

**SOURCES AND SUSTAINABILITY OF THE CYCLE OF HIGH-PERFORMANCE
COMPETITIVE SWIMMING IN SERBIA**

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Abstract

The subject of this paper concerns the nature of individual changes and the origin of organizational ones that have led to the progress and breakthrough results of competitive swimming in Serbia. Serbia's first swimming medals were won at the Olympic Games (OG), World Championships (WCh), and European Championships (ECh) in the senior and junior categories for both men and women, and the world and European records were set during the analyzed period (2000-2016). The Serbian male and female swimmers also marked the period concerned with winning the title of Serbia's best athletes in both senior and junior categories (2008 and 2009, 2010). Descriptive, structural, functional, and causal analysis of the facts related to this period of development of competitive swimming in the Republic of Serbia, as the method applied in this paper, led to the conclusion that the talent of an athlete, top coaches, in addition to new training practice, science, technology, innovation (NIT), SOFT programs, and the involvement of meso and macro levels of sports organization represent the factors relevant to the progress in individual performance as well as to the intensive growth of competitive swimming in the examined period. The limited capacities of competitive swimming have been determined in terms of the sustainability of the top competition results achieved. In this paper, the international and national cultural narrative of the men's 100m butterfly final at the Beijing 2008 Olympics (Čavić vs Phelps) was elaborated.

Key words: COMPETITIVE SWIMMING / PERFORMANCE PROGRESS / CULTURAL NARRATIVE / ČAVIĆ vs PHELPS/

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CYCLE OF THE HIGH COMPETITION PERFORMANCES OF SERBIAN SWIMMERS

Descriptive, structural, functional, and causal analysis of the facts related to the development of competitive swimming in the Republic of Serbia, as the method applied in this paper, led to the conclusion that the talent of an athlete, top coaches, in addition to new training practice, science, technology, and the involvement of meso and macro levels of sports organization represent the factors relevant to the progress in individual performance as well as to the intensive growth of this sport in the period between 2000 and 2016. The essence of the analyzed changes and the designation of the progress bearers, as a counterpart of the life cycle, can be presented through the following periods:

- Embryo (2000): Participation of nine swimmers (seven men and two women) at the Sydney 2000 OG)...
- Birth (2001-2004): Title of Junior European Champion-2001 (Milorad Čavić); first finals at the WCh in Barcelona-2003 (Milorad Čavić, Mladen Tepavčević); first medal and first world record at the WCh (Dublin, 2003) in the 100m butterfly short-course (25-meter pool) (Milorad Čavić); first semi-finals at the 2004 Athens OG (Milorad Čavić) ...
- Childhood and adolescence (2005-2007): Medals at the first World Championship (2006) and European Junior Championship (2007) in the butterfly (Ivan Lender) and breaststroke (Čaba Siladi) events; ...
- Mature age (2008-2013): Senior ECh: Milorad Čavić (2008, 2012) and Velimir Stjepanović (2014); medal at the Beijing OG - 2008 (Milorad Čavić), medals at the WCh in Rome - 2009 (Milorad Čavić, Nađa Higl), world record (Milorad Čavić), and European records (Nađa Higl, Milorad Čavić); two finals at the London OG - 2012, first Serbia's relay at the OG (4x100m freestyle), first swimming medals at the Mediterranean Games (2009), first medals at the European Youth Olympic Festival - 2009 (Velimir Stjepanović), Youth Olympic Games - Singapore-2010 (Velimir Stjepanović), European Games - 2014 (Anja Crevar).
- Old age (2015-2016): Swimmers' participation at the Rio OG, participation in other competitions included in the programs of the European and world swimming organizations; ...
- Swimming heritage: Medals in all major competitions of the international swimming program; world, continental and championship records; titles of the best sportsman (Milorad Čavić, 2008, 2009) and sportswoman (Nađa Higl, 2009) of Serbia awarded by the National Olympic Committee of Serbia (NOC Srb); organization of international competitions in Serbia (European Junior Championships in 2008 and 2011; organization of swimming competitions at multi-sport events in Serbia (European Youth Olympic Festival, EYOF 2007, Universiade - 2009); participation of the Serbian Swimming Federation's representatives in the bodies and organs of continental and regional swimming organizations. The epilogue of this period includes one female swimmer and two male ones as the holders of National Awards for contribution to the development and affirmation of sports in the Republic of Serbia. There are two coaches who are the holders of National Awards, whereas a greater number of coaches are the recipients of cash rewards for their top results achieved in sports... No positive doping tests have been registered in doping controls among Serbian male or female swimmers.

Table 1. National teams' Ranking at the 2009 Rome World Aquatics Championships (source FINA - International Swimming Federation)

	Ranking	Gold	Silver	Bronze	Total
1	USA	11	11	7	29
2	China	11	7	11	29
3	Russia	8	8	4	20
4	Germany	7	4	1	12
5	Australia	4	5	10	19
6	Great Britain	4	3	2	9
7	Italy	4	1	5	10
8	Serbia*	3	1	0	4

* Medals for Serbia were won by swimmers (2-1-0) and national water polo team (1-0-0)

“THREAD“ FOR THE PROGRESS OF COMPETITIVE SWIMMING IN SERBIA

The story of records and limits in sports does not only have its origin in training and competitions and science, but it also has the meaning taken from cultural and physical anthropology (Jevtić, 2012). Attaining a personal achievement and achieving excellence means being better than the previous performances. If this were to be expressed through the marginal growth theory, which is, in fact, a struggle for an advantage that might be 0.01 second, as in the case of the race between Milorad Čavić and Michael Phelps in the 100m butterfly event at the Beijing Olympic Games, then reaching progress and achieving excellence would mean subtle shifting of natural limits, ethical norms, canons of ethics, social support, organization, science, innovation, technology, SOFT programs, as well as of many other factors on which a top-level swimming result is based.

The competitive swimming practice has identified swimming techniques and coordination attributes of swimmers as determinants of individual progress (Maglischo, 2003). These are followed by morphological characteristics and motor abilities (Colwin, 1992). All of them together are contained in Timakova's theoretical context about the courses of swimmers' development. According to this theory, personal growth and thereby consequent performance progress are based on the existence of three subtypes of swimmers. Thus, the *somatic subtype* ensures their progress through morphology and kinanthropometry. The form and essence of a technique (fast, slow, mixed; anticipatory coordination) are registered in the "*water sensitive*" subtype, while the capacity and power of aerobic and anaerobic energy processes represent the core of the *type gifted with energy performance* (Vorobjova, Vorobjev, 1977). It was difficult to find a Serbian swimmer from the analyzed period who sublimated all the three subtypes, due to which the individualization of training preparation, according to the characteristics of one or two subtypes, was a top cognitive challenge for the coaches, their poetic knowledge, experience, and wisdom. Accordingly, it can be concluded that the training preparation program that led to the progress and international competitiveness of the Serbian swimmers was highly determined by the characteristics of the swimmers themselves, the competencies of the coaches, as well as by the factors of support provided by the professional and scientific structures around that specific swimming reality. In this regard, it was registered that the NOC Srb supported the efforts of the swimmers, coaches, their clubs, and the Serbian Swimming Federation (SSF) to develop competitive abilities and competitive strategy through the improvement of individual techniques. The aim in the area of swimming techniques included the conceptual and stylistic changes that will allow swimmers to train and compete in a mechanical, bioenergetic, aesthetic, and kinesthetic (new) way. Cameras, body-worn sensors, wireless transmission technology have set new standards and revolutionized the work of coaches (Batorova, Stastny, Motucka, Januar, 2016; Ride, Ringuet, Rowlands, James, 2013). The acquisition of these and similar real-time data

