware of how the laws of motion influence their swimming. Newton's Third Law of Motion can be seen in the action of one part of the swimmer's body being reflected in the reaction of another part. For example, a downward push with the arms will be matched by an equal and opposite reaction by the legs.

Small errors can become engrained habitual motor patterns and correcting these errors takes more time than learning the correct patterns in the first place. As young swimmers grow their bodies change and they must continually re-learn to swim each stroke, which in essence are new skills. Swimming has an advantage over many sports by not operating to distinct seasons. In general swimmers will have a short break from training and competing, often one month, and then continue with their schedule. This means young swimmers are practising each stroke through each growth spurt. It is important for coaches to be mindful of this and observe and help each swimmer to maintain correct technique throughout the swimmer's active swimming career.

Body Segments

The human body consists of several segments, head, trunk, arms, and legs, all of which must be coordinated to produce the most efficient movement while being moved independently. The smooth coordination of the body parts is the major challenge for all athletes and minor changes can produce unwanted consequences and results. In swimming, the aim is to achieve the most streamlined body position to reduce the amount of resistance in the form of drag and eddies while exerting maximum force on the water to propel the body forward.

Off-centre travel is the result of body segments moving out of synchronisation, applying unequal forces, and not applying forces in the desired direction of travel, all of which cause unbalanced movement and non-linear travel. Causes of non-linear travel can occur:

- At the start
    - Uneven push with legs
    - Twisted or bent body
    - Uneven swing of arms
    - Head turned to one side
- During the Stroke
    - Uneven force applied by arms and/or legs
    - Twisted body (body position not streamlined)
    - Hand entry, backstroke and freestyle, different distances from centre line
    - Hand and feet action not balanced and even
    - Force applied in non-intended direction of travel
- During the Turn
    - Uneven push with legs
    - Twisted body position entering and leaving the turn
    - Exaggerated lifting or lowering of head and/or trunk

Purpose

The purpose of this paper is to explore in a theoretical manner the possible ways in which swimmers can deviate from the centre of the lane and thus increase the distance travelled and consequently the time taken to complete the race.

In all strokes each side of the body performs the same action. There are two styles:

1. Long axis strokes: the actions occur consecutively, and
2. Short axis strokes: the actions occur simultaneously.

In all strokes the aim is to apply maximum forces in the direction of travel and to minimise forces which do not act in this direction. In other words, the forces generated by one side of the body must be equalled by the forces generated by the other.

A. Long Axis Strokes: freestyle and backstroke

Freestyle and backstroke are executed as long axis strokes—one side of the body performs an action while the other recovers to begin the same action, thus creating continuous movement through the water. This forms a sequence of force-action:recovery-action. The challenge for the swimmer is to ensure each side of the body produces the same amount of force, and the recovery action produces the minimal amount of resistance.

B. Short Axis Strokes: breast stroke and butterfly

In contrast, the other two strokes, breast stroke and butterfly, are executed with each side of the body performing the same action as though each was mirroring the other around the short axis through the swimmer's hips. The challenge for the swimmer is to produce the same amount of force with both sides of the body, simultaneously.

Calculations

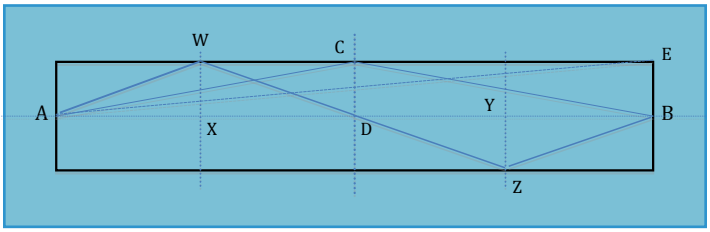
A selection of measurements and calculation techniques are applied to swimming, to extrapolate possible outcomes, and draw conclusions for coaching and training. It must be stressed the figures are theoretical and do not represent precise distances. However, they provide a set of parameters which swimmers and coaches can consider when looking at the most effective way of achieving that ever-present goal of personal best times.

The accepted adage is the shortest distance between two points is a straight line. The focus in this paper is to explore the magnitude of the increases in distances travelled by swimmers who do not travel in the straight line along the centre of the lane. When racing, swimmers travel in a lane 25 or 50 metres long by 2.5 metres wide.

