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The Javelin

The view of the DVfL of the GDR on talent selection, technique and main training contents of the training phases from beginner to top-level athlete

E. Arbeit, K. Bartonietz, P. Börner,
K. Hellmann, W. Skibbia

"These are excerpts from the main lecture on the javelin throw given by Karl Hellmann, SC Motor Jena, at the International Coaches' Seminar in East Berlin, March 4-7, 1987. The present article illustrates the contents of a long-term training process, lasting 8 to 10 years, that the authors consider the best method to bring talented adolescent athletes to world-class level."

Translated from the original German by Jürgen Schiffer

1. Introduction

At the date of this lecture it is a little more than one year until the Olympic Games 1988. One year before the Olympic Games in 1968, the world records in the javelin throw were as follows: Women: 62.40m, Men: 91.72m. At that time, performances like today's world records were utopian for both coaches and athletes. Performances of 77.44m (women) and 104.80m or 85.74m with the new javelin (men) were beyond expectation and imagination.

We are convinced that, in spite of the changed flight characteristics of the new men's javelin, throws over 90m (men) and over 80m (women) will be achieved in the foreseeable future. We have come to these prognoses on the basis of practical experience we have had over a number of years. The development of top-level performances clearly points to man's possibilities as a result of systematic training.

In connection with performance development in the Javelin coaches are confronted with the following problems:

— talent selection;

— the most purposeful technique for javelin throwing;

— efficient teaching methods;

— conditional prerequisites for present and future top-level performances and world records;

— methodological concepts for achieving top-level performances under changed conditions.

Based on our practical experience, we have come to the conclusion that there is still a considerable potential of improvement which can be utilised for performance development.

Particularly, the conditional capacities and the technique of javelin throwing can be improved. As coaches with more than 20 years of vocational experience, we are of the opinion that the degree of the utilisation of the physical potential has decreased.

Experimental investigations with a javelin launching apparatus have shown that the new men's javelin can fly over 100.00m (maximum distance: 104.50m) if it is launched with an initial velocity of $29.5ms^{-1} \pm 0.37ms^{-1}$ even though it has lost its gliding quality and its flight curve closely approximates a ballistic curve.

However, javelins thrown by Uwe Hohn (GDR) with an initial velocity of $31.375ms^{-1} \pm 1.05ms^{-1}$ only flew between 74.50m. and 77.00m. Many athletes have no difficulty in achieving a release velocity of $29.5ms^{-1}$.

From the result of these experiments, we have concluded that we must look closer at the release technique and its immediate preparation. Apart from this, we have come to conclusion that the widely held opinion that the new javelin favours the so-called "strength throwers" – provided that they exist at all – as opposed to those throwers who are technically well prepared is wrong. On the contrary, as the records get better, i.e. as the release velocity increases, technical proficiency becomes more important.

Proceeding from these findings, the opinions of the DVfL of the GDR on the following points were presented at the Coaches, Seminar:

— talent selection;

— technique of javelin throwing;

— performance structure in the training phases of the javelin thrower;

— main task of the various training phases.

In this article, we concentrate on the first three problems.

2. Talent selection

Contrary to those countries in which baseball is popular, coaches in the GDR have to proceed from the fact that the overarm throw is no longer a part of the natural movement repertory of children and youths. However, every coach knows that the natural aptitude for throwing is a prerequisite of top-level performances in javelin throwing.

The expansion of the pentathlon to the heptathlon is a convincing proof of this statement. Although multi-event athletes are above average as far as speed strength is concerned and do a lot of javelin training, those heptathletes who do not have a natural aptitude for throwing are not able to utilise their physical potential for the javelin throw movement.

When selecting young talents one should bear in mind that the javelin throw is an event which makes very high demands on both speed strength and the specific coordinative abilities.

As far as outward appearance and nervous types are concerned, the

athletic-leptosomatic type of athlete meets the basic requirements of javelin throwing.

The primary selection criterion, however, is the nervous type and not the physical constitution as is the case in other throwing events.

Table 1 shows that with world-class javelin throwers the spectrum of body height and weight is so broad that these characteristics are obviously of secondary importance.

The table supports our statement: height and weight are not significant selection criteria. The time of talent selection is much more important.