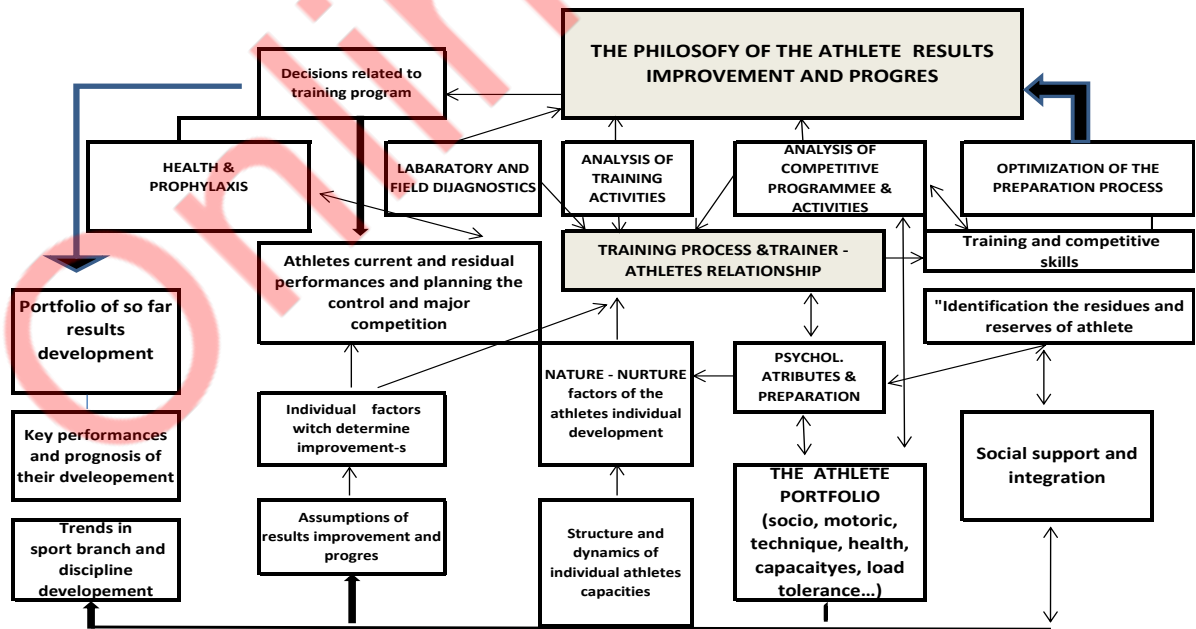
was enabled to the Serbian swimmers and coaches during the regular training program, but also during the training at higher altitudes, by visiting the specialized analytical centers in the Netherlands, bringing the experts and their work into the Serbian sports system, as well as by equipping the Republic and Regional Institutes of Sports. The NOC of Srb took the lead in these activities.

When observing either an athlete's progress, competition performance, overall development of competitive swimming in Serbia, or something else, it can be seen that the support given to personal growth occurred around general and specific factors of the development of competition performance (Jevtić, 2011). This natural and inductive conclusion, as it may be said, was based on the analysis of the National Olympic Committee's documents on the planned and realized training and competition activities through the "Olympic Preparation" programs (Jevtić, 2006, 2009). The analysis of both of these documents of strategic development on the Olympic route, as well as of the accompanying administrative sources of their implementation, has indicated that the preparation programs were fulfilled by: (a) innovative training methods (interval hypoxic, at a higher altitude, ideomotor, Hiit...); (b) sports medical care and protection; (c) exercises in the function of motor learning (in the function of the swimming style remodeling); (d) sports and psychological preparation; (e) support regarding adequate nutrition and appropriate supplementation; (f) sustainable budget. In addition, the analysis has singled out the following conclusions on individual growth i.e., progress which, in accordance with the title of this article, can be considered a source of the development of (high-performance) competitive swimming in Serbia:

- I. The analyzed period (2000-2016) can be described through the talent and personal growth of the male and female swimmers progressing to the title-holders at the world and continental championships (in the junior and senior categories of both genders). The progress of performance was established around the factors of the nature of an athlete (*natura*) and around the training and competition environment (*nurtura*). The central place in connecting and achieving synergy between the athlete and his/her environment belonged to the coaches, their knowledge, pedagogical skills, as well as the training and competition programs they created. It can be explained in more detail by the following statement of Sebastijan Higl: "*Although I do not claim that the implemented program of Nada Higl was original, yet it was ours since it was filled with understanding a large number of training attributes of the previous training, Nada herself and my capacities as a coach to create a stimulating training environment*" (Higl, 2013).
- II. A significant number of experts and specialists from other fields were involved in supporting the progress of the swimmers of Serbia.
- III. Personal, implementation, rehabilitation and prophylactic technology as well as the technology of measurement and acquisition of relevant data on biological, psychological and motor status of the male and female swimmers' training also was of the utmost significance in the race for the world class sport.
- IV. The progress was pre-determined by the personality traits and talent of each of the male and female swimmers as well as by identifying the factors that lead to top results in a given swimming event. In competitive swimming, as well as in modern sport as a whole, the imperative for progress is recognized in technique and speed of movement, therefore, top swimming performances are delivered through the imperative of precise and stable technique, in addition to maintaining competitive swimming speed at the competition (Jevtić, 2001). As for the importance of technique and possible misconceptions regarding the physiological essence of this sport, James Counsilman, one of the world's most recognized experts, has pointed out that swimming is unlikely to make much progress through blood lactate analysis and reflection on training physiology, as well as that although he completed his doctoral studies in physiology, he would rather have a degree in biomechanics. "*I have come across*

very few facts from the field of physiology that can be applied in swimming by an average coach, so I can conclude that working on and mastering technique have much more potential for the progress of competitive swimming." (According to Higl, 2013). In other words, swimming technique, primarily its substantial aspect (factors of fast, mixed, anticipatory and slow coordination), as well as the overall locomotion speed, lead to the improvement of performance, which has, on the other hand, affected the attractiveness and evaluation of competitive swimming in science, media, technology, sports industry, and social environments.

V. The aforementioned deductive statement can be better understood through Anokhin's theory of functional systems (Jevtić, 2011). All the complexity of reaching a functional system that develops a top result is described by its essential-actual reality, and which, in the function of elaborating the subject of this paper, is presented as a diagram (mind map) showing the factors of a system structure around the topic of "philosophy of progress from individual to top-level performance". (Scheme 1). The cognitive spaces of this diagram have resulted from the generalization of the facts from the documents of the OCS and its Directorate for Sports OCS (Jevtić, 2011, 2014). However, most of the identified spaces of this functional system are characterized by variability i.e., it can be concluded that *there is no training and competition constant*, therefore, there is no "final truth" that has definitely led to the improvement and progress. Intentional and unintentional variability of the factors of the detected spaces, and accordingly, the degree of their relevance to the entire system and to the competition outcomes of the male and female swimmers, was planned around the athletes' individual attributes and the expediency of training, competition, technology, science, organization, and budget. Therefore, it can be concluded that the progress of the Serbian male and female swimmers to the world top class was pre-determined by the quality of knowledge and coaching skills, as well as by the breakthrough innovations of the factors in the athletes' micro, meso, and macro environments. These are all part of deductive reasoning in the form of a functional system (Scheme 1).



