Performance Analysis of Individual Swimmers for Elite Competitive Swimming

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Abstract

Each and every swim coaches' permanent concern is on the performance improvement and not on the medals won by his swimmers. There are a multitude of parameters that contribute to the performance. There are different workout sets designed to target specific areas of the body for performance enhancement. The primary aim of the work in this paper is to design, establish and develop a strategy to come up with a performance test set and the analysis of that data collected and to direct the coach and the individual swimmer towards excellence. Once the data is analysed, the appropriate steps can be taken and focused on the swimmer and thus enhance his/her performance. This paper considers the parameters such as Stroke Rate, Stroke Count and Heart Rate as its basic Parameters including Pacing as one of the supporting parameter in performance analysis. This paper focuses on the 'Free Swim' Phase of a swimming race for performance analysis conducted on 10 individuals for a period of 10 months in a short course swimming pool with the temperature as a variable component. Each and every swimmer is different and has his/her own pace of learning, adapting, understanding thus the key feature of this paper is that, this analysis is focused on an individual swimmer and not on a group of swimmers thus gives better approachability and flexibility for performance improvements at the individual level. The results of the analysis will facilitate the primary aim of the work and thereby allow the coaches to realise the area of focus where the individual's performance can be enhanced.

***Key words**: swimming, performance analysis, free swim, individual*

1.0 INTRODUCTION

Swimming is an individual or team sport and activity. Competitive swimming is one of the most popular Olympic sports, with events in freestyle, backstroke, breaststroke, and butterfly. In addition to these individual events, Olympic swimmers also participate in relays. In a swimming race, there are basically four contributing factors/ phases. The Start phase, free swimming phase, turn phase and finish phase. Each and every phase mentioned is very crucial and critical in its own terms. [12]

1.1 **Start phase**: This is the initial phase that begins with the start trigger of the event and ends with the swimmer breaking the surface of the water. This phase has the maximum contribution when it comes to short distance races. The start is always important when it comes to any sport. It has to be explosive, accurate and perfect. In an analysis conducted in Beijing Olympics 2008, it showed that in 50 meter races, the contribution of the start was 26% where the area of study was the first 15 meters of the race which is the official maximum allowable distance for a swimmer to break the surface. This phase has three basic components. Block, flight and underwater. The block phase refers to the time between the start trigger and the swimmer leaving the block. The flight phase is from the end of the block phase to the entry of the head of the swimmer in to the pool. The underwater phase can be broken into two subsets of gliding and swimming and accounts for the period between entry and the swimmer reaching 15 meters, a distance typically used to define the end of the start phase. [12]

1.2 **Turn phase**: There are two kinds of turns in swimming. The tumble turn used in freestyle and backstroke events where the swimmer performs a forward roll on approach to the wall and kicks off only with their feet and the other turn is the open turn which is used in butterfly and breaststroke events where the swimmer touches both hands on the wall and kicks off with their feet. In an analysis conducted in Beijing Olympics 2008, it showed that in 200 meter races, the contribution of the turn was 21% where the area of study was 5meter approach and 10 meter depart from the wall. [14]

1.3 **Finish phase**: This is as important as any other phases. In fact this is the deciding phase that determines the position of the swimmer in the race. Again, taking the Beijing Olympics, 2008 as reference; 100 meter butterfly event, Milorad Cavic v/s Michael Phelps. For almost 95 meters, Cavic was leading but in the end, the finish phase(last 5 meters of the race), Phelps overtook Cavic and beat Cavic in 0.01 seconds grabbing the Olympic Gold Medal and the Olympic Record with a record timing of 50.58 seconds. This shows the importance of this phase.

1.4 **Free swimming phase**: As known in any field of study, maintaining is the most difficult part. Thus this work helps an individual to maintain his/her strength and efficiency during the race by enhancing performance through the data collected from the performance tests conducted. This is the main aim of study of this paper.

