KINEMATICS OF MARATHON RUNNING TACTICS
PART ONE: COURSE PROFILE

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The paper presents a description of geometry of marathon courses. The following courses were taken into account: Edmonton 2001 (IAAF World Championships), Boston 2002 (city marathon), Berlin 2002 (city marathon), Athens 2004 (Olympic Games). Based on course profile (for every 1 km) coefficient of course difficulty was calculated. The most flat course profile was that of Berlin Marathon, the toughest profile was that of Athens Marathon.

KEY WORDS: marathon run, tactics, kinematics, course profile.

INTRODUCTION: Long distance running was always one of the main forms of human movement. It was utilized in hunting, in fighting, for message distribution and for other purposes. In Ancient Greece it was common to run very long distances, e.g. from Athens to Sparta. The legend has it that a Greek soldier ran in full gear from Marathon, where Greeks defeated Persian Army, to Athens with the news of victory. The legend also has it that he died afterwards. One must say his tactics of running was wrong.
At present long distance running takes place at the stadiums, in the streets of cities and outside the cities. This kind of running is very popular. For example, in New York City 2003 marathon 35 thousand runners participated (www.maraton, 2004).
During contemporary marathon distance running there are those who have very good tactics of running (Fig. 1 A) and those who have very poor tactics of running (Fig. 1 B).

A

B

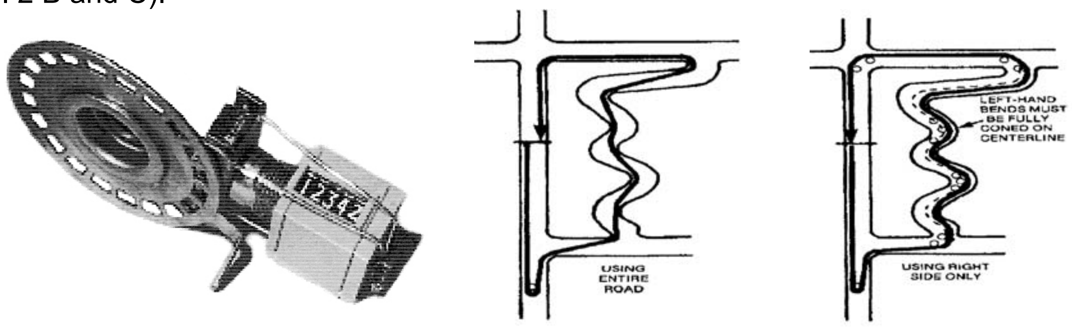
Figure 1: The winner with good tactics of running (A) and the looser with poor tactics (B) (Moore 1984).

Every runner, when establishing tactics for the particular run, has to take into account his or her fitness preparation and actual possibilities of the body. Also configuration of the running course, in case the run takes place outside the stadium, has to be considered.
The purpose of the entire scientific work was investigation of running tactics of the best world marathon runners taking into account geometry of the running course. The purpose of this paper is a presentation of running courses' profiles of the few best known marathons.
Since 2004 International Association of Athletics Federations (IAAF) gathers the best world times of marathon runs and considers them as the world records. In order to validate the record the distance and its measurement has to conform special requirements.
Regulations are as follow:

1) distance in a straight line between start and finish points shall not be further apart than a half of a marathon distance;
2) decreasing in elevation between the start and finish shall not exceed an average of one in a thousand, i.e. 1 m vertical per 1 km horizontal;

3) it is necessary to verify a course by the IAAF or AIMS (Association of International Marathon and Road Races) at least two weeks before the run or just after the run;
4) it is necessary to mark every 5 km of a marathon distance and a half of a distance with an error not exceeding 0.1 %, i.e. 42 m for the whole marathon distance.

The measurement of a distance is accomplished with the help of a calibrated bicycle with dromo-meter (Fig. 2 A). This device acts based on counting the revolutions of a wheel with known radius. During measurement the shortest possible route has to be taken into account (Fig. 2 B and C).



A B C

Figure 2: Measuring of marathon distance: A – Jones-Oerth dromo-meter (www.aims 2004), B and C – rules of measuring (www.iaaf 2004).

