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**Introduction.** Over the years training undergoes certain changes. Obviously, many years of applying the same types of exercises may result in "blocks" or "barriers" which are difficult to overcome. In the training process diversity of exercises and measures is indispensable. Although there are groups of training measures one cannot renounce in the course of preparations, a question arises about the scope and proportions in which such measures should be applied. An analysis of many years' preparations of a competitor gives the possibility of checking on changes that take place over the years, and in consequence presents an opportunity to find most effective solutions.

In the year 1994 Janusz Iskra and Andrzej Kosmol [2] conducted an analysis of a many years' training cycle of a runner (400 m Hurdles). The materials concerned P.K., Polish top hurdler, holder of the fifth result (49.75 s) in 400 metres in Polish track and field history. It is a unique analysis, as it concerns as many as 7 years of the competitor's sports career, including the juvenile, junior and senior ages. Unfortunately, the analysed period did not include the year of the competitor's record achievement. The present analysis has been based on this example.

**The aim.** The aim of the paper was to define the structure of a competitor's training in 400 m Hurdles in the course of many years' sports career. A need had appeared to optimize the training structure in order to improve performance.

**Materials and method.** Conducting a computer analysis became possible thanks to adopting a uniform method to code training workload. Computer programme TreOb 4.0, produced in Theory of Sport Unit at the Academy of Physical Education in Warsaw [4] was used for the analysis. It allows for systematic recording of the training process. In order for a training to be coded, training measures had to be classified. And so the division differentiates between two "levels" (fields) which describe the performed work.

The energy field comprises and differentiates exercises according to energy sources and appropriate energy transformations (aerobic, lactic acid anaerobic and non-lactic acid anaerobic).

/T1/ - influence of supportive character, aerobic transformation zone

/T2/ - aerobic transformation zone

/T3/ - mixed transformation zone (aerobic - anaerobic)

/T4/ - lactic acid anaerobic transformation zone

/T5/ - non-lactic acid anaerobic transformation zone

The information field comprises measures divided according to the type of influence: comprehensive, channelled and special.

**Comprehensive (C)** measures, developing athlete's physical potential, having no direct influence on shaping specialist dispositions defined by the championship model of a certain discipline.

**Channelled** measures (**Ch**), above all shaping specialist efforts' mechanisms. These are purposefully chosen exercises developing those features of fitness preparations which are prominent for a given (or future) specialisation.

**Special (S)** measures create a special complex of functional, fitness and physical properties, according to the rule of progressive adaptation to participation requirements.

Groups of training measures were identified with the help of the register of training measures in 400 m Hurdles, which has been described by Iskra [4].

The relation between workload and performance was assessed with the use of Pearson's correlation factor. Relevance of differences was established at the level of 0,01%.

The material collected in the present paper concerns the training of J.A. over a seven-year period of seasons 2000–2006. In all the analysed seasons the competitor's performance was on the level of first sports class (table 1). During all seasons since the year 2002 he was a finalist in Seniors Poland Championships, and in the year 2006 he became the bronze medallist of Poland Championships.

Table 1

**J.A.'s performance development in consecutive seasons**

season →	2000	2001	2002	2003	2004	2005	2006
result in a season (s)	53,24	52,84	52,08	52,43	52,60	51,72	51,87
age (years)	20	21	22	23	24	25	26
<sup>x</sup> of the results (s)	54,08	53,69	53,02	52,88	53,19	52,30	52,40

**Results.** Similarly to the abovementioned article of Iskra and Kosmol [2], we can divide the analysed period into three phases. The first covered the seasons 2000–2002 and was characterised by a considerable progress in results. Obviously, the greatest progress was recorded in the year 2000, as it was in fact before that season that a specialised hurdle training was commenced, and the isolated participations in the previous year should be regarded as incidental. The second phase spans over the years 2003–2004, when the competitor's results were worse than his personal best. The third phase covers the years 2005 and 2006, when the personal best was broken and a considerable progress in relation to the previous season was noted. Reasons for the improvement in the year 2005 should be sought especially in the change of training process organisation, as well as in proportion, intensity and volume of applied measures. Let us look closer at these changes.

**Variability of workload in information field.** Total work time ( $\Sigma C+Ch+S$ ) was between 160 and 224 h. Table 2 presents work time in consecutive seasons. We can observe a considerable growth after the year 2001 and next stabilisation at the level above 200 h. This involved reducing the number of practical classes at the Academy of Physical Education and, in consequence, increasing the number of trainings. In the year 2005 the number of trainings and the work time were reduced, the cause being a surgery the competitor underwent at the beginning of the season, as well as an injury which would twice force the athlete to break up trainings.