It is well-known that in the GDR talent spotting and selection are done with 12 to 13 year old athletes. At this age, the girls are going through their adolescence while the boys have not yet reached puberty or puberty is only in its initial stages.

This fact is particularly meaningful because the biological age decisively influences the physiologically justifiable degree of load.

The time of talent selection is mainly determined by the following organizational conditions:

— concentration of the best youths in children's and youths' sport schools;

— 13 year old youths are the youngest participants in the central children's and youths' Spartakiads, which in the GDR are the best opportunity for talent selection.

Neverthless, the time of talent selection has proved favourable for the following reasons:

— it makes possible five years of systematic training up to the first participation in the European or World Junior Championships;

Table 1 - Constitutional characteristics of selected world-class javelin throwers

Name, Country	Best performance		Height	Weight
Hohn (GDR)	104.80	—	1.98m	112kg
Jewsjukow (URS)	93.70	83.68	1.90m	100kg
Tafelmeir (FRG)	91.44	85.74	1.90m	87kg
Michel (GDR)	96.72	83.52	1.88m	97kg
Puuste (URS)	94.20	83.40	1.88m	90kg
Petranoff (USA)	99.72	85.38	1.86m	98kg
Lusis (URS)	93.80	—	1.80m	90kg
Wolfermann (FRG)	94.08	—	1.76m	89kg
Kinnuen (FIN)	92.70	—	1.74m	82kg
Lillak (FIN)	74.76		1.81m	74kg
Richter (GDR)	66.66		1.88m	86kg
Sakorafa (GRE)	74.20		1.77m	73kg
Felke (GDR)	75.40		1.72m	63kg
Sanderson (GBR)	73.58		1.70m	71kg
Todorova (BUL)	71.88		1.70m	74kg
Fuchs (GDR)	69.96		1.69m	68kg
Whitbread (GBR)	77.44		1.66m	69kg

— it ensures the beginning of technique training at a good motor learning age.

There are, however, arguments for laying the foundation for the teaching of javelin-throw technique at a much earlier age. As the experiences of acrobatic sports show, the conditions for motor learning are much more favourable between the age of 7 and 13.

Table 2 shows the exercises and the corresponding performance demands on which our system of talent selection is based.

The most important exercise both from the point of view of technique and throwing performance is the rounders ball throw. As can be seen from Table 2, performances of 70.00 or 75.00m for the boys and between 55.00 and 60.00m or between 60.00 and 65.00m for the girls are a good basis for beginning with systematic training. This tests battery must be supplemented with:

— checking the mobility of the shoulder girdle;

— checking the coordinative capacities as shown in sport games;

— anthropometric measurements (particularly for the determination of final height);

— checking the physiological aptitude for the loads of competitive-sport oriented training (the main focus should be on the examination of the spinal column);

— checking the intellectual capacity.

It must always be borne in mind that the selection of talent is a process. Only in the course of this process, i.e. in training, does the athlete's trainability, loadability, motor learning capacity, etc. become obvious.

On the basis of theoretical considerations and practical experiences of coaching many athletes, we have come to the conclusion that *talent only indicates the possibility of later success in sports. Success itself is the result of the combination of talent and years of hard work.*

Table 2 - Test battery and performance demands for the selection of young javelin throwers

Exercise	Performance demands			
	Girls		Boys	
	12/13 years	13/14 years	12/13 years	13/14 years
Height	1.70m	1.70m	1.70m	1.75m
Rounders ball	55-60.00m	60-65.00m	65-70.00m	70-75.00m
60-m-sprint (crouch start)	8.50sec	8.40sec	8.30sec	8.20sec
30-m-sprint (flying start)	4.25sec	4.15sec	4.00sec	3.90sec
3 hops, right leg	6.50m	6.80-7.00m	6.50m	7.00m
left leg	6.50m	6.80-7.00m	6.50m	7.00m
Shot put	10m (3kg)	11m (3kg)	11m (4kg)	12m (4kg)
800-m-run	2:35.0	2:32.0	2:30.0	2:25.0

3. Effective javelin-throw technique from a methodological and biomechanical point of view

The physical-mathematical principles of determining the theoretical throwing distance have frequently been described in the existing literature.