Scheme 1. Diagram (mind map) of the structure of training and competition preparation for top-level swimming achievements (Jevtić, 2013, 2019)

- VI. The program of swimmers' preparation for their participation in sporting events such as the OG, WCh, and ECh was conditioned by the value of their individual performances. Timely recognition and objective evaluation of an individual performance were one of the preconditions for the coaches' innovative steps, as well as for mobilizing the support of the factors of the sports system and the society of Serbia for its further development. All the complexity of the challenges related to the evaluation of an individual performance, in order to assess its international competitiveness, and thus plan the further development of an individual male or female swimmer, is described in Graph 1, where Velimir Stjepanović's performance in the 200 butterfly final (01:55.07 ranked sixth at the OG in 2012) was analyzed in relation to the medal zones at the OG (2012) and WC (2013) and the European Championship (2014) (Jevtić, 2014). It is obvious that Stjepanović's performance in the middle of the Rio Olympic cycle remained competitive in Europe, that it was far from a medal at the WCh, while the Olympic medal preparation program should have produced an improvement of about 2 seconds or 35 points according to FINA Point Tables (scoring table made in relation to the world record). The desirable progress of Stjepanovic's performance, in terms of increasing its competitiveness to winning a medal at the Olympics, would be a challenge even for "more sophisticated systems of competitive swimming".



Graph 1. Results in the 200 butterfly event (abscissa) in relation to the FINA Points Table (ordinate)

- VII. The criterion competition standard was reached after a decade of training and competition activities filled with the contents and goals achieved in each of the individual periods from the multi-year development of an athlete (Ropret, Jevtić, 2019). The multi-annual performance development plan for reaching the standard, and then for winning a medal, was also accompanied by the adverse effects on the swimmers' health and the termination of their competitive sports careers. The careers of some of the best Serbian swimmers ended prematurely due to injuries and illnesses. However, it should be noted that the progress was not accompanied by the therapeutic use exemption protocols (TUEs). There were no positive doping test findings. The doping sample collection and accompanying analyses were conducted by both the National Anti-Doping Agency of Serbia (ADAS) and the World Anti-Doping Agency (WADA). (Dikić, 2018).
- VIII. The shallow system of swimming organization required the sparring partners to be engaged from other systems, the Serbian swimmers' to go and visit entrepreneurial sports and training camps, as well as such camps to be invited and hosted to perform their activities in Serbia (Jevtić, 2011b).
- IX. When listing the breakthroughs made by the elite swimming in Serbia, the implementation of programs in the field of professional careers, social issues, and financial security of the swimmers, their personal trainers, and experts in their environment (SOFT programs) was of equal importance.

TECHNOLOGY AND SERBIAN SWIMMING BREAKTHROUGH

Technology continuously leaves traces and directs the development of civilization, which is registered in competitive swimming as well. The subject of this paper covered the period of intensive

development of the competitive performance due to the application of new technology (2000-2010). The great breakthrough swimming results in the world, including Serbia, achieved during this period, can be attributed to the influence of the technology of swimwear material and design. After ten years of support given to this area of technology, it seemed that competitive swimming would not easily return to the "natural" sources for human movement-swimming and training methods.

Instrumentalism offered the broadest, and at the same time "blurring," view of the analyzed period. It was claimed that technological breakthroughs are nothing but "tools - devices - instruments" that serve the purposes of their users (Omoregie, 2016). According to this theory, technology is considered "neutral," so the swimsuits (material and design), which were used from 2000 to 2010, were classified into the sports industry products intended for swimmers. Nevertheless, the impact of the technology of swimwear design and material on the performance in the period from 2000 to 2010 can be described by the three peaks of performance progress with a measurable effect on the physiological and biomechanical overcoming of the immanent skills and abilities of man. Thus, it was assessed that the result in the men's 100m butterfly event was improved by 3.87s or 2.6%, and in the women's 200m breaststroke event it was improved by 3.56s or 2.45% (Berthelot et al., 2010).

Figure 2 also shows a different design - model of swimsuits worn by Milorad Čavić and Michael Phelps in the Beijing Olympics final (2008). The degree of body surface coverage can be attributed to the self-deterministic period in which both swimmers chose a swimsuit model for their own purposes. A year later, in the historic race in the 100 butterfly event at the WC in Rome (2009), and with the finish performance better than the 50-second margin, both swimmers swam in the swimsuits that covered their entire bodies except for the feet and hands. This was a period in the development of competitive swimming during which it was determined that the technology of swimsuit materials and their designs are not neutral in relation to performance.

The causal and functional analysis of 50m breaststroke swimming including two repetitions with the maximum intensity (Figure 1), the first repetition swum in a swimsuit according to the rules applicable since 2010 (image A), and the second repetition in line with the rules applicable until the end of 2009 (image B), gave rise to the obvious kinematic differences in Nadja Higl's swimming. The epilogue of these measurements at the altitude training center, advanced in terms of information and technology, in Sierra Nevada, Spain, is also a framework for understanding the challenges for Nadja Higl's training and competition plan and program in the conditions of reduced support of the technology of swimsuit materials and designs. The difference observed between the two mentioned measurements, approximated in relation to the 200 breaststroke event, can significantly explain the nature of the lag and the reasons for the loss of competitiveness of Nadja Higl's performance at the competitions following January 1st 2010. In this regard, Nadja Higl's coach stated: *"After the ban on high-tech swimsuits in competitions, much more attention had to be paid to the body position as the core creating the conditions of other swimming stroke factors and their integration towards a competition performance.... The challenges of muscle contractions and shifting the center of gravity from the ends toward the center of the lever, which were absent in female swimmers when swimming in full-body swimsuits, had to be compensated and controlled by connecting and timing within the stroke whole, in addition to the optimum engagement of trunk muscles, in the new conditions. The biomechanical analyses have indicated that full-body swimsuits allowed swimmers to keep their hips and legs in a position which could be said to be biomechanically most suitable, but which was reached in a passive manner (i.e. benefits resulting from the suits, author's comment) rather than in an active way (i.e. skills, author's comment) (Higl, 2013).*