Work in the field of comprehensive (C) measures would grow until the year 2003, when a decrease occurred. Channelled (Ch) work remained at the level of about 15 h, and the subsequent decrease in comprehensive work was accompanied by an increase in channelled measures. This increase, however, did not bring about any improvement of results. The use of special (S) measures would grow in the period of result improvement (2000-2002). A decrease in the use of special measures would bring about a deterioration of performance. Another increase, which occurred in the year 2005, brought an improvement of the personal best. In the year 2006 this value was a little greater than in the preceding year, but it constituted a smaller percentage in the total work time. In the case of J.A. special work turned out to be most strongly correlated (.74) of all the measures in the information field.

**Variability of workload in energy field.** Work in energy field would also undergo considerable changes. It reached its highest values in the first intensity area. This was influenced especially by the long warm-up, which – almost unchanged - takes place before every training session. Taking this into consideration we can see that the competitor would devote most time to work in the second and third area. Aerobic efforts were characterised by high correlation factor (.83). This was confirmed by the research of Iskra and Kosmol, although in their study the abovementioned values would be subject to greater fluctuation. We notice that in the two best years the values in the second area are very similar. Smaller amount of work in the third area in the year 2005 was in turn caused (among others) by a surgery in October (popular team games and supplementary sports) and an injury received in winter (mountain hikes, mixed endurance training). After the year 2000 in the fourth area, which includes the effort of participation in 400 m Hurdles, there was an increase to about 12 h. A considerable increase in the year 2004 to 19 h was not reflected in result improvement. In 2005 the use of measures from the fourth area was greater than in other years (except for the year 2004) despite a smaller number of trainings. This was caused by a change of training model. In the fifth intensity area volume was close to 2 h, and an increase to almost 3 h of effective work time can be noticed in the year 2006.

Table 2

**Variability of J.A.'s training workload in the information and energy fields  
in the analysed period (h:min:s)**

Type of workload	SEASONS						
	2000	2001	2002	2003	2004	2005	2006
INFORMATION FIELD							
C	144:15:21	156:46:33	194:45:13	203:22:07	198:17:54	163:28:35	177:59:39
Ch	13:00:10	14:37:59	15:06:33	17:14:13	18:50:18	14:53:49	19:29:15
S	3:05:06	3:44:41	4:01:06	3:48:14	3:31:01	3:44:44	3:50:31
TR	160:20:37	175:09:13	213:52:52	224:24:34	220:39:13	182:07:08	201:19:25
ENERGY FIELD							
T1	75:19:39	84:38:44	85:26:18	96:20:59	105:41:32	75:32:34	71:54:40
T2	37:53:34	37:36:21	57:38:48	58:47:32	40:26:24	55:43:50	59:08:00
T3	36:03:40	38:50:51	56:57:47	54:39:42	52:42:11	35:32:13	53:01:24
T4	9:12:06	11:48:52	11:40:24	12:10:16	19:16:46	12:57:11	14:21:33
T5	1:51:38	2:14:25	2:09:35	2:26:05	2:32:20	2:21:20	2:53:48

After 2004 there was a visible change in J.A.'s training. It was decided that the volume of training should be decreased, while its intensity was increased. In relation to the preceding year there was an increase in work of special character. Seasons with best results are characterised with smaller volume of supporting efforts and bigger volume of aerobic efforts. The data are presented in table 2.

**Variability in training measures' application structure.** A change in trainings is also visible in the use of individual training measures. Tempo endurance of submaximal and maximal intensity was most extensively used in the year 2005 despite "losing" part of the season due to injuries. In 2006 another change was introduced and the use of this measure was decreased in favour of interval tempo endurance.

Short rhythm endurance (short rhythm → running over 1-3 hurdles) in the years 2001–2004 would take about 20 minutes, in 2005 the number of such stretches was substantially decreased. Medium rhythm endurance (medium rhythm → running over 4-7 hurdles) was the basis of training in 2000, later we can see a decrease in favour of long rhythm endurance (long rhythm → running over 8-12 hurdles). In the years 2005-2006 there was again an increase in the use of the medium rhythm, with a simultaneous increase of the number of long stretches with 8 and more hurdles. The longest work time devoted to shaping rhythm endurance on hurdles in 2006 did not bring an expected improvement of personal best. In seasons with best results long rhythm endurance constituted about one third of total rhythm work. J.A.'s long rhythm was characterised by high correlation with the results (.72).

Shaping technique by marching over hurdles was also highly correlated (.73) with the results. Greatest amount of work was performed in 2005, in spite of the smallest number of trainings. It could seem that a 25-year old competitor already has a well-shaped technique, but constant work on technical basics proved profitable. All the more so, that these values are frequently a few times lower than in the analysis by Iskra and Kosmol.