MATERIAL AND METHOD: The following marathon courses were taken into account (Lipinska, 2005):

1) Edmonton – IAAF World Chamionships in 2001 (103 men and 103 women participated);
2) Boston – City marathon in 2002 (16963 runners participated);
3) Berlin – City marathon in 2002 (25978 runners participated);
4) Athens – Olympic Games in 2004 (102 men and 89 women participated).

Detailes of geometry of a course were taken from homologation documents presented by the organizers of a run. Based on these documents the course was divided into 1 km fragments (Fig. 3). Then vertical and horizontal distances were calculated in order to obtain tangent for each 1 km fragment. In addition a sum of ascent and descent fragments was obtained, and mean data for the entire distance. Quotient was calculated for ascent and descent fragments of a distance.

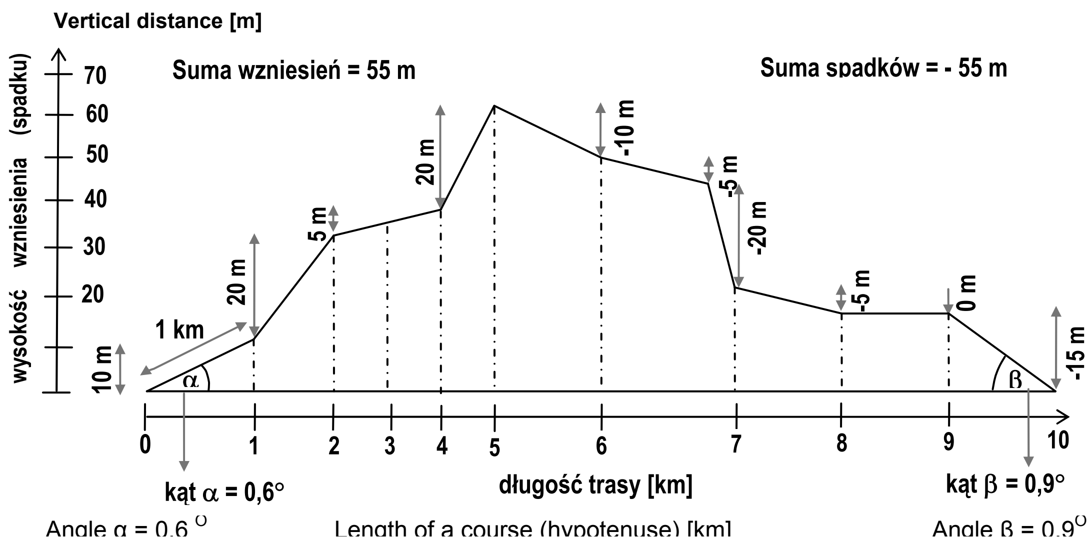


Figure 3: Geometry of a maraton course (fragment, an example) (Lipinska, 2005).

In order to describe the difficulty of a course a coefficient of a course difficulty (Ccd) was calculated /1/.

$$Ccd = [\Sigma (p \times tg\, \alpha)] \times 100 \qquad /1/$$

where: Ccd – coefficient of course difficulty, p – parameter for 1 km course's fragment (a = 1.0 for horizontal, b = 0.8 for descending, c = 1.6 for ascending (Costill, 1976)), α – angle of descending or ascending hypotenuse of a course's fragment.

RESULTS AND DISCUSSION: Figures 4 - 7 present profiles of investigated marathon courses. Data on X axis are consecutive kilometers of a course, data on Y axis are meters above sea level.