Throwing distance is mainly determined by the following factors:

— release velocity;

— the complex of aerodynamic conditions of the javelin throw.

In simplified form, the possible throwing distance is determined by the following equation:

$$L = \frac{V_o E}{g} \times \sin 2\alpha$$

Thus, the aim of the javelin thrower is to achieve an optimum release velocity.

In this context, we refer to the article on javelin throwing published in *NSA*, n. 3/1986 where the biomechanical principles of javelin throwing are described in detail.

According to our experiences, a purposeful technique is the most important prerequisite of top-level performances. Simultaneously, the quality of the technical ability decisively influences the effectiveness of training.

Sooner or later technical faults or weaknesses turn out to be performance and load limiting factors. Technical faults in javelin throwing itself or in training exercise are frequently the cause of overuse lesions and injuries which inevitably result in an interruption of the systematic performance buildup.

The following criteria are decisive for the usefulness of a certain technique:

— the movement sequence must enable the thrower to transmit all his physical potential to the javelin throw.

— the athlete must feel comfortable in "his movement".

The most important qualitative criterion of the effectiveness of a movement is the rhythm on which it is based.

As mentioned above, the aim of the movement is to impart to the javelin an optimally high velocity at the moment of release.

Numerous authors have examined the relationship of release velocity on throwing distance. Figure 1 (on the following page) shows the results of these examinations, which, apart from some differences, are identical.

Thus, it becomes obvious that new records are only possible if men achieve release velocities over 32.00 ms^{-1} and women release velocities over 26 ms^{-1}.

As far as we know, there are in other sport events no comparable demands on speed (as the last element of a kinematic chain).

The influence of the new men's javelin on the regularity shown in Figure 1 has not yet been sufficiently investigated. On the basis of our investigations, which are supported by Terauds' and Borgström's calculations, it can be definitely concluded that with increasing speed there is also an increasing reduction in throwing distance.

For this reason, the relationship between release velocity and throwing distance which is characteristic of the new javelin (Figure 1) does not run parallel to the typical curve of the old javelin. Further investigations will show whether the characteristic curve of the new javelin runs approximately

linear, as hypothetically assumed, or according to an exponential function.

How can the athlete fulfil the demand for a high release velocity in practice?

Like other authors, we divide the total movement into phases solely for didactic reasons; otherwise we consider the javelin throw movement as a whole. We differentiate between:

— the cyclic part of the run-up;
— the acyclic part of the run-up;
— final acceleration.

Both the cyclic and acyclic part of the run-up serve the preparation of the throw although they have different functions; the final acceleration characterises the release movement.

The final acceleration is decisive for the throwing distance. It should, however, be emphasised once again that the final acceleration is an inherent part of the total movement.

As a result of a throwing movement which is carried out effectively we discovered a characteristic curve of final acceleration (Figure 2).

The acceleration-time-curves of our top-level athletes show a high degree of approximation to the ideal curve, which is achieved by R. Fuchs, P. Felke, D. Michel and U. Hohn (see Figure 3 on page 64).

It can be seen that there are clear-cut differences between the curves of R. Fuchs and P. Felke; the same holds true for the curves of D. Michel and U. Hohn.

The curves of P. Felke and D. Michel correspond to our idea of an effective technique to a high degree. The curves show that the athletes are able