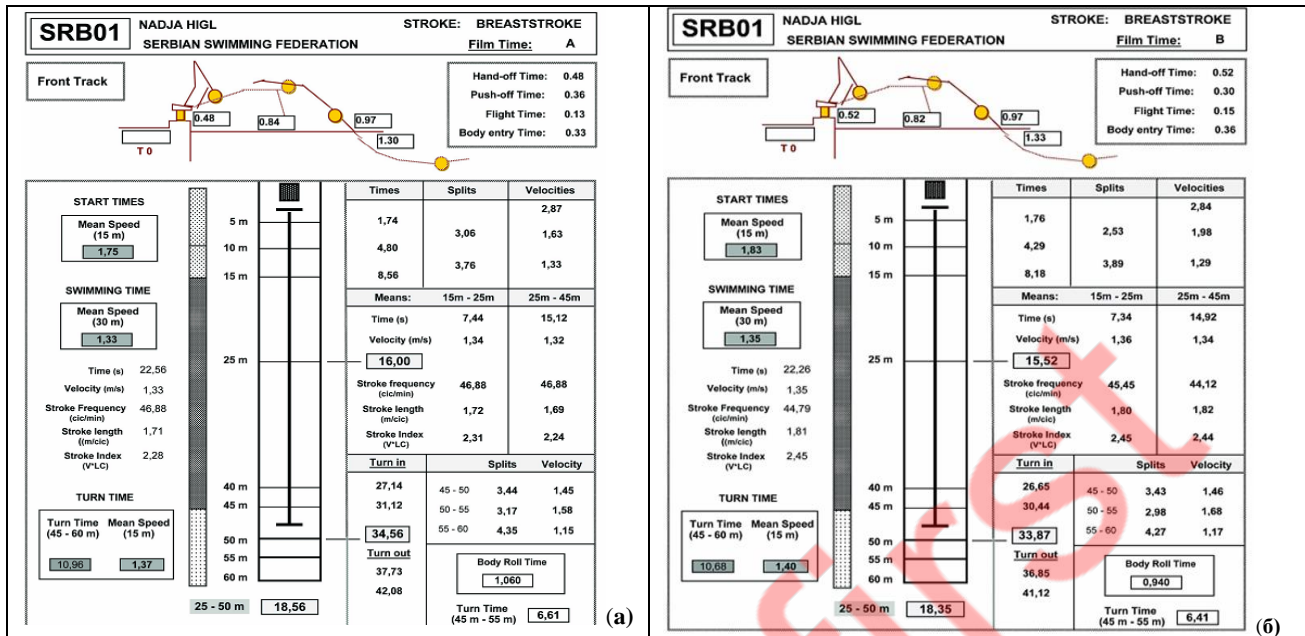


Figure 1. Kinematics of the two 50m breaststroke repetitions with the maximum intensity in two different swimsuit models (Recording and analysis were conducted at the High Altitude Training Centre in Sierra Nevada, Spain, in January 2010)

At the London Olympics (2012), after the changes in the rules pertaining to swimwear, the times of Michael Phelps and Milorad Čavić were slower by four-tenths of a second and almost a whole second, respectively, in comparison to the results from Beijing (2008). Both swimmers were significantly behind the result of the historic race in Rome (2009). The eliminated influence of swimsuits, age, injury and several months of training break, altered posturography and its accompanying effects on buoyancy, floating, symmetry, in addition to the taper and retaper probably extended and insufficiently controlled, were just some of the determinants of Milorad Čavić's breathing pattern selected in his second Olympic final (Table 2).

Table 2. Notational analysis of the breathing patterns of the final race in the 100 butterfly event at the London Olympic Games¹

Swimmer	Time	Breathing patterns 1/50m	Breathing patterns 2/50
Phelps (USA)	00: 51. 21	3-1-1-1-1-1-1-1-1-1-1-1	2-1-1-1-1-1-1-1-1-1-1-1-1
Le Clos (RSA)	00: 51. 44	3-1-1-1-1-1-1-1-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-3
Korotyshkin (RUS)	00: 51.44	3-1-1-1-1-1-1-1-1-1-1-1	1-1-1-1-1-1-1-1-1-1-1-1-2-2-1
Čavić (SRB)	00:51. 81	3-2-2-1-2-1-2-2-1-2-	2-2-2-2-2-2-2-2-4
Deiber (GER)	00: 51.81	3-2-1-2-1-2-1-2-1-2-1-1-1	2-1-1-2-1-1-2-1-1-2-1-1-2-1-1-1-
Verlinder (NED)	00: 51.82	1-2-2-2-2-2-2-2-2-1-	1-1-2-2-2-2-2-2-2-3
McGill (USA)	00:51.88	3-1-1-1-1-1-1-1-1-1-1-1-	2-1-1-1-1-1-1-1-1-1-1-1-1-3
Czerniak (POL)	00: 52.05	3-2-2-2-2-2-2-2-	1-1-1-2-1-2-1-2-1-2-1-2-1-2

This discussion of the technology of swimsuit materials and designs has become more lively after ending the era of advanced swimming suits and returning to the challenges of nature and the human body shape in the water. The study of swimming mechanics occurs again through individual models of swimmers' body shapes, principles of propulsive efficiency excluding artificial stimuli, with an orientation towards learning and sensorimotor images in coordinated forms of movements and skills (Table 3). Continuous acquisition of information about a swimmer through the so-called biohacking (a trend in

¹ Russell Mark: Butterfly Breathing Patterns, in USA Swimming Technique presentation (www.usaswim.org).

stimulating the connections formed between the swimmer's brain, organs, and body), as well as the accompanying motor training and mastering the parts and stages of techniques, have been restoring swimming to its original being. In other words, the achievements made in the international swimming community, including Serbia, in 2009 i.e. world records (193) and other records, can be subsumed under the influence of the technology of competitive swimsuit materials and designs. Afterward, there was a period of overcoming the existing situation. Human nature, curiosity and reason have won once again! Swimming records continued to fall, including the one from the historic race in the 100m butterfly event at the WCh in Rome (2009). Caeleb Dressel (USA) has demonstrated a swimming technique that can be called innovative and different from the swimming techniques of Čavić (slow coordination) and Phelps (mixed coordination). Dressel is characterized by a unique - individual rhythm, body position and timing between the propulsive phases of insweep and outstroke, push and pull, and thrusts with the chest. The biomotorics of his start (diving, gliding and breaking the water surface up to 15m) and underwater swimming after leaving the turn (not more than 15m), in addition to the aforementioned, have been mastered and coordinated below the new world record times in 50m-long pools (00: 49.50) and 25m-long pools (00: 47.78). It is obvious that the swimming performance (in the 100 butterfly event) has been developed through the synergy of temporal, spatial and kinetic attributes of the technique factors, on the one hand, and the individual characteristics of a swimming type, i.e. biomotor and psychological attributes of a swimmer, on the other. The personality attributes and accompanying individualization of training indicate the existence of different models and challenges in training and competition preparation (Sanders, Thow, Fairweather, 2011), and also suggest the necessary specialization of coaches and teams in an athlete's environment. Specialization in the field of training methodology is established on the principles of practical and scientific knowledge about the swimmers' growth to their excellence at the top or elite level.