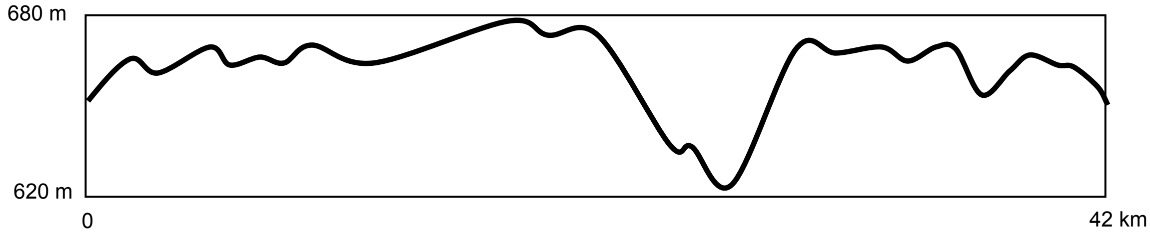


Figure 4: Course profile of Edmonton 2001 marathon (Lipinska, 2005).

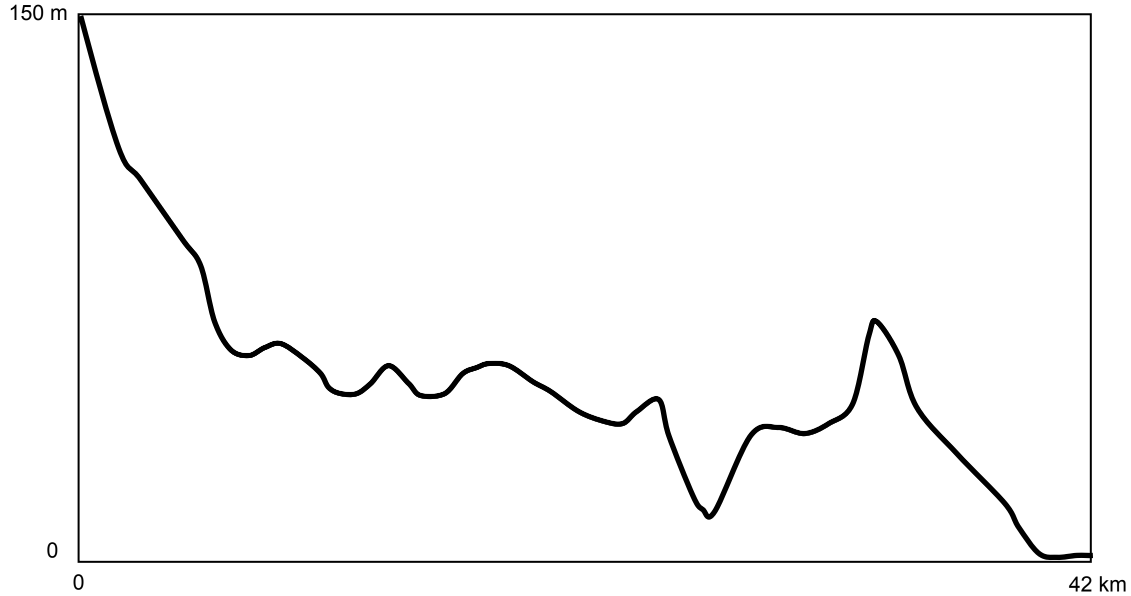


Figure 5: Course profile of Boston 2002 marathon (Lipinska, 2005).

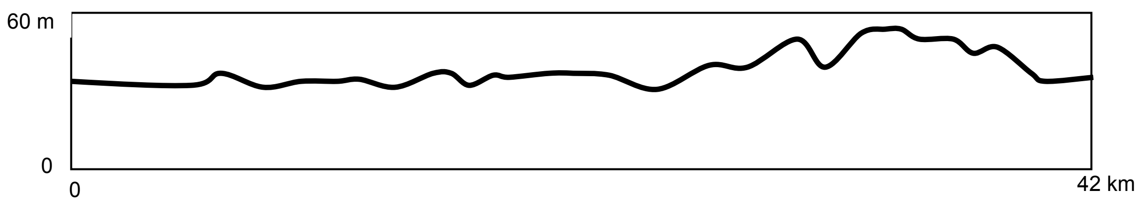


Figure 6: Course profile of Berlin 2002 marathon (Lipinska, 2005).