1.5 **Performance**: The whole work in this paper keeps the performance as base and talks only with respect to performance. Performance improvement has a lot of factors contributing to it. The broad classification yields two branches of factors – Physiological demands and Biomechanical factors.

1.5.1 Sports physiology focuses on how muscle and organs function to produce movement and performance. The physiological demands include the following areas; energy metabolism, muscle fibre type and function, strength, power, muscle endurance [8] and other related energy systems.

1.5.2 Biomechanical factors are the actions of forces by the structure function of biological systems. The work in this paper focuses on Biomechanical factors. These include contraction type, force, power, leg

kick quantity, body position and stability, Stroke Count, Stroke Rate and Heart Rate. In Biomechanical Factors, this paper focuses on Stroke Count, Stroke Rate and Heart Rate.

1.5.2.1 **Stroke Count**: It's the number of strokes taken for a specified distance considering both hands when swimming.

1.5.2.2 **Stroke Rate**: It's basically Stroke Count but with respect to one minute. Thus the number of strokes taken per minute is Stroke Rate.[1, 5]

1.6 **Performance Analysis**: Performance Analysis is a specialist discipline involving systematic observations to enhance performance and improve decision making, primarily delivered through the provision of objective statistical (Data Analysis) and visual feedback (Video Analysis). In the work in this paper, the analysis is done on the performance tests taken by the individual to enhance the capabilities and excel the swimmer in his/her endeavour. [6, 13]

2.0 METHODOLOGY

Methodology is the systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge. Typically, it encompasses concepts such as paradigm, theoretical model, phases and quantitative or qualitative techniques.

2.1 **Participants**: The key feature of the work in this paper is the versatility of the performance test set. It does not depend on age, gender, type of swimming pool (short course or long course). It is highly individual centric and focuses only on that individual. The individual is his/her own competition. For the sake of better understanding of the results obtained from the analysis, two individuals' (say male and female) overall performance analysis has been considered in this paper.

2.1.1 "Short course" is the second type of pool configuration currently recognized by Federation Internationale De Natation Amateur (FINA) which is the International Swimming Federation and other swimming bodies for pool competition which has 25 meter length, as its dimension; the other/primary pool length being "Long course", where the pool is 50 meters in length. Olympic and the World Aquatics Championships are conducted in a long course pool.

2.2 **Criteria**: The test is conducted once every month and the interval gap between the tests is kept fairly constant. The individuals were told to be in pre-race mode and were instructed to have ample amounts of fluids. This test is only for 100 meter front crawl or free-style which is as shown in Figure 1.1.

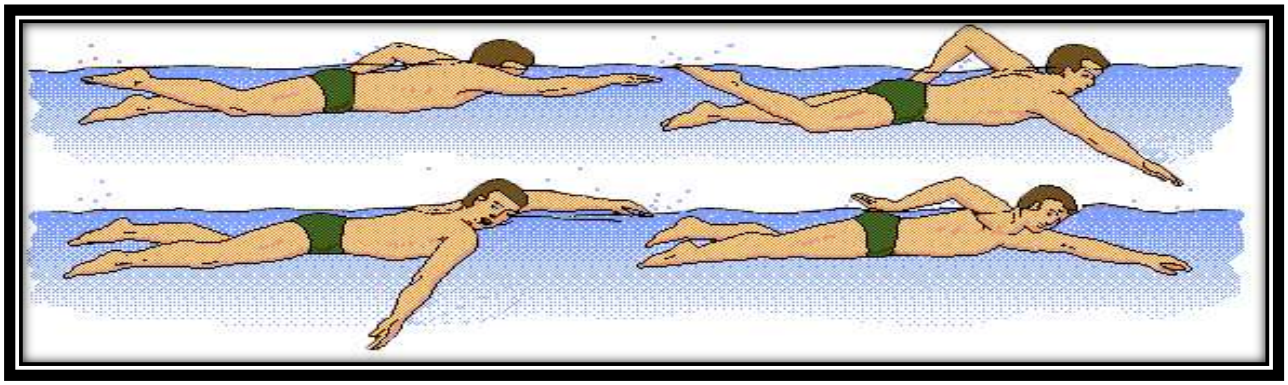

Figure 1.1: Front crawl style of swimming

2.3 **Data collection**:

2.3.1 Parameters considered:

2.3.1.1 Stroke Count: Initially the Stroke count is done for both hands every 50 meters and then when compiling the data for analysis, it's converted to 100 meters.