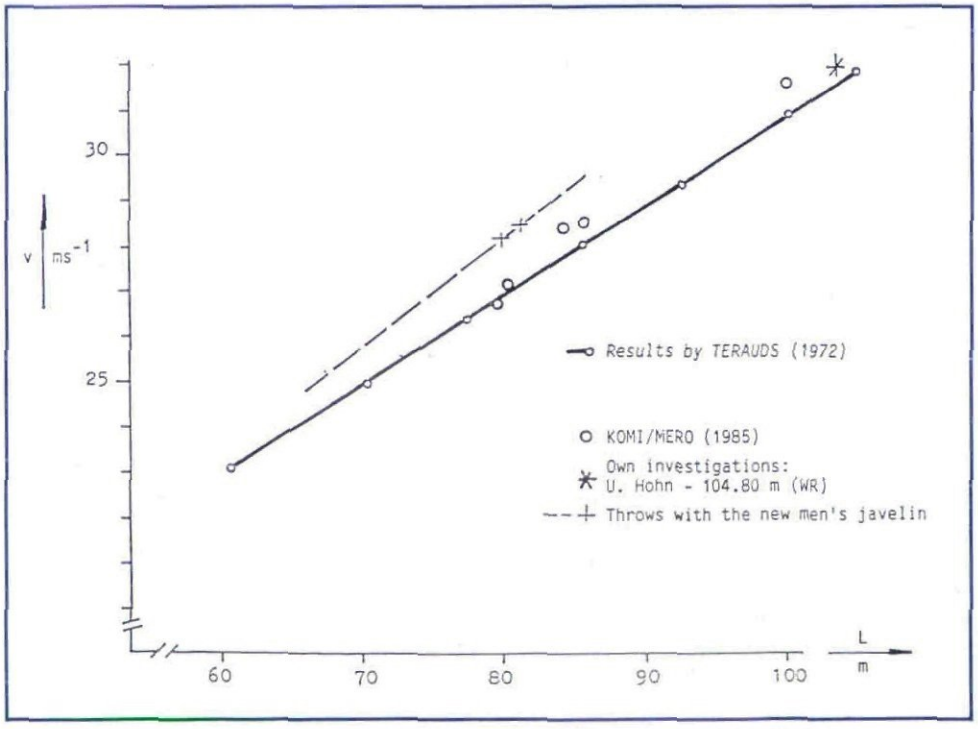

Figure 1 - Relationship between release velocity and throwing distance (men's javelin throw)

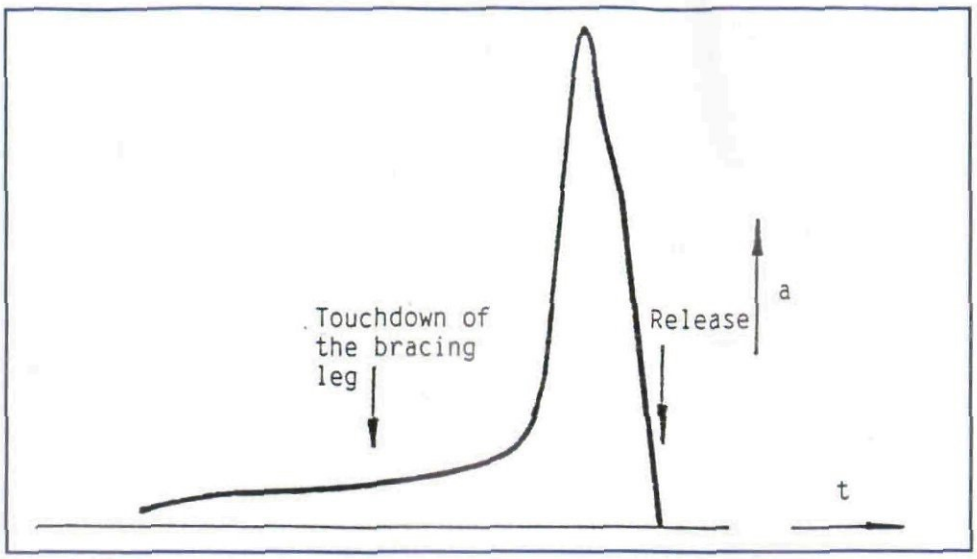

Figure 2 - Ideal acceleration-time-curve

to translate a high level of speed strength capacities into the javelin-throw movement.

It becomes obvious that as far as speed strength is concerned R. Fuchs was not as strong as today's throwers. We are also of the opinion that even U. Hohn's throwing technique could be improved.

Figure 4 (on page 65) shows that even top-level athletes can further improve their technique (depending on the development of their conditional capacities).

The most important comments on Figures 3 and 4 are:

1) As far as the acceleration-time-curve is concerned, top-level athlete differ from lower-class athletes in the following aspects:

– they achieve a higher total impulse ($Fa \times \Delta t$);

–they achieve a higher absolute value of acceleration force (Fa_{max});

– the rise of their acceleration-time-curve is much steeeper which means that in the phase of final acceleration they achieve a grater force gradient:

$$\frac{Fa_{max}}{At}$$

which according to Verchoschansky is a measure of explosive strength.