Table 3 Butterfly stroke swimming attributes of Milorad Čavić and Michael Phelps (generalization according to Jevtić 2001, 2007, 2009, Di Nino, 2014)

Individual attributes	Milorad Čavić	Michael Phelps
Dominant individual characteristics -competition event:	50 and 100m butterfly, 50 and 100m freestyle	100 and 200m butterfly, 100, 200 and 400 freestyle, 200 medley...
Kinematics and kinetics of swimming methods:	<p>Shoulder driven propulsion, specific:</p> <ul style="list-style-type: none"> - The shoulder region is fixed with the blades as a precondition for more efficient actions of the shoulder girdle muscles and arm muscles. - Relying on the forearm extensor muscles. - The body depth (body position on the water surface and the degree of buoyancy), the accompanying height of the hips on the water surface, and consequently, the amount of passive and active resistances created are critical. - The strokes are used effectively during gliding and sliding after a turn, but not during the middle part of the race 	<p>Body driven propulsion, specific:</p> <ul style="list-style-type: none"> - Higher amplitude of the insweeps and outstrokes, the torso is suppressed and elongated, the force impulse is generated from the foot muscles, through the hips to the chest which is suppressed and elongated. - Relying on the central body muscles - the core muscles - The strokes are used effectively during all stages of the race (sliding and gliding after the start and turn, during the middle section and entering the finish).
Swimming coordination:	<p>Slow coordination model, specific:</p> <ul style="list-style-type: none"> - Unstable and under the influence of fatigue, declining pace. - Higher total propulsive force, a rough picture of swimming style due to "noise-filled" order of movements and timing of technique details. - Unstable rhythm, problems with the symmetry of movements of different etiology (injuries, muscle imbalance, ...) - Kinematic swimming model based on the spatial parameters of the insweeps and outstrokes. 	<p>Mixed coordination model, specific:</p> <ul style="list-style-type: none"> - Stable, steady pace. - Relying on the length of the insweeps and outstrokes, refined and simultaneous body movements, more efficient transfer of propulsive force leading to energy efficiency. - The order and symmetry of movements are subordinated to the rhythm. - Pull frequency reserve and swimming strategy relying on the pull temporal parameters
Swimming bioenergy:	<p>Relatively pure energy type (anaerobic power and limited anaerobic capacity), specifically:</p> <ul style="list-style-type: none"> - Greater fatigue of small muscle groups and their early "elimination." - Later activation of aerobic energy processes (higher time constant of aerobic processes = lower energy efficiency = challenge for constant propulsive efficiency). 	<p>Combined energy type (anaerobic capacity, aerobic power and capacity), specifically:</p> <ul style="list-style-type: none"> - Controlled fatigue, optimum time constant of activation of aerobic processes. - Earlier activation of aerobic energy processes (lower time constant of aerobic processes = higher energy efficiency = relatively stable propulsive efficiency)

ORGANIZATIONAL SUPPORT TO THE PERFORMANCE PROGRESS

The analysis of the work of successful national swimming systems, including those from the Mediterranean region, has indicated that the progress and improvement are determined by the factors of an athlete's macro environment, including: conservative and liberal attitude of the sports organization towards change and progress; market and industry-oriented mission of the sports branch; media value of a sporting event and "sports heroes" (Bayle, Madella, 2002; Madella, Bayle, Tome, 2005). The informal race for the "holy grail" of an efficient and medal-rich national sports system has a significant impact on an athlete's growth and the accompanying progress of the competition performance (Jevtić, 2019). The progress of Serbian swimmers and competitive swimming itself can be subsumed under the effect of a synergy of the "golden triangle" (athlete - training program - coach) and its environment. Therefore, one of the characteristics and outcomes of the analyzed period of Serbian swimming is strengthening the "golden triangle" constituents and relations as well as the synergy of a large number of actors of the meso and macro levels of sports organization in supporting an individual's progress towards medals and international records. In a way, this can be considered a good starting point for the sustainability of the top-level competitive swimming in Serbia.

An advance towards the challenges of progress and records was possible only through a sports organization regarded as assertive by athletes (Jevtić, 2012). The internal resources of the Serbian Swimming Federation were inadequate, either in terms of numbers or qualitatively and materially, to deal with the talented swimmers' problems. However, the SSF's commitment to the progress of male and female swimmers was not questionable. Faced with the challenges of many development agendas, the SSF was able and willing to determine a significant part, from the limited resources of its development, and direct it to the progress of an individual and his/her performance. Unequivocal support was provided by the NOC of Srb and the Ministry of Youth and Sports (MoYS). The Republic Institute for Sport, the Anti-Doping Agency of Serbia, and the Center for Supplementation and Nutrition should be added to this hybrid model in terms of providing organizational efficiency for the needs of competitive swimming.

Despite the attractiveness of competitive swimming and the events dominated by Serbian swimmers, the absence of sponsorship activities was still evident. Hence, there could not be recognized the economic valorization of the image of the Serbian swimmers and swimming organization in the function of their current and future development, despite the greatest sporting successes! The organization was unable, unwilling, or undetermined in regard to the unique opportunity for its future development. The swimmers, individually, tried to work on their personal image, but, unfortunately, in doing so they opted for or relied on politics and politicians. Numerous plans and promises for the development of individuals and swimming as a sport itself lasted as long as the news about the swimmers' successful achievements in the daily print and digital media. It is clear that many of the actors in the macro environment failed to adequately respond to the needs and challenges faced by competitive swimming and to recognize the importance of enhancing the capacities for self-transcendence in respect of values and organization and for the SSF's development towards a high-performance sports organization.

The challenges of development, advancement, and progress of a competition performance were covered through the portfolio of an athlete; training program; sports event; NIT factors (Scheme 1). It is clear that not only the "golden triangle" elements but the entire system surrounding this sport lie behind delivering a competition performance and developing an efficient national system of competitive swimming. The history of training and competition preparation and competition performance progress is indisputable, yet it is not in a dialectical relationship with the assumptions of sustainable development. In

other words, self-transcendence cannot be registered within the swimming organization, as such as it has been outlined in the form of spiritual and physical unity (Koprivica, 2018) in the case of swimmers. Namely, if the progress were regarded as the final results in the mentioned competitions and records only, the assumptions of the sustainability of competitive swimming in Serbia would be neglected thereby. This is what we are witnessing today, unfortunately, not only in competitive swimming but also in many other sports in Serbia. The progress, both of athletes and of their organizations, must "contain the assumptions of substance, value, and behavior dualism" (Kretschmar, Daireson, Luelin, Gleeves, 2020).

SWIMMING IN SERBIA – NATIONAL AND INTERNATIONAL CULTURAL NARRATIVES

Man, as a homo symbolicus, assigns meaning to events, experiences, relations, seeking symbolism and purpose. "This measure is shaped in the form of a unique, subordinate system of cultural symbols that are perceived as linguistic, music, art, social, political, religious, folklore, and all other visible forms, including even those forms invisible to the eye (Tutnjević, 2016). In a culture², such as Serbian, verbal and non-verbal expressions of an experience represent a stabilizing and integrating mechanism, since the self of spiritual and cultural identity, including the overall life experience, is formed through a cultural narrative. Swimming, together with competitive swimming, has been always understood as a context that rationally transfers the meaning of human physical activity into the field of culture and the image of individual and social heritage and progress.

Sport in Serbia is a part of the national cultural narrative. However, the injustice done to athletes in competitions has established itself as dominant in relation to most other narratives³. Accordingly, the narrative of the events that took place at the Beijing OG (2008) in the men's 100 butterfly final exceeded the national narrative framework and expanded as the global one. The guiding idea of each story, including this one about the winner of the race concerned, implies that there is no single truth or only one true interpretation of events, on the contrary, there are many ways to interpret one experience. Therefore, it is no wonder that the cultural (swimming) narrative of this event, including its value, scope, and truthfulness, has been formed as a belief in the defeat of sports in collision with the bad officiating.