2.3.1.2 Stroke Rate: Initially the Stroke Rate is done for both hands every 50 meters and then when compiling the data for analysis, it's converted to 100 meters.

2.3.1.3 Heart Rate: The heart rate is calculated for 6 seconds and is kept as is for analysis. The heart Rate is checked manually i.e. by the individual himself/herself at three different times. Immediately, post 30 seconds and post 60 seconds.

2.3.2 The performance test set and its specifications: There are four parts to this test. There is no clear cut definition stating that this is the only and ultimate test set to be used for performance analysis. It can be developed by anyone and in any method. This test set is a result of – 'Design of Experiments' concept in statistical engineering.

2.3.2.1 Set 1: 3 x 100 meters freestyle on 1 minute 40 seconds. The parameters are calculated as specified. The heart rate is checked after the completion of the set as specified. The swimmer was asked to clock a timing which was 8 seconds off his/her best performance time in 100meter freestyle. The swimmer was asked to hold on to the time to adjust his/her tempo and pace. [7]

2.3.2.2 Set 2: 3 x 100 meters freestyle on 1 minute 50 seconds. The parameters are calculated as specified. The heart rate is checked after the completion of the set as specified. The swimmer was asked to clock a timing which was 6 seconds off his/her best performance time in 100meter freestyle. The swimmer was asked to hold on to the time to adjust his/her tempo and pace. [7]

2.3.2.3 Set 3: 3 x 100 meters freestyle on 2 minutes. The parameters are calculated as specified. The heart rate is checked after the completion of the set as specified. The swimmer was asked to clock a timing which was 4 seconds off his/her best performance time in 100meter freestyle. The swimmer was asked to hold on to the time to adjust his/her tempo and pace. [7]

2.3.2.4 Set 4: 1 x 100 meter freestyle All Out. That is the swimmer is asked to give his/her best performance or clock timing, closest to his best performance. The heart rate is calculated after the finish of the 100 meters All Out race as specified.

Note:

a) The swimmers are told to do Easy swim of about 200 to 300 meters in between the sets and are advised to drink ample amounts of fluids. [8]

b) The key here is for the individual to know the pace and timing sense.

c) The whole set is performed from within the water i.e. no starts were done from the block except for the last set (1 x 100 meters Freestyle All Out).

d) The Heart Rate was checked manually by the individuals themselves for duration of 6 seconds in the recovery phase. The same data can be recorded in the data sheet.

e) Recovery phase: the Time period during which the individual checks his/her pulse and reports it to the observer.

3(3 x 100) + 1x100 Max - PERFORMANCE TEST SET				
Date :		Name :		
SET 1	TIMINGS	STROKE RATE (50)	STROKE COUNT (50)	AVERAGE
3x100 FS @ 1:40				
HEART RATE				
IMMEDIATE	POST 30 SEC		POST 1 MIN.	
SET 2	TIMINGS	STROKE RATE (50)	STROKE COUNT (50)	AVERAGE
3x100 FS @ 1:50				
HEART RATE				
IMMEDIATE	POST 30 SEC		POST 1 MIN.	
SET 3	TIMINGS	STROKE RATE (50)	STROKE COUNT (50)	AVERAGE
3x100 FS @ 2:00				
HEART RATE				
IMMEDIATE	POST 30 SEC		POST 1 MIN.	
FINAL 100 MAX	TIMINGS	STROKE RATE (50)	STROKE COUNT (50)	REMARKS
1 X 100 FS				
HEART RATE				
IMMEDIATE	POST 30 SEC		POST 1 MIN.	