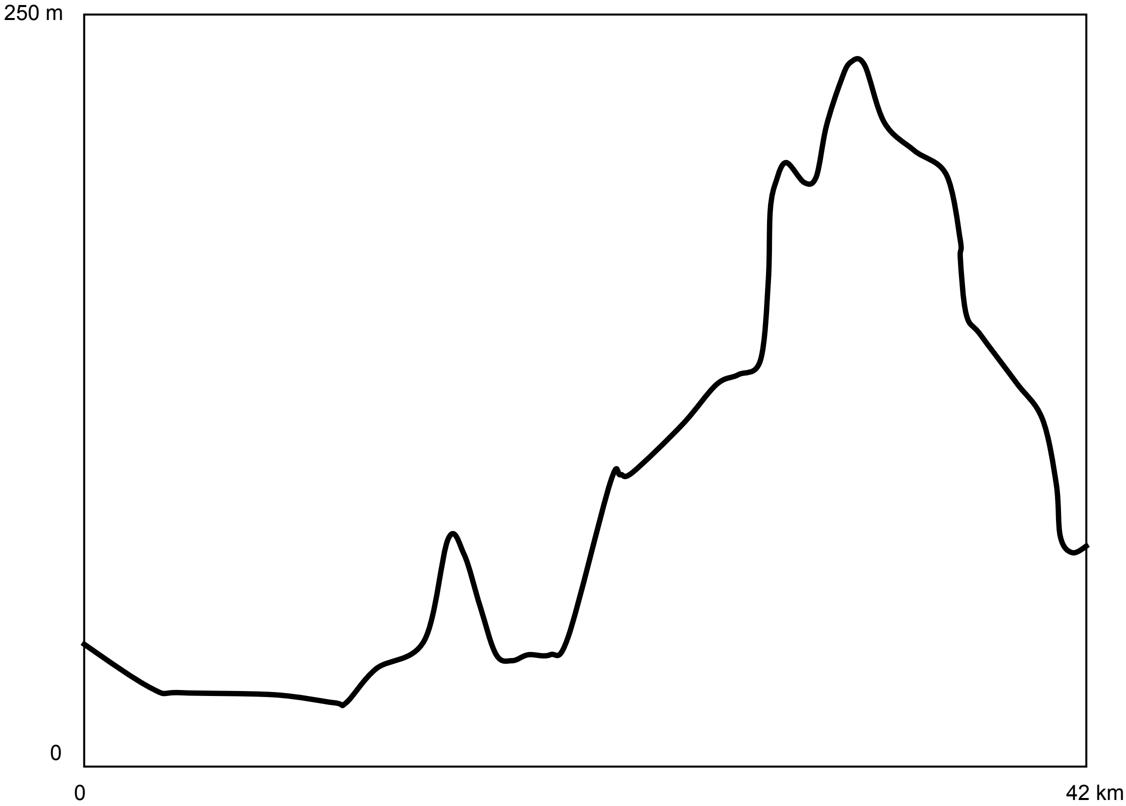


Figure 7: Course profile of Athens 2004 marathon (Lipinska, 2005).

The most flat course profile was that of Berlin Marathon. This profile is excellent for obtaining the best time of running. The Boston Marathon profile has a descent fragment of almost 100 m per 6.5 km. Nevertheless this should not be run with greater velocity since that fragment is at the very beginning of a course. The most toughest profile was that of Athens Marathon. For example from 20th km to 32nd km the course ascended 200 m. Table 1 presents data of ascending and descending fragments of courses.

Table 1. Data of courses profiles' fragments, Ccd – coefficient of course difficulty.

Edmonton 2001				Boston 2002				Berlin 2002				Athens 2004			
ΣDesc.	ΣAsc.	D/A	Ccd	ΣDesc.	ΣAsc.	D/A	Ccd	ΣDesc.	ΣAsc.	D/A	Ccd	ΣDesc.	ΣAsc.	D/A	Ccd
-105	104.5	1.0	8.3	-228	80.5	2.83	5.4	-49	48.5	1.01	3.7	-222	257	0.90	14.2

American marathon runners made their training runs on high altitude on the course similar to that of Athens 2004 (Wilber, 2005). During Olympic runs they obtained silver (male) and bronze (female) medals. This shows that knowing a course profile is worthwhile.

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