There are a number of possibilities when considering the distance travelled by a swimmer. The first is the minimum, in a long course race, 50 meters. Observers will have noticed swimmers do not always travel in a straight line joining the centre of the lane, but often touch the end of the pool to either side, and many swimmers travel towards and near the lane lines. Any deviation from the centre will add to the distance travelled. The following calculations are designed to put numbers to that additional distance. In all cases the distance swum is further than 50 metres, which is the straight line between points A and B in all of the diagrams.

Swimmers travel with a gap between their body and the lane line. This distance has not been considered in the calculations below.

Scenario 1



Where: AB = 50m; AD, DB = 25m; CD, WX, YZ = 1.25m; AX, XD, DY, YB = 12.5m

If the swimmer travels directly to the side of the lane at the other end of the pool (1.25 m off centre) they will have travelled an additional 0.0156 m along line AE in the diagram above.

Using Pythagoras' Theorem:
Side 1 = 50 m
Side 2 = 1.25 m
Distance = 50.0156 m
AE^2 = AB2 + BE2
= 502 + 1.252
AE = 50.0156 m

If they were to travel directly from the starting block to the side of the lane at the 25 metre mark (AC) they will have travelled an additional 0.031 m. And if they then swam back to the centre at the end of the lap, it is possible they could have travelled an additional 0.0624 m. (AC + CB) over the completed lap.

AC^2 = AD2 + CD2
AC = 25.03123

AC + CB = 50.0624 m

A swimmer who swims in a zigzag pattern, to the side of the lane and back to the centre every 12.5m, (AW + WD + DZ + ZB) the additional distance travelled would be 0.249m.

AW^2 = WX2 + AX^2
AW = 12.562344

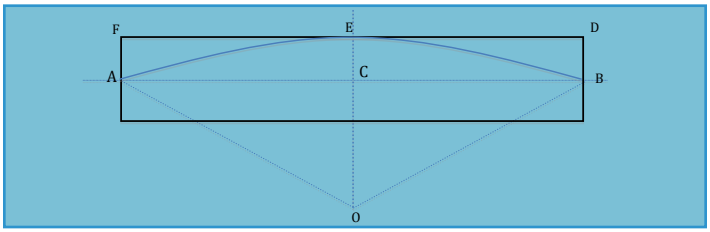
AW+WD+DZ+ZB = 50.249376m

It is not usual for swimmers to follow a straight path to the side of the lane either to the 25 metre mark or the other end of the lane. It is more likely for them to follow a curved path. The swimmer will make gradual changes in direction to get back on line and as they move forward these changes result in an arc. Two scenarios have been analysed to illustrate this possibility.

Scenario 2

In this scenario the swimmer veers to the side of the lane making it to the rope at the 25 metre mark and then implementing correcting strategies to finish in the centre of the lane. This path will describe the shape of an arc. The distance travelled in this instance will be 50.083 metres.

Calculate distance of arc AEB



Where: AB = 50m; AC, BC = 25m; AF, CE, BD = 1.25m; EO = radius of circle of arc AO; EO, BO = diameter; Chords = AB (ACB+ BC) and [(EC + CO) + radius

Step One (calculate radius)
Use chord properties; when 2 chords intersect the products of each are equal.

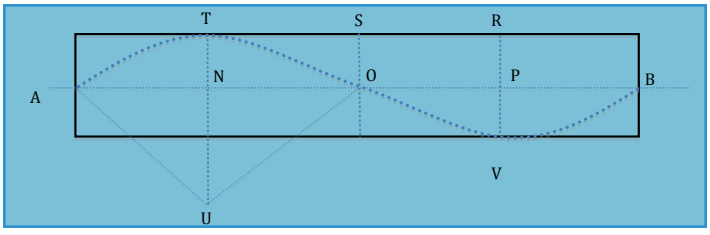
AC x BC = EC x (CO + radius)
Radius = 250.625 m

Step Two (calculate angle AOB)
Angle AOB = angle AOE + EOC (equal because in equilateral triangle).
sin EOB = 5.724^0
Angle AOB = 11.45^0

Step Three (calculate arc)
Length of arc AB = angle/180 x pi x radius
Arc AC = 50.083 metre

Scenario Three

This pathway is a double arc—the swimmer veers towards the rope, over-corrects at the 12.5 metre mark, heads towards the rope 37.5 metre from the start, and corrects to finish in the centre of the lane.