Fig 1.2 Format of Data Sheet used to enter the details needed for performance analysis

Details of the individuals considered are

INDIVIDUAL 1

GENDER: MALE

Date of Birth: 3rd April 2002

Group 2

INDIVIDUAL 2

GENDER: FEMALE

Date of Birth: 15th December 2001

Group 2

The objectives of the performance test are explained to the individuals beforehand.

a) Increase Stroke Rate by recovering the stroke faster
b) Decrease Stroke Count by finishing each stroke completely
c) The swimmers are instructed to pace their race and not sprint the whole test.
d) Maintain heart rate by incorporating rhythmic breathing pattern
e) Balance energy invested in the test set 1, 2 and 3 and explodes in set 4.

The individuals who were on pre-race mode were made to perform the performance test set according to specifications. A group of observers record and gather the data from the individuals' performing the test in a Data sheet as shown in Figure 1.2. Again, this data sheet can be formatted as per the requirements of the swim coach. The data can be gathered accordingly and complied into a graph/chart for better understanding and to know the trend and areas of attention requirements as shown in Figure 1.3 and Figure 1.4.

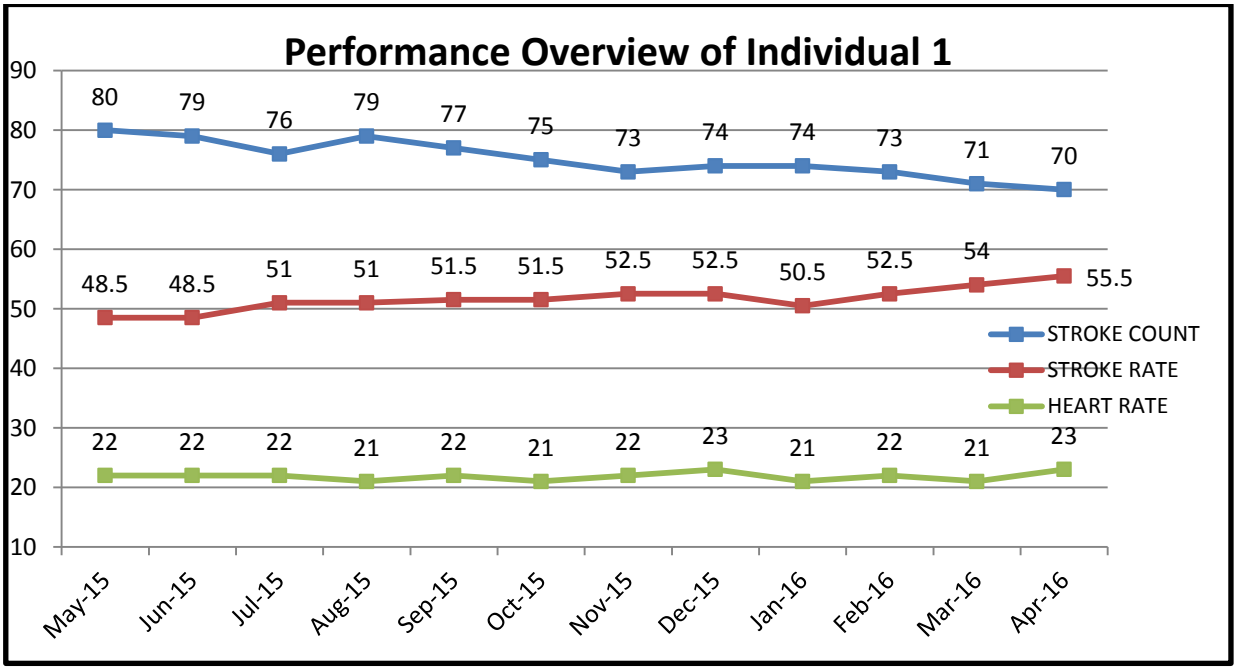

Fig 1.3 Overview of performance test set conducted on individual swimmer 1 - 1 x 100 meters Free Style

