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Performance Prognosis in Swimming

by

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The system of evaluation and prognosis of performance is based upon the performance evaluation of both Czech and Slovak swimmers – juniors and seniors, and the best world swimmers (top ten of all time in each discipline). When using mathematical relations and correlations, it is possible to determine the coefficients of optimal curves of the dynamics of performance development in each event. One of the main roles prior to setting up individual prognosis is the choice of the most suitable duration of time series. It is generally recognized that time series that are either too short or too long, give less reliable results. Along time series is negatively influenced by the lower level of performance in the past, on the other hand, short time series does not offer enough information for producing relevant prognosis.

The following methods were used while data had been processed: time series method, method of regression, least square method and method of extrapolation.

Key words: *prognosis, swimming, sport performance, time series method.*

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Introduction

The training of athletes is an organized and planned activity. If prognosis indicates that a drop in performance may affect the forthcoming sport events, the organization of the training process or its adjustment should prevent this undesirable development. If prognosis indicates a positive trend, the overall effort must be actively focused on continuous improvement of performance, by improving the management of organization and by adjusting and shaping up the training of the athlete.

Prognosticating of sport results is connected with many methodological difficulties. The problem of predicting sport results is related to defining the range of factors that influence the results directly; factors that are either connected to them or that enter particular relationships with them. The factors influencing sport results are most often interwoven with those that do not enable the formalization of the system, such as scientific – technical progress, from the biological point of view it is the ones that the grade assumptions, talent, assumed genotype of an athlete, organization, or scientific – methodical, geographic conditions etc.

Prognosticating is a hazardous activity for everybody who has accepted the role of a prophet. One can be in a danger of indefiniteness and inaccuracy of the data; the intricacy of the prognoses influenced by "real world", the tendency of humans to accept what they had wished for rather than to accept real status, the emotional character of human thinking and also the tendency to hound the acceptable explanation of the facts through the hastily just-in-time built scheme.

Tilinger (1983) shows that the first reaction towards prognosis is often skepticism to its truthfulness. This lack of trust, coming from the general subconsciousness of prognosis as opposite to reality, is not apt in the prognosis concept as the orientation helps in the process of planning and managing the training process.

The next argument must be a low accuracy of prognosis. The accuracy of the complex development of efficiency and the training process can never be as accurate as in physics or technical sciences. These sciences have fewer factors and conditions. In their case we deal mostly with deterministic dependencies and not so often with stochastic.

The majority of prognosis is known for their higher or lower grade of inaccuracy, and it is necessary to make it accurate at the level, where the directing measures are accepted in order to be used for gaining the information about the future. The basic problem is to raise the accuracy of the already realized prog-

nosis. It is necessary to minimize possible deviations of the prognostic assessment from the real times.

Prognosticating as a management function characterizes a specific situation, direction, and contents of activities of co-operating institutions. From the point of view of theory and practice, sport performance prognosis can be divided according to several criteria. Two big groups of prognosis can be distinguished in terms of their focus:

1. Prognosis of performances at top international competitions
2. Prognosis of performances of a specific competitor – individual prognosis.

These groups of prognosis are divided into subgroups:

1. *For the first group* it is possible to file all the prognoses regarding the expected performance of the winner or the finalist in the crucial competition or the prognosis of the performance level for a certain year. These prognoses provide a norm that has to be met, so that success is reached. Here belong:
   - prognoses of performance level in particular disciplines or sports at World Championships, Olympic Games, European Championships (performances 1st, 3rd, 6th, 10th etc.),
   - prognoses of world (national) performance level in a particular year (1st, 10th, 20th, 50th place in world charts etc.),
   - prognoses of development of world records (swimming, athletics etc.),
   - prognoses of development of indirectly measured sports (team sports, gymnastics etc.),
   - prognosis of successfulness of national teams at the Olympic Games or World Championships (scoring for 1st – 6th place).
3. *For the second group* it is possible to file prognoses regarding the prediction of the performance of a particular athlete as a complex matter or research dedicated to particular components of the performance structure (and to the factors of the sport performance), matters of training development, anthropometric, somatic, mental and other characters and skills necessary for the performance at a particular level. To this group belong:
   - prognoses of performance dynamics for a particular individual,
   - prognoses of structure development of the sport performance of an individual,
   - prognoses of increase in the training load of an individual,
   - prognoses of dealing with mental aspects of the discipline by an individual, etc.

Material and methods

One of the main tasks prior to the development of a prognosis itself is the selection of the most appropriate time series length. In principle, a too short or a too long time series negatively affects the reliability of results.

The set for prognosis of performance of the winners at the Swimming World Championships 2001 in Fukuoka, Japan, formed the winners of particular events from 1978 (n = 156).