2) With athletes of many years' training, technical changes are possible and even necessary. The degree of these changes depends on the athletes' level of explosive strength.

This means: technique cannot be worked on in isolation. An efficient throwing technique can only be achieved on the basis of highly developed javelin-specific conditional prerequisites (in particular speed strength).

It has already been mentioned above that on the basis of the experiments with the launching apparatus we have come to the conclusion that javelin throw performances can be signific-

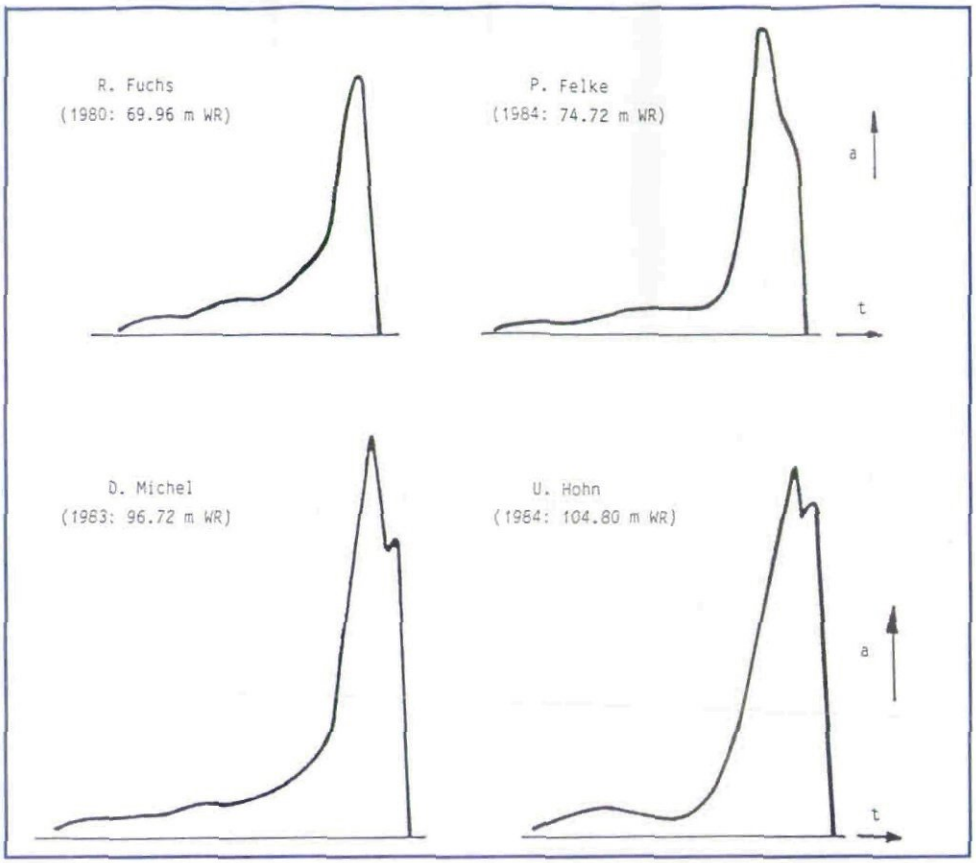

Figure 3 - Acceleration-time-curves of the final javelin throw movement (in brackets: personal best performance)

antly improved by "hitting the javelin" exactly. Thus, the athlete's goal must be to make the vector of the acceleration force act right through the longitudinal axis of the javelin. In other words, $\Delta\alpha$ must tend towards zero[1]. *This guarantees the most optimal* aerodynamic conditions for the flight of the javelin.

In reality, however, all throws are influenced by forces which act transversely to the horizontal axis of the javelin. These forces result in considerable deformation of the javelin. These deformations lead to a reduction in throwing distance. The reasons for this are as follows:

— The deformations of the javelin bring about a reduction in release velocity.

— The elastic deformations are compensated by slight vibrations which together with the rotation of the javelin results in a considerable reduction in velocity in the first phase of the flight curve.

[1] $\Delta\alpha$ is the difference between the attitude angle of the horizontal axis of the javelin and the angle of release. In publications on javelin throwing this difference is called angle of attack.