Drama of the Olympic swimming final and controversy of the world swimming organization

The number of articles that appeared in popular periodicals and professional and scientific journals showed that the outcome of the final race in the 100 butterfly event at the OG in Beijing went beyond the national boundaries, and as such, it has become part of the world sports narrative. In part, the exhibition dealing with technology and Olympism in the premises of the International Olympic Committee (2010) was dedicated to this Olympic outcome. The analysis of this narrative, and more precisely of the events that took place during and immediately following the end of this Olympic swimming final, extends to the end of the second decade of the 21st century. The permanence or eternal relevance of this narrative stems from the (un) willingness of many to accept that realistic and objective measurements were defeated by that what is referred to as precise measurement. In other words, in the background of the discussions regarding this Olympic final, there can be seen a dualism between the *objective fact* that Milorad Čavić was the first to reach the finish line, which was visible to the naked eye, and the *questionable configuration and accuracy of the mechanical measurement system*. The finish order in the race, which was considered as subjectively perceived at the time, but today it has been confirmed as the objective perception, was the reason for the SSF representatives to file a complaint to the International Swimming Organization (FINA) for determination of the facts and review of the decision rendered by the panel of officials who supervised this race. A FINA's response was received very soon afterward. It was

based on an argument pertaining to the accuracy of the "error-free mechanical measurement system," including the chief referee's comment that there was no doubt that "the Serbian swimmer was the second to touch the wall" (author's comment: this could imply that the officiating was objective since the officials, among other things, are responsible for determining the finish order indisputably)". "Omega", as the official timekeeper, pointed out that "there was no human intervention" in the measurement system operations, by which they probably wanted to challenge the belief, which was spreading rapidly then, that this final was "paved" with manipulations. Both answers, as it will be shown by later events, were questionable in terms of truthfulness and correctness. Both then and now!

The amendments to FINA's technical documents on this issue have shown that the accuracy of measuring equipment is not on a par with the objectivity of a competition (objective determination of the finish order). Omega later admitted that Čavić was the first to reach and touch the pad of the measurement system (objectively, he is the winner of this race), but also adding that "Phelps pressed it harder". This was an argument in favor of the accuracy of the measurement system. However, the same company subsequently worked on the measurement system, shifting it to the millionth of a second (the new "Quantum" time measurement system). The description of swimming events does not specify how hard swimmers have to press the measuring pad at the finish of a race, therefore, the question arises in regard to how it has become decisive! In addition, the behavior of the chief referee has opened up a question of the officials' objectivity in determining the ranking in the finals of this event. The lack of a debate within FINA, as well as within the International Olympic Committee itself, regarding possible bad officiating, and inappropriate behavior of the chief referee and the officials, raised doubts about a conspiracy theory but also opened an issue regarding the principles of fair play, equality, and objectivity in sports, which is declaratively advocated by everyone in the international sports movement.

Subsequent changes in the rules applicable to swimming competitions, as well as Omega's statements, have indicated that the winner of this final was not objectively determined. According to FINA, the confusion regarding the objectivity of the finish order of this race (Milorad Čavić was the first to touch the finish line) arose from the observer's subjective perception. This FINA's statement implies that all those present in the "Water Cube" and TV viewers around the globe "were deceived by their own senses" and that they did not function according to the *Cognitio, ergo sum* model. Mark Schubert, the head coach of the US swimmers in Beijing, and Bob Bowman, the longtime coach of Michael Phelps, were among those who saw that Milorad Čavić was the winner of the race. Mike Bottom (a longtime coach of Milorad Čavić), who was watching this race with the two USA Swimming's prominent figures mentioned above, also testified about this. Bottom pointed out: "I only remember standing next to Bob Bowman when he said, 'Oh no, he lost it,' Schubert was of the same opinion. Then he looked at the scoreboard and added, 'Oh, my God.' "It was just another one of those races when everything ran smoothly for Michael (Michael Phelps)" (Gonyales, 2020). The "absence of a sense of victory" could also be recognized in Phelps's reaction, as he did not perceive his finish as a win in a sports fight, but looked for the scoreboard to see his ranking. This can be determined quite easily, by reviewing the video, and without any special knowledge or skills from the field of behavioral psychology.

It is also interesting what Mike Bottom said about Mark Schubert who noticed the Serbian delegation's reactions to the ranking in this final race, and, as Bottom described, "marched" into the Control Room, where the officers of Omega (official measuring equipment), according to Schubert's statement, refused to show the video recordings, with a comment that everything was functioning properly. Although he was not the party that filed the complaint, the USA Swimming's representative "marched" into the Control Room and requested to review the video! The complainants were not either

allowed to do so. The representatives of the SSF and NOC Srb were invited to watch the disputed recordings the next morning! It should be noted that FINA refused to organize a public review of these recordings. They behaved in an arrogant manner, stepped out of the vision of their existence, abandoned all Olympic values ... Intentionally or not, they are to blame for the existence of a kind of conspiracy theory in competitive swimming. FINA's arrogance, and not the authority, can be seen in the statement of Ben Ekumbo from Kenya (FINA official), who stated about the SSF's objection: "Michael Phelps is the greatest one we have ever had. No matter what, he would win the race. Tomorrow he will do something (in the 4x100 medley relay) that will make him an alien"(Crumpacker, 2008a). A prophet, a visionary, or whatever, but Ekumbo cannot be said to be an official in accordance with sports ethics!

Maybe Čavić did not win the race. Maybe the touchpad didn't measure precisely (the next day problems were also registered on the pad in the lane four, author's comment), maybe Omega (Phelps's long-term sponsor, author's comment) was against Čavić, ...! Regardless of all the foregoing, it was "a hell of a race that will be remembered in various ways, as long as we care about things like swimming and the Olympics" (Gonyales, 2020). "I don't want to fight against that," Čavić said in his first statement, immediately after the race. "It was difficult to determine. I had a long finish. Phelps had a short finish. I'm not angry at all. Technology is not perfect. It may be (that I touched the pad before Phelps did). It's not something I'm focused on. It's a pity that the time of both of us couldn't be 00: 50.58. It would be nice to share a gold medal with him (Crumpacker (2008b). "I think that, if we were to go through this once again, I would win!" "A loss of 1/100 of a second is the hardest loss you can experience at the Olympics. I saw the goal. If you ask me if I'm disappointed, the answer is no, it's a miracle just to be here. I enjoy the experience deep in my heart. It's an amazing feeling for me to have come this far. I wish I had won a gold, but I'm also happy with a silver medal."

The subjective perception (according to the FINA's judgment), yet, as it will be determined later, the objective feeling of those present in the "Water Cube" and spectators around the world, was that Phelps was defeated (Gonzales, 2020). Čavić was the first to reach the finish line and touch the pad. The world has started debating the issue of objectivity. Everyone had their own personal impression, but there were few about the finish order of this Olympic final. On that day in Beijing, at the OG, a "drama plotted around the objectivity of competitions at the Olympic Games" took place. Once again, the question of objectivity in sports being just a myth has been put forward. In this example, it is established on the accuracy of the measurement system, the arrogance and pride of the officials and the international swimming organization. The accuracy of measurement is a source of errors, and thus a myth in exact experimental science, where the measurements are always accompanied by statements about possible errors, while the differences in repeated measurements induce "replicable crises" (Collins, 2019). In the sports movement, the FINA and the IOC made no statements about errors, a kind of dualism of objective and precise, bad officiating, which is indicated by the statements of officials!

The calmness and sportsmanship associated with the acceptance of the ranking in Beijing were interrupted a year later, ahead of the World Championship finals in Rome (2009), by Čavić saying: "I was the first to touch the finish line, but I did not push it hard enough to activate the measurement system," concluding that this was a problem for FINA and Omega (Crouse, 2009).