Out of strength building training measures general strength of lower limbs would show particularly high correlation (.91), this measure was most extensively used in the years 2002, 2005 and 2006, that is the ones with best results. Toe stands with load would have an equally high correlation for J.A. (.89), but the use of this measure was similar in all the cycles and fluctuated around 20 minutes.

Also plyometric exercises and half-knee bends with heavy load had high correlation (.77). Although within the hybrid feature of running strength (special running exercises performed in difficult conditions) an increase in volume would be related to performance improvement, the greatest amount – performed in the year 2004 – was not reflected by an improvement of sport results.

Another measure of high correlation (.83) for J.A. was continuous aerobic running. It is worth noting that it were most extensively applied in the season of 2005, despite a smaller number of trainings.

Table 3

**Variability of applying (h:min:s) by J.A. selected training measures  
in the analysed seasons and their relation to result level**

MEASURES	SEASONS							Relation
	2000	2001	2002	2003	2004	2005	2006	
RUNNING AND TECHNICAL MEASURES								
TEMPO ENDURANCE SUBMAX. AND MAX.	0:25:33	0:18:09	0:22:48	0:26:10	0:41:13	0:58:03	0:19:59	0,39
SHORT RHYTHM	00:10:58	00:20:58	00:20:33	00:17:11	00:20:02	00:05:46	0:04:41	-0,45
MEDIUM RHYTHM	00:17:40	00:13:15	00:08:13	00:08:22	00:09:41	00:13:30	0:23:55	0,08
LONG RHYTHM	-	00:10:51	00:13:52	00:13:35	00:08:20	00:09:38	0:18:56	0,72*
MARCHING OVER HURDLES	00:35:15	00:35:36	00:40:42	00:31:48	00:44:08	00:58:54	0:45:34	0,73*
CONTINUOUS AEROBIC RUNNING	19:07:00	18:53:45	23:51:46	26:41:54	25:10:00	27:12:00	27:04:48	0,83*
STRENGTH MEASURES								
GENERAL STRENGTH (LEGS)	00:23:09	01:08:34	01:53:41	01:38:59	01:42:50	01:59:44	2:08:17	0,93*
TOE STANDS	00:15:45	00:18:00	00:21:00	00:19:30	00:21:10	00:22:00	0:21:00	0,89*
½ KNEE BENDS	00:01:50	00:24:48	00:38:37	00:30:48	00:26:48	00:30:50	0:28:56	0,77*
PLYOMETRIC EXERCISES	00:02:00	00:02:51	00:03:24	00:02:00	00:00:40	00:07:10	0:08:12	0,77*
RUNNING STRENGTH	3:01:52	3:49:04	3:23:34	4:37:58	6:47:47	5:10:22	5:11:05	0,37

\* relevance at the level of 0,01%

**Discussion and conclusions.** Within the analysed period, for the purposes of the paper divided into three periods, there appeared relations very similar to those presented in the analysis by Iskra and Kosmol (1994). In the first phase (2000–2002) there was a dynamic result improvement, accompanied by an increase in training workload. During 2003 and 2004 seasons workload would become even greater. This was possible also thanks to graduation from the Academy of Physical Education, as studies would load additional exercises onto the competitor. However, this fact was not reflected in performance improvement. In the third phase, that is in 2005 season, basing on the analysis produced with the use of the TreOb4 programme, a change in the preparation model was introduced. Further increase of the volume of some measures in training was abandoned, and training intensity was increased. This increase is visible on the example of tempo endurance of submaximal and maximal intensity. Simultaneously elementary hurdle technique was being shaped (marching and skips). During that year a demand of many authors [a.o. 1, 5] was met, which concerned increasing the application of special measures and refraining from constant increase of volume in favour of intensification. Despite the surgery and two injuries during 2005 season, values of many measures in the fourth and fifth intensity area were highest over the years. Performance improvement was also visible on the example of flat distance (400 m), where in the year 2005 the competitor improved his personal best by more than half a second. This allowed among others for reducing the number of strides taken between hurdles in the first part of the distance. In the year 2006 another remodelling of the training was introduced, the number of running stretches within tempo endurance of great and submaximal intensity was reduced in favour of interval tempo endurance. Despite getting a result below 52 seconds and winning a medal in Poland Championships, the competitor did not manage to improve his personal best in that year.

Further development of the competitor's career should be directed at shaping tempo endurance of greatest intensity, and above all at shaping rhythm endurance. Special attention should be paid to

glycolitic (anaerobic) endurance, shaping the possibilities of continuing most intense effort while muscles are getting more and more tired and sore [3]. The competitor has great reserve in running technique. It seems important to increase speed possibilities of the competitor through practicing maximum speed, but without disrupting the rhythm of strides between hurdles.

It is desirable to further analyse the training of the best hurdlers and on that basis to draw up training plans for the following seasons.

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