Where: AB = 50m; AO, OB = 25m; AN, NO, OP, PB = 12.5m; TN, SO, RP = 1.25m; UA, UO, TN+NU = radius; Diameter = 2(TN + NU).

Calculate distance AT + TO + OV + VB (ie two equal arcs AO and OB)

Step One (calculate radius). Use chord properties
AN x NO = 125m
Radius = 63.125m

Step Two (calculate angle AUO)
Angle AUO = AUT + TUO (equilateral triangle)
Angle AUO = 22.84^0

Step Three (calculate arc)
Length of arc = angle/180 x pi x radius
= 25.163m
Distance travelled for lap = 50.326m

The distance travelled when following the double arc pathway will be 50.326 metres. This shows, the more a swimmer deviates from the centre straight path, the more he must make corrections in direction, and this adds more distance. The more deviations the more additional distance swum. The following table illustrates this phenomenon. All distances are in metres.

Pathway	Race distance	Actual Distance	Difference
Straight, centre	50	50	0
Diagonal straight to side of lane	50	50.015	0.015
Chevron (to and from 25 metre straight)	50	50.062	0.062
Double chevron (12.5m)	50	50.249376	0.249376
Arc through 25 metre	50	50.083	0.083
Double arc	50	50.326	0.326

The increased distances become more apparent for longer distances. For example:

Pathway	Race distance	Actual Distance	Difference
Straight, centre	100	100	0
Diagonal straight to side of lane	100	100.03	0.03
Chevron (to and from 25 metre straight)	100	100.124	0.124
Double chevron (12.5m)	100	100.49875	0.49875
Arc through 25 metre	100	100.166	0.166
Double arc	100	100.652	0.652

And,

Pathway	Race distance	Actual Distance	Difference
Straight, centre	200	200	0
Diagonal straight to side of lane	200	200.06	0.06
Chevron (to and from 25 metre, straight)	200	200.248	0.248
Arc through 25 metre	200	200.332	0.332
Double arc	200	201.304	1.304

These comparisons demonstrate how the small deviation from the straight path started at the beginning of the race can produce a cumulative effect, or result, as the distances increase, which in turn compounds the initial change in direction.

Scenario Four

A further scenario is where the swimmer weaves to and from between each lane line in what Gary Hurring describes as multi-directional changes. This track will not be included in the calculations in this paper.

Race distance

The next step is to consider the effects of additional distance on the time taken to complete a race distance. Additional distance must result in additional time required if the swimmer maintains their average speed for the race. It is possible to calculate the increase in average speed required to cover a race of say 100 metres if the swimmer adds distance by veering from the centre pathway. Other than travelling on the straight path, the only way to reduce the time taken is to increase the average speed. When a swimmer travels at 2 m/s, a 2 cm difference in distance travelled corresponds to 0.01 second lost.

Over 50 metres a swimmer who travels along any of the three more complex paths which deviate from the centre line, will travel between 6cm and 32cm further. If we use the Olympic Record (2008: 21.30 second) for the men's 50 metre freestyle, adding 6cm to the distance would mean the swimmer would have to increase their average speed from 2.3437m/s to 2.350m/s, 2.351m/s for 8cm, and 2.363m/s for 32cm, respectively.

In the 100m backstroke race (2008 OR = 52.54 seconds) the increases in average speed would be from 1.903m/s to 1.905m/s (6cm), 1.906m/s (8cm), and 1.916/s (32cm).

The same effects are seen when applied in races for women. In a 50m freestyle race (OR 24.06 seconds) when covering the additional distance the swimmer would have to increase their average speed from 2.078m/s to 2.08m/s (6cm), 2.082m/s (8cm), and 2.09m/s (32cm) to win the race. Similarly in the 100m backstroke the increase in average speed would need to go from 1.702m/s to 1.703m/s (6cm), 1.704m/s (8cm), and 1.712m/s (32cm).

2008 Olympic Games

Consider the 2008 Olympic women's 50 metre Freestyle final. Times = (First) 24.06 sec, [2.078 m/s], (Second) 24.07 sec. [2.0077 m/s], (Third) 24.63 sec. [2.030 m/s]. At the winner's speed the swimmer takes 0.0298 seconds to travel 0.062 metres. Adding this time to the race results the time of 24.0898 secs which would have been third place.