The set for the individual prognosis was formed by two swimmers, one being a female swimmer M.P. from the swimming club ŠKP Košice and two Slovak national team swimmers M.M. a L.K.

When processing data the following methods were being used: method of time series, regression, minimal squares and extrapolation.

Performance prognoses at top international competitions

Predicting future performance level is an inseparable part of those skills and knowledge of a coach that are necessary for scientific management of the training process. In order to prepare the team or an individual most efficiently for the climax of the season (Olympic Games, World Championships, etc) it is inevitable to prognosticate the performance level within two, respectively four years ahead with the greatest probability. Based on the information gained it is possible to prepare an appropriate plan, consider the real chances of it being put into practice, as well as the concrete methods and means of preparation aimed at achieving the maximum output at one's individual edge of abilities.

The program of the World Championships in Fukuoka included the men's 800 m free style, women's 1500 m free style as well as the 50 m breast stroke, back stroke and butterfly (men and women). It was these events for which it was not possible to predict the winners' times, because we did not have the necessary time line (with the little bit of skepticism it is possible to count on the reduced performances which can be the inter-times of men – 1500 m freestyle and women – 800 m free style). The time line of the performances from the World Championships cannot substitute the time line of the Olympic Games and vice - versa. The times reached at the Olympic Games are typical for its level of continental and world records (the performances oscillate around the performance curve y = -1), as it is at the World Championships (the performances move mostly around the optimal performance curve y = 0).

Table 1 shows the survey of prognosticated performances that were calculated for Fukuoka, and the reached performances of the winners – men and women at the 2001 World Championships.

Table 1

Predicted and real results in swimming at the 2001 World Championships in Fukuoka (Turek - Ružbarský, 2001).

Event	Men		Women	
	Prognosis	**Reality**	**Prognosis**	**Reality**
50 freestyle	22,00	22,09	24,78	24,47
100 freestyle	48,21	48,33	54,06	54,18
200 freestyle	1:46,16	1:44,06	1:57,65	1:58,57
400 freestyle	3:42,94	3:40,17	4:06,42	4:07,30
800 freestyle	- - -	7:39,16	8:22,67	8:24,66
1500 freestyle	14:43,73	14:34,56	- - -	16:01,02
50 backstroke	- - -	25,34	- - -	28,49
100 backstroke	54,19	54,31	1:00,42	1:00,37
200 backstroke	1:56,77	1:57,13	2:07,82	2:09,94
50 breaststroke	- - -	27,52	- - -	30,84
100 breaststroke	1:00,44	1:00,16	1:07,18	1:07,18
200 breaststroke	2:09,76	2:10,69	2:24,56	2:24,90
50 butterfly	- - -	23,50	- - -	25,90
100 butterfly	52,22	52,10	58,20	58,27
200 butterfly	1:55,41	1:54,58	2:06,04	2:06,73
200 Ind. Medley	1:58,48	1:59,71	2:10,38	2:11,93
400 Ind. Medley	4:13,40	4:13,15	4:35,34	4:36,98

Table 2 shows the ratio of predicted and real performances in the percentage and the difference marked as delta (difference between the winners' times that were prognosticated and actually reached at the 2001 World Championships in Fukuoka) (Turek – Ružbarský, 2001).

At the 8th World Championships eight world records were set, but none of them were reached by women. The percent difference between the prognoses and reality is 99,97%. The total difference (delta) between the prognoses and reality is 0,658, so the successfulness of the predicted performances of the winners at the World Championship in Fukuoka was 99,34%.

Approaches to individual performance prognosis

One of the essential problems of an individual prognosis in swimming raised the following question: "What is the specific form of the performance curve for the majority of top athletes in a particular event?" The answer to this question can be reached at by two methods.

1. Complex method
2. Analytic method

Table 2

The ratio of the predicted and real performances of winners at the 2001 World Championships in Fukuoka (Turek - Ružbarský, 2001).

Event	Men		Women	
	Relation P/R %	D **delta**	**Relation P/R %**	D **delta**
50 freestyle	99,592	0,407	101,267	1,267
100 freestyle	99,752	0,248	99,779	0,221
200 freestyle	102,018	2,018	99,225	0,775
400 freestyle	101,258	1,258	99,644	0,356
800 freestyle	- - -	- - -	99,606	0,394
1500 freestyle	101,048	1,048	- - -	- - -
100 backstroke	99,779	0,221	100,083	0,083
200 backstroke	99,692	0,308	98,368	1,632
100 breaststroke	100,465	0,465	100,953	0,953
200 breaststroke	99,288	0,722	99,765	0,235
100 butterfly	100,230	0,230	99,880	0,120
200 butterfly	100,724	0,724	99,455	0,544
200 Ind. Medley	98,972	1,028	98,825	1,175
400 Ind. Medley	100,098	0,098	99,408	0,592
AVERAGE	**100,224**	**0,674**	**99,712**	**0,642**

The complex method of prognosticating – is appropriate and accurate for cases when arepresentative file of data about all factors that influenced the issue is available.