As stated exactly in the title of this section, the drama of the Olympic swimming final has led to the cultural narrative that has not been based on the accuracy of measurement, as it is of secondary importance. The narrative has been established around the original romantic and objective sports values, primarily around the objectivity of competition, equality of competitors, and fair officiating. The exam in ethics caused by this drama, all the controversies of FINA, and the silence of the IOC, its bodies and

commissions, remained without a passing grade. The controversy between the objectivity of competitions, work of the officials, and even the sustainability of the proclaimed values of sports and Olympism, provoked the interest of the world-famous "VISE" series that presented this final vividly in the title of its episode from 2016 which reads: "**Milorad Čavić - the one who defeated Michael Phelps** (objective outcome of this race, author's comment), **but lost gold by the force of the finger** (measurement accuracy, author's comment)." Mark Spitz, the most successful athlete (swimmer) of the modern Olympics until this final, stood for maintaining and preserving the objectivity of competitions. In the US media and swimming public community, this attitude was presented as a statement forced by jealousy due to the loss of the title of "the best Olympian in the world".

Forensic experts joined the discussion on the accuracy of measuring this historic Olympic final by presenting several facts, from the field of their professional cognition system, but also doubts about this race and, reinforced an amalgam of the impartialities of this Olympic final, by pointing out the following (Fiin, 2016):

- Public discourse relied on a "time measurement system" correcting what was seen with the naked eye i.e., that Čavić won!
- The epistemological value lies in understanding the mechanical objectivity of the race.
- In order to better understand the issue, it is important to identify spatial (distance) and temporal parameters (speed), so that the time difference of 0.01 of a second was derived as a difference in the distance passed amounting to 16.67 mm/min.
- FINA regulations governing the pool length allow dimensional tolerances of 30 mm between the ends of the walls of a given swimming lane. This tolerance is greater in relation to Milorad Čavić's estimated lag of 16.67 mm.

Summarizing the value and behavioral aspect of this race, it can be concluded that the facts about it are inconsistent, however, this race has created the swimming narrative which is approached reflexively as well as prospectively.

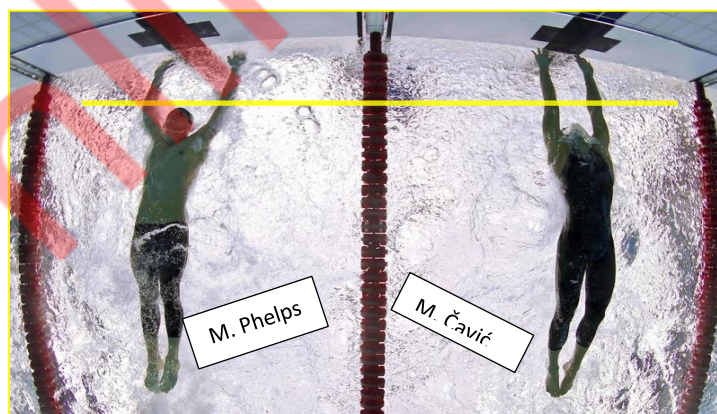


Photo 1. Entering the finish and the swimmers' head-crown line

The footage taken from the bottom of the pool, in the absence of the official recordings distributed by FINA, was the source of discussions and subsequently induced observers' judgments on the finish order. Repeated and slow-motion footage convinced TV audiences around the world of who was the first to touch the finish line. However, the head-crown line of both swimmers should also be analyzed for a more objective explanation (presented with on Photo 1). In measurements, the crown line is used as an anthropometric point that should eliminate inter-individual differences in the skeleton longitudinal

dimensions, which is the arm length in this case. It is visible that the crown of Phelps's head was closer to the finish line, but Čavić's face was above the water surface already at the time when he touched the pad. However, the crown line and the face elevated at the time of entering the finish cannot clarify, with certainty, the performance difference margin of 0.01 second, primarily due to the unknown parameters of camera position and shooting angle in relation to both swimmers. The distance between the camera and the water surface (the depth of an Olympic-size pool is 3m), but also the FINA's single frame which displays different phases within the swimming-stroke cycles of Čavić and Phelps also represent a significant problem.

CYCLE OF THE TOP-LEVEL SERBIAN SWIMMING - LEGACY FOR PRIDE AND LEARNING

From the Sydney Olympics (2000) to the Rio Olympics (2016), Serbia's competitive swimming opened and, unfortunately, closed a dynamic cycle of its development during which a high level of internal changes in working with talented athletes was shown. The changes have led to the progress in a large number of progress-relevant factors and resulted in a high level of competitiveness of the Serbian swimmers in the most significant competitions of the international swimming program.

During the analyzed period (2000-2016), competitive swimming developed from a second-category sport to a sport of the first category at the national level. From the participant status of the male and female swimmers in the National Olympic Committee's delegation at the Sydney OG, through the status of a sport with the potential for the finals at the Athens Olympic Games (2004), the first, historic, Olympic medal for the independent state of the Republic of Serbia was won in swimming at the Beijing OG (2008). There were two swimmers who competed in the finals at the London Olympic Games (2012). At the Rio OG (2016), as if the "Olympic circle" had closed with everything returning to the beginning and to the participant status of the swimmers in the National Olympic Committee's delegation. Slightly more intensive development has been recorded through the appearances at the World Championships, from the swimmers' status of participants in the WCh in Fukuoka (2001), two finals in Barcelona (2003), to three medals, one world and two European records at the WCh in Rome (2009). Of course, the highest level of competitiveness and the largest number of medals were reached i.e., won by the Serbian swimmers at the European Championships in the analyzed period.

In this paper, the process of learning about competitive swimming in Serbia was established around a thread that has managed to connect the swimming preparation programs, athletes and coaches' environment, organization, etc. in the function of progress of personal performance with an orientation towards international records and the whole of competitive swimming in Serbia.

By generalizing the subject of this paper, which concerns the factors that have led to the progress of personal performance towards top-level performance, it is obvious that the changes in Serbian swimming occurred, that they were time-limited, as well as that their dynamics, national and international significance, in a way, reflected the positive events in the development of Serbian society, sports and competitive swimming itself during the first two decades of the New Millennium.

The technology of swimsuits materials and designs, which followed the progress of performance and the competitiveness of Serbian swimmers, has changed the training and competition practice, "pushed" records forward, and at the same time impressed the advocates of science and technological development in sports. Although it is often filled with oxymoron solutions of the sports industry and market, it is still evident that technology was represented in the Serbian swimmers' training through personal (gadgets, hydration, supplementation, etc.), implementation (modern swimming suits, props,

devices and means of underwater communication) and prophylactic and rehabilitation technological equipment and devices (preparations, ice baths, altitude tents, modulators of muscular electrical stimulation, etc.).

In addition to SOFT programs, new training and competition practices and efficient organization were strongly supported also by science, innovation, and technology (NIT). The place and role of NIT and SOFT programs in the development of competitive swimming, in the case of Serbia, can be characterized as a legacy from which, such as from any other legacy, it is possible to learn and set new practical and theoretical paradigms.