It is interesting to examine the 1,500 metre freestyle event because the compounding effect is greater. If, on each lap, the swimmer touched the end of the pool in the centre and veered to the side of the lane at the halfway point the total distance travelled would be 1,501.86 (30 X 50.062) metres. This is an additional 1.86 metres. At a speed of 1.702 m/s the swimmer would take 1.092 seconds to cover this additional distance. The resulting time would have earned the swimmer the bronze medal.

In the women's 400 Freestyle event the additional distance travelled would be 0.496m (8 X 0.062m). The average speed for the winner was 1.6446 m/s, while the average speed for the second placed swimmer was 1.6441 m/s. At the speed of 1.6446 m/s the swimmer would travel 0.496m in 0.3015 seconds. The difference in time between first and second place was 0.07 seconds, between second and third place 0.23 seconds, and between first and third 0.30 seconds. If the winner maintained the average speed but added the additional distance and subsequently the 0.3015 seconds they would not have received a medal.

Although when the numbers are considered in isolation they may seem small, their potential impact becomes more clear when we compare the differences with other swimmers and examine the impact over the longer distances.

The differences between individuals decrease as athletes rise through the levels of performance. At the elite level the differences are small. This is illustrated in the tables of selected 2008 Olympic swimming results below.

Event	Margin 1 & 2	Margin 2 & 3	Margin 1 & 3
Men 100 Free	0.11	0.35	0.46
Men 200 Back	0.39	0.60	0.99
Men 100 Breast	0.29	0.17	0.46
Men 200 Fly	0.67	0.27	0.94
Men 400 IM	2.32	1.93	4.25
Women 100 Free	0.04	0.23	0.27
Women 200 Back	0.99	0.90	1.89
Women 100 Breast	1.56	0.61	2.17
Women 200 Fly	0.54	1.54	2.08
Women 400 IM	0.44	1.82	2.26

In general the differences between place getters is smaller in the shorter races when compared with the longer races. There is more distance, and time, over which the small changes can be manifested. This is the basic thesis of this approach; small changes away from the mechanically sound skill performance will result in amplified effects as time and distance increase. The changes, or errors, will have a compounding effect.

Lessons to learn

A. More distance, more time.

1. All swimmers should travel the shortest required distance by swimming along the centre of the lane.

2. To swim in a straight line the swimmer must have a balanced stroke in which equal force is applied by each side of the body.

3. The forces exerted by the swimmer must be in the desired direction of travel. Any force which acts away from this direction will cause the body to travel off the centre line. Additional energy must be expended, and additional forces must be applied to move the swimmer back onto the centre line.

B. Mechanically correct performance

4. Swimmers must receive instruction and feedback to assist them to gain and maintain the skill necessary to travel on the centre line.

5. Swimmers need to learn to use appropriate cues to tell them when they are on the centre line and conversely when they veer away from it. Cues can be;
    - distance from lane lines,
    - the relative position of objects around the pool and on poolside,
    - the centre line marked on the bottom of the pool,
    - markings on the roof or ceiling (backstroke),
    - starting blocks and centre markings at the end of the lane (breast stroke and butterfly),
    - feeling of pressure of body parts on the water during each phase of the stroke,
    - feel of water flow along and around the body,
    - balanced push off from starting blocks, and on each turn.

C. Instruction and coaching

6. It is recommended coaches focus on teaching and encouraging the development and maintenance of correct technique. Irrespective of body build and personal idiosyncrasies, the laws of the universe apply to everyone. Forces produce movements in the direction in which they are applied. Therefore, athletes must be taught how, and when to apply forces. (Newton's laws of motion, coordination, timing, and sequence of stroke).

7. Learning involves a change in behaviour. To change behaviour an athlete requires feedback. The numbers in this paper illustrate how small changes in performance can produce comparatively large differences in times and placings in races. Athletes can learn to correctly perform the mechanically sound skills. They can also learn to associate internal feelings with correct performance and specific times. When all of these factors are put together the athlete is in the best possible state to achieve his optimal performance.

8. Correct technique will 'cause' the swimmer to travel in a straight line between the markings at each end of the pool. (A tautology—trying to swim in a straight line focuses the swimmer on correct and balanced technique; correct and balanced technique causes travel in a straight line). Focus on one, and the other follows.