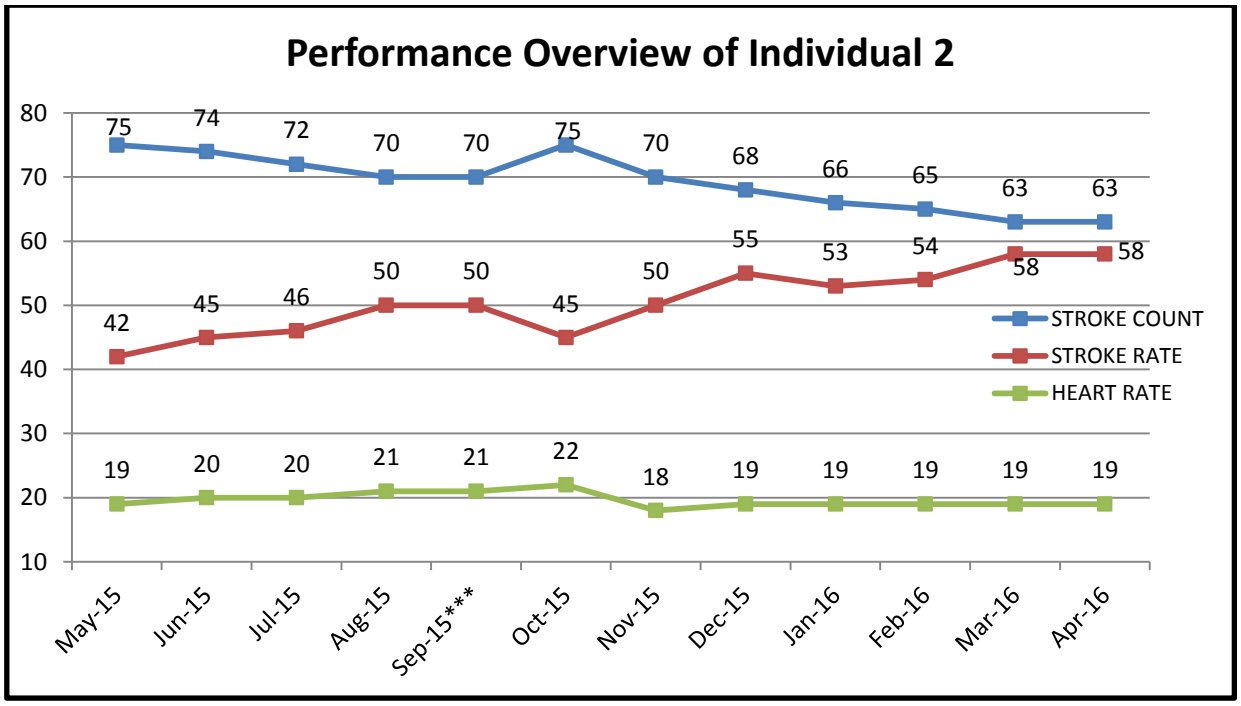

Fig 1.4 Overview of performance test set conducted on individual swimmer 2 - 1 x 100 meters Free Style

(***- did not swim the test set as Individual 2 was not available hence the pervious data is retained)

3.0 RESULT

Results of the performance test were seen reflecting in the actual performance of the individual in the competitions;

Individual 1 competed in the District Level Meet Organised by Greater Mumbai Amateur Aquatic Association (GMAAA) in May, 2015 and then competed in the Time Standard Meet organised by Glenmark Aquatic Foundation (GAF-TSM), twice, in September of 2015 and in December of 2015 respectively which were Short Course type Swimming Pools. Individual 1 also performed in Long Course Swimming Pool by competing in the competitions organised by Maharashtra Swimming Association (MSA) in June, 2015 and in Singapore National Level Meet held in March, 2016.