Today, after the top results occurred in Serbian swimming, this ex-post reflection emphasized the characteristics of an individual in achieving excellence, and at the same time explained the differences and distinctions among male or female swimmers. By identifying the swimmers' characteristics, individual causalities (essence), type, hierarchical superposition of skills and abilities, etc., some but not all of the trends in modern swimming have been illuminated.

The facts that shaped the international and national cultural narrative resulting from the ranking of the final in the 100m butterfly event at the Beijing Olympics (Čavić vs Phelps) were elaborated. This cultural narrative can be used for further learning, but it can also be valued as a legacy in the assessment of the modernity and actuality of the Serbian swimming breakthrough in the analyzed period.

REFERENCES

1. Batorova, M, Stastny, J, Motucka, J, Januar, M. (2016). Development of an analysis of swimming techniques using instrumentation and the development of a new measurement method at Brno University of Technology. *10th INSHS International Christmas Sport Scientific Conference, International Network of Sport and Health Science*. Szombathely, Hungary
2. Bayle, E., Madella, A. (2002). Development of a taxonomy of performance for national sport organizations. *European Journal of Sport Science* 2(2):1-2
3. Collins, H. (2019). Applying Philosophy to Refereeing and Umpiring Technology. *Philosophies* 4, 21; doi:10.3390/philosophies4020021.
4. Colwin, M.C. (1992). *Swimming into the 21st century*. Leisure Press, Champaign, Illinois.
5. Crouse, K. (2009). Phelps rival is speedy with his lips; Bashful he's not, Cavic is a verbal typhoon ahead of rematch with American. *The International Herald Tribune*, p. 13.
6. Crumacker, J. (2008a). *Chronicle Olympic Bureau* <https://www.chron.com/sports/olympics/article/Phelps-wins-7th-gold-ties-Spitz-s-Olympic-record-1551253.php>
7. Crumacker, J. (2008b). Phelps wins 7th gold, ties Spitz's Olympic record. *Chronicle Olympic Bureau*, Aug. 15.
8. Di Nino, A. (2014). Science and innovation of sprint coaching. FINA Swimming Coaches Golden Clinic. Doha (www.fina.org)
9. Dikić, N. (2019). Anti-doping agency - knowledge, staff, innovations in the fight for pure national sport. *Physical Culture*, 73(1), 72-88
10. Finn, J. (2016). Timing and Imaging Evidence in Sport: Objectivity, Intervention, and the Limits of Technology. *Journal of Sport and Social Issues* 40(6) 459–476.
11. Gonzalez, J. (2020) Hitting the Wall. *The Ringer*. <https://www.theringer.com/2020/7/29/21345181/milorad-cavic-michael-phelps-2008-olympics-beijing-100-butterfly-conspiracy>
12. Higl, S. (2013). Trenažni program Nađe Higl u godini evropskog rekorda i naslova svetske prvakinja. Diplomski rad [Nadja Higl's training program in the year of the European record and the title of world champion. Graduate thesis. In Serbian]. Beograd, Fakultet sporta i fizičkog vaspitanja.
13. Evtić, B. (2013). Олимпийская программа в контексте развития системы национального спорта. [The Olympic program in the context of the development of the national sports system. In Russian / Ukrainian]. *Наука в олимпийском спорте*, 1, 27-36.
14. Jevtic, B. (2019). Progress of competition results in top and elite sport – challenge for sports medicine and sports sciences. Invited Lecture. *The 2nd Serbian International Sports Medicine Conference New dimension in sports medicine*. Book of abstracts 75-76.
15. Jevtić, B. (2012). Olimpijski programi – sistem inovacije u sport Srbije. [Olympic programs - the system of innovation in sports in Serbia. In Serbian]. *Međunarodna naučna konferencija: „Efekti primene fizičke aktivnosti na antropološki status dece, omladine i odraslih“*, str. 19-33. Beograd, Fakultet sporta i fizičkog vaspitanja.

16. Jevtić, B. (2001). Teorijska sinteza energetske kapaciteta plivača. [Theoretical synthesis of swimmers' energy capacities. Doctoral thesis. In Serbian]. Beograd. Fakultet fizičkog vaspitanja.
17. Jevtić, B. (2011) *Plivanje u nastavi*. [Swimming in teaching. In Serbian]. Beograd, Fakultet sporta i fizičkog vaspitanja.
18. Jevtic, B. (2019). The system of sports in the state of the independent Republic of Serbia - From a thoughtful beginning to exhausting state interventionism. *Physical Culture* 73 (1): 1-22
19. Jevtic, B. (2011). *Olympic preparations of Milorad Cavic*. Belgrade, Partizan Swimming Club,
20. Jevtic, B. (2014). *Velimir Stjepanović's Olympic preparation program*. Belgrade, Partizan Swimming Club.
21. Jevtic, B. (2006). Olympic programme of NOC of Serbia "Beijing 2008". Belgrade, Olympic Committee of Serbia.
22. Kanchan,T.,Kumar,M., Pradeep, G. Kumar, K., & Yoganarasimha, M.D. (2008). Skeletal Asymmetry. *Journal of Forensic and Legal Medicine*,15:177-179.
23. Koprivica, Č.D. (2018). *Homo maximus. Elements of sports philosophy*. Belgrade. Ukraine
24. Kretschmar, S., Daireson, M., Luelin, M., Gleeves, J. (2020). *History and philosophy of sports and physical activities* [In Serbian]. Novi Sad, Faculty of Sports and Physical Education.
25. Maglischo,E.W.(2003). *Swimming Fastest:The essential reference on technique,training, and program design*. Champaign,IL:HumanKinetics.
26. Madella, A., Bayle, E., Tome, J. (2005). The organisational performance of national swimming federations inMediterranean countries: A comparative approach. *European Journal of Sport Science*, 5(4): 207-220.
27. Omoregie, O.P. (2016). The impact of technology on sport performance. *Proceedings of INCEDI 2016 Conference*. Accra,
28. Osborough,C.D. & Peyrebrune, M. (2008). *Butterfly technique: what happens when the swimmer gets tired?* Available at www.coachesinfo.com (Accessed: 10th June 2010).
29. Psycharakis,S. & Sanders, R.(2008).Shoulder and hip roll changes during 200m front crawl swimming. *Medicine and Science in Sports and Exercise*, 40 (12):2129-2136.
30. Ride, J., Ringuet, C., Rowlands, D., & James. D. (2013). A Sports Technology Needs Assessment for Performance Monitoring in Swimming. *Procedia Engineering*, 60: 442-447.
31. Ropret, R. & Jevtić, B. (2019). Long-term development of the athlete - from theoretical and practical model to cognitive problem. *Physical Culture*, 73 (2), 190-205.
32. Sanders, H.R., Thow, J. , Fairweather, M.M. (2011). Asymmetries in Swimming:Where Do They Come from? *J. Swimming Research*, Vol. 18
33. MChollet,T.C., Seifert, L., & Chollet, D. (2009). Effect of force symmetry on coordination in crawl. *International Journal of Sports Medicine*, 30;182-187.
34. Tutnjević, S. (2016) *Srpski kulturni narativ*. [Serbian cultural narrative. In Serbian]. Beograd.Svet knjige.
35. Vorobjeva, I.E. & Vorobjev, N.A. (1977). *Ispoljavanje adaptacija u sportskom treningu kao jedan od oblika biološkog prilagodavanja organizma na uslove sredine i razvoja*. *Trenerska tribina* 3.

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