The analytic method of prognosticating – the swimmer who wins the Olympic Games or the World Championship usually reaches the performance level that meets the 10th place level in world charts of FINA (La Federation Internationale de Natation) during the year prior to this competition, which has statistically been evaluated by Svoboda (1984 a). There is a determined hypothesis that the swimmer with the necessary dispositions for the final placement at the Olympic Games or the World Championship reaches better results already in the preparation period in comparison with those who do not have these dispositions.

The method of extrapolation is very useful when prognosticating, especially in individual sports. It is conditioned by the possibility of quantification of results, by using the computer techniques and by the possibility of retrospectiveness of reached performances. By using the several methods of the extrapolation and the choice of the appropriate function it is possible to reach considerable approximation of the prognosis to the real performances. Herning and Klimmer (1980, according to Turek, 1996) consider that the problem of the limit performance lies in the fact that we do not know how to assign exactly, only to

assess, what is caused by the factor of uncertainty as the greatest problem of the prognostic trend.

Various authors usually rely in their prognoses on a single variable, in particular, performance improvements. They recommend comparing individual improvements with the theoretical model of sport performance progress designed for a particular discipline. The theory of sport uses general formulas describing the course of sport performance as a function of time:

$$y = (f)x$$

The particular function can be best described by means of a second order polynome *(Svoboda, 1983, 1984; Tilinger, 1983; Turek, 1991, 1996; Ružbarský-Turek, 2001b; Turek-Ružbarský, 2001)* of the following form:

$$y = a + bx = cx^2$$

where: y = performance value in points
a,b,c - constants for a particular swimming event - tailor-made for men and women.
x – time.

This polynome reflects all three sport performance dynamic constituents, including an ascending constituent (continuous improvements in performance), performance stabilization (maximum possible performance), and a descending constituent (performance drop).

Prognosticating individual performance

The theoretical prognoses for the development of performance are much easier to develop for the so called objectively measured sport disciplines, in which the performance is expressed in specific and generally accepted units (athletics, swimming, etc.)

The study of the process of performance development and discovering the generally valid regularities is very important for the running judging of the perspectives of particular athletes. On the basis of knowledge of the performances that will be necessary for the placement at the important competitions we stand in front of the problem, if the observed athletes are able, in several years, to perform at the highest level (World or European) with the hope of success. The performance development of a competitive swimmer can be divided into several stages:

- the preparation period
- the period of basic preparation
- the period of efficient preparation
- the period of top preparation (peak sport performance)
- the period of the fade – (drop in performance)

An optimum performance dynamics can be determined by means of curves which rather than being specified according to the 10th position in the world in a particular calendar year are determined according to the average time of ten best performances, which yields a higher value.

The range of performance channels differs in terms of both events and gender. Initial attempts in sport prognoses were based on a 50 point channel width. A subtler evaluation of the FINA statistics has revealed that the performance channel widths are not standard; on the contrary, they are internally differentiated depending on events and gender *(Svoboda, 1984, Turek . Ružbarský, 2001).*

This method can be advantageously applied to the training process. When the data concerning the swimmer performance improvement dynamics are transferred into a nomogram, a coach can get a fairly precise picture of the present performance and future perspectives of individual swimmers.

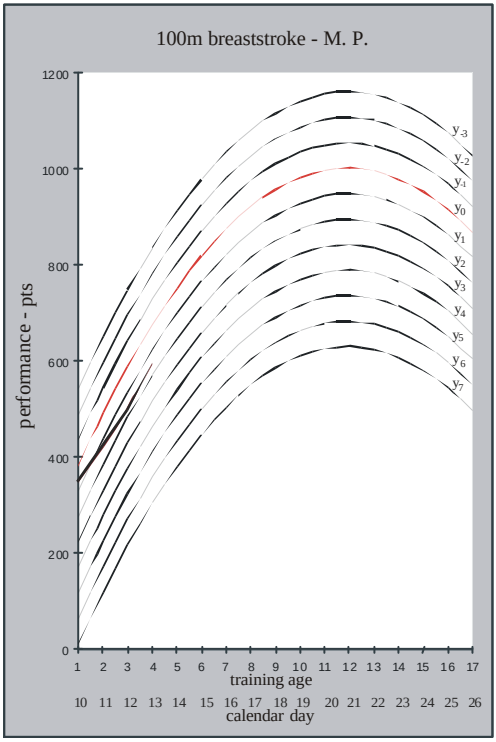

Fig. 1. *M.P.'s performance development nomogram: 100 m breaststroke (Turek-Ružbarský, 2001)*

Example:

Swimmer M.P. (fig. 1) got from the first to the second performance channel after three years of controlled training. No performance dynamics stagnation occurred between the first and the second year of training, but the performance dynamics is not sufficient for reaching a higher performance channel level. The nomogram data indicates that the performance curve between the second and the third years of controlled sport training develops continuously in the second performance channel. By implication it may be assumed that this loading guarantees subsequent development in the same channel.