Individual 2 performed in Long Course Swimming Pool by competing in competitions organised by the Maharashtra Swimming Association (MSA) which were the State Level Meet in June 2015 and the National Level meet in August, 2015

Later Individual 2 participated in the Senior National Level Meet Organised by Swimming Federation of India (SFI) in November, 2015.

Table 1.1 Result of individual 1 in Short course competitions

EVENTS	TIMINGS OF THE INDIVIDUAL IN THE SHORT COURSE COMPETITION		
	GMAAA MEET – MAY ‘15	GAF TSM MEET - SEP ‘15	GAF TSM MEET - DEC ‘15
400 meters free style	5:00.68	4:41.74	4:23.79
800 meters free style	10:40.11	9:42.64	9:29.96

Table 1.2 Result of individual 1 in Long course competitions

EVENTS	TIMINGS OF THE INDIVIDUAL IN THE LONG COURSE COMPETITION	
	MSA STATE MEET - JUN ‘15	SINGAPORE NATIONAL LEVEL MEET - MAR ‘16
400 meters free style	5:01.64	4:23.79
800 meters free style	10:22.24	9:11.75

Table 1.3 Results of Individual 2 in Long course at Maharashtra Swimming Association (MSA) competitions

EVENTS	TIMINGS OF THE INDIVIDUAL IN THE LONG COURSE COMPETITION		
	STATE MEET – JUN ‘15	NATIONAL MEET – AUG ‘15	SENIOR NATIONAL MEET – NOV ‘15
200 meters free style	2:12.22**	2:11.94*	-
400 meters free style	4:40.76**	4:38.73	-
800 meters free style	9:40.09	9:29.42*	9:29.19
1500 meters free style	18:43.95	18:05.72	18:16.91
400 meters individual medley	5:27.41	5:19.53	5:24.29

(*-National Record; **- New Meet Record)

As seen, the performance tests prove to represent the status of the swimmer and is directly related to the results obtained in the competitions thus the performance test can be said that it holds good for performance analysis.

4.0 INFERENCE

The ideal trend that the individual has to follow, for his performance to excel is

a) Stroke Count: Downwards trend
b) Stroke Rate: Upward trend

4.1 **Stroke Count and Stroke Rate**: An increase in Stroke Count induces Fatigue in swimmers thus the amount of 'pull' or 'thrust' gained per Stroke must be improved. Each stroke must give maximum thrust to the swimmer. This can be improved by using dry land exercises (tera band or stretch cords). [11]

Area of focus: The muscular power and strength training for the upper body of the individuals.

4.1.1 Ways for improvement:

a) focusing on other Biomechanical factors and Physical demands
b) Pacing the whole race. (Either technique is used i.e. fast-slow or rhythmic or slow-fast). [9]
c) Following one rhythmic pattern of breathing.
d) Better control and stability on body roll.

4.2 **Heart Rate**: Importance of this parameter is that this parameter is analysed to know the metabolism rate of the individual swimmer. How fast is the individual able to recover? There are times when swimmers are too tired / exhausted even after the race is concluded and are not properly prepared for the next race. In some situations, the events in the competition might be back to back. The way of analysis can be done by comparing the heart rates of the individuals during the recovering phase.

Area of focus: The Breathing Pattern of the individual.

4.2.1 Ways for improvement:

a) Better Control on drills and movements
b) Focus on one pattern of Breathing.
c) Breathing exercises and core stability.

5.0 CONCLUSION

Performance analysis helps the coach as well as individual to excel in his/her endeavour. No inference can be drawn from the initial months of testing. Once 3 or 4 months of testing is done and enough data is collected, a pattern/trend is found and thus helps to critically analyse and focus on the areas that require attention. This is one of the test set that helps to decide on the performance capabilities of the swimmer and helps to analyse the data such that to come to strategic conclusion. Such test sets can be designed by any one and the credibility of the test set has to be considered before applying it on the real world. The major advantage of this test set is that it can be applied to any individual anywhere in the world.

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