Suggestions for research.

The distances cited in this paper are theoretical and have been calculated without measuring actual distances swum. The next stage would be to measure distances covered by swimmers in training and competition sessions. The theoretical and practical results could then be compared.

1. Track swimmers during a race to compute the distance travelled, time taken, and average speed. This information could be fed back to the coach and swimmer to guide appropriate changes.
   GPS-styled tracking instruments and cameras could be mounted above and at each end of the pool.

2. The figures of specific laps can be provided to the swimmers who can then connect the times with the feelings. This is joining mental skills with coaching and scientific measures. The measurements can be used to reinforce the feelings.

The following can cause deviations from the most efficient stroke:

1. Freestyle

Position of hands at entry. What is the effect when one hand enters the water in a different position to the other? For example, thumb first versus little finger first. The distance of entry point from centre line of body.

Path of hands and arms during the pull/push phase.

Position at which hands leave the water to begin the recovery phase. For example, if one arm exits below the hip and the other at the waist.

Position of elbows at exit. For example, one high and the other low.

Turn. Position of head at the initiation of the turn. For example, lifting the head, which increases the surface area of the body pushing against the water and causes a downward reaction of the body.

Position of arms during the pull/push phases of the cycle.

2. Backstroke

Position of hands on entry. For example, little finger or thumb first. The distance of the entry point from centre line of the body.

Position of hands during pull/push phases of the cycle. For example, one arm is more bent than the other.

3. Breast stroke

Is the position and action of arms and legs the same on each side of the body? Is the body balanced?

If the position of one limb changes, how does this produce a change in the applied force?

4. Butterfly

Is the position of arms and legs the same on each side of the body? When the position changes, is there a change in the applied force?

What visual cues are used by the swimmer to maintain a straight line of travel?

5. General

If a swimmer veers from the centre line at the beginning of a lap, but is then able to travel in a straight line, for example close to the lane line or to the left of the centre black line marked on the bottom of the pool, why is it not possible for them to remain in the centre of the lane for the complete lap?

How well can the swimmers monitor the pressure exerted by their body on the water and make the changes necessary to maintain motion in a straight line?

The timing and execution of the turn, for example an uneven push with the legs, twisting of the body and arms, and turning the head to one side.

Discussion

The primary focus for coaches and swimmers during training is on sets and distances swum. Over time swimmers aim to accumulate a high number of kilometres in each stroke. The purpose is for the athletes to develop their aerobic capacity and to ingrain the movement patterns. Other components of fitness, speed, power, and strength, are also developed with a variety of combinations and permutations of sets. Some athletes attend gymnasium sessions to balance their training regime with weight training, stretching, and other aerobic exercises.

The findings of this analysis point to the importance of biomechanically sound skill performance, and how small initial deviations can produce magnified effects in terms of distance travelled and elapsed times. For all swimmers to reach their potential as athletes, often measured by personal best times, they must spend a significant amount of time and effort during training sessions learning, and making automatic, the most efficient execution of each stroke. The results achieved by spending time on correcting errors and focussing on the correct performance will more than compensate for any time taken away from accumulating distance. Training sessions should be a balance between fitness development through distances swum, and perfecting technique. The successes and improvements achieved by the swimmers will act as motivation for more effort, which in turn will result in further improvements.

Conclusion

The numbers in these examples appear small and could therefore be assumed to be unimportant, particularly for learners and lower level performers. Swimming is performed in a fluid environment where forces must be applied in the desired direction of travel or they will produce undesirable movements and reactions, which in turn will diminish efficiency and speed. Each swimmer must work to make the most of the forces, and actions and reactions as they are able.

Success can stimulate motivation to meet additional challenges and in turn to achieve higher levels of success. Mechanically sound movements reduce the factors which increase the amount of energy required to achieve a desired result. This leaves more energy to apply to increasing speed.

This theoretical analysis suggests swimmers who veer from the centre of the lane travel further than the prescribed distance. As a consequence they will record slower times. Technically sound performances will enable swimmers to be most efficient as well as covering the minimum allowed distance, which in turn will increase the likelihood of them achieving the ever present goal of a personal best time. •

1 Appreciation is expressed to Mr. Gary Hurring, Senior Coach, Capital Swimming Club, Wellington, New Zealand, for describing this example and providing other helpful feedback.

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