The precision of the prognosis calculated by means of development curves is relatively high (table 3). The result in 100 m backstroke was at the lower limit of the calculated individual prognosis.

Fig. 2 illustrates a performance development nomogram of the most successful Slovak swimmer (M.M.) in the 200 m freestyle.

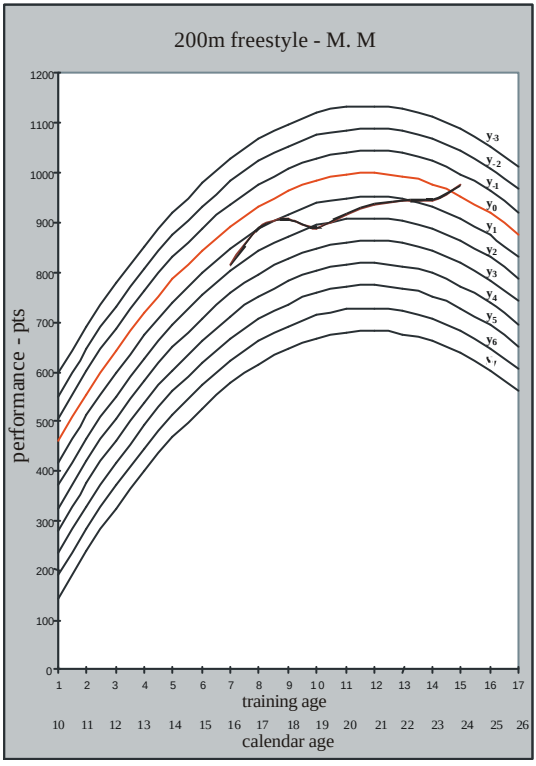

Fig. 2 *M.M.'s performance development nomogram: 100 m freestyle* (Turek-Ružbarský, 2001)

Table 3

Individual prognosis and the actual result of M.P. in the 100 m breaststroke

M. P.	performance in the 1998/99 season	prognosis 1999/2000	min.	max.	reality-july 2000
100 breaststroke	1:24,37	1:18,5	1:19,5	1:17,5	1:19,65

The performance curve in the nomogram indicates an almost optimal performance dynamics. It decreased before the swimmer's travel abroad. The nomogram performance curve ends in 2000 when M.M. reached an optimal performance curve, which was acknowledged by two silver medals won at the Olympic Games.

With the help of the nomograms it is possible, with acceptable accuracy, to detect any change in the dynamics of performance development.

Discussion and conclusions

One of the most important tasks in developing an effective performance prognosis is the selection of the most adequate length of time series. There is no single universal mathematical curve used for the approximation of trends for individual disciplines. A prognosis must be developed for each discipline according to various mathematical curves. They establish the basis for the selection of a function which represents and expresses the past, present, and future development in a specific discipline. Current trends at the medium time-span prognoses level simply can not cover the extreme individual performance improvements in particular disciplines. These are cases of particularly talented individuals. Any simplified or more complex prognostication procedures may only provide a probabilistic estimate of future performances. It is only after the completion of arespective swimming event, for which the prognosis is designed, that the relevant factors determining the actual sport performance can be determined. In developing a prognosis it is necessary to compare the factors which underlie the prognosis with those which have actually determined the sport performance.

Graphic nomograms, including a performance development curve, make it possible to get a reasonable picture of the actual performance and the perspectives of the individual swimmers. An individual performance prognosis enables us to prognosticate the performance dynamics of a swimmer with a high level of precision. Swimmers thus can be grouped into individual performance chan-

nels according to their actual performance by reflecting the age and the performance for the period of at least three years.

A non-stable performance dynamics course in individual performance channels, which is characterized by transitions between individual channels, indicates an inappropriate training process. Given the recommended loading and an adequate physical health of a swimmer, the transition by more than two performance channels within an annual training cycle is impossible. A swimmer who failed to improve during three training seasons in any event can hardly make any improvements in the future. Any improvement is conditioned by a radical change in training volume, intensity and training conditions.

Performance improvements which are conditioned by acontinuous development in the range of 30 to 90 points a year are of more permanent nature; the majority of performance leaps are time-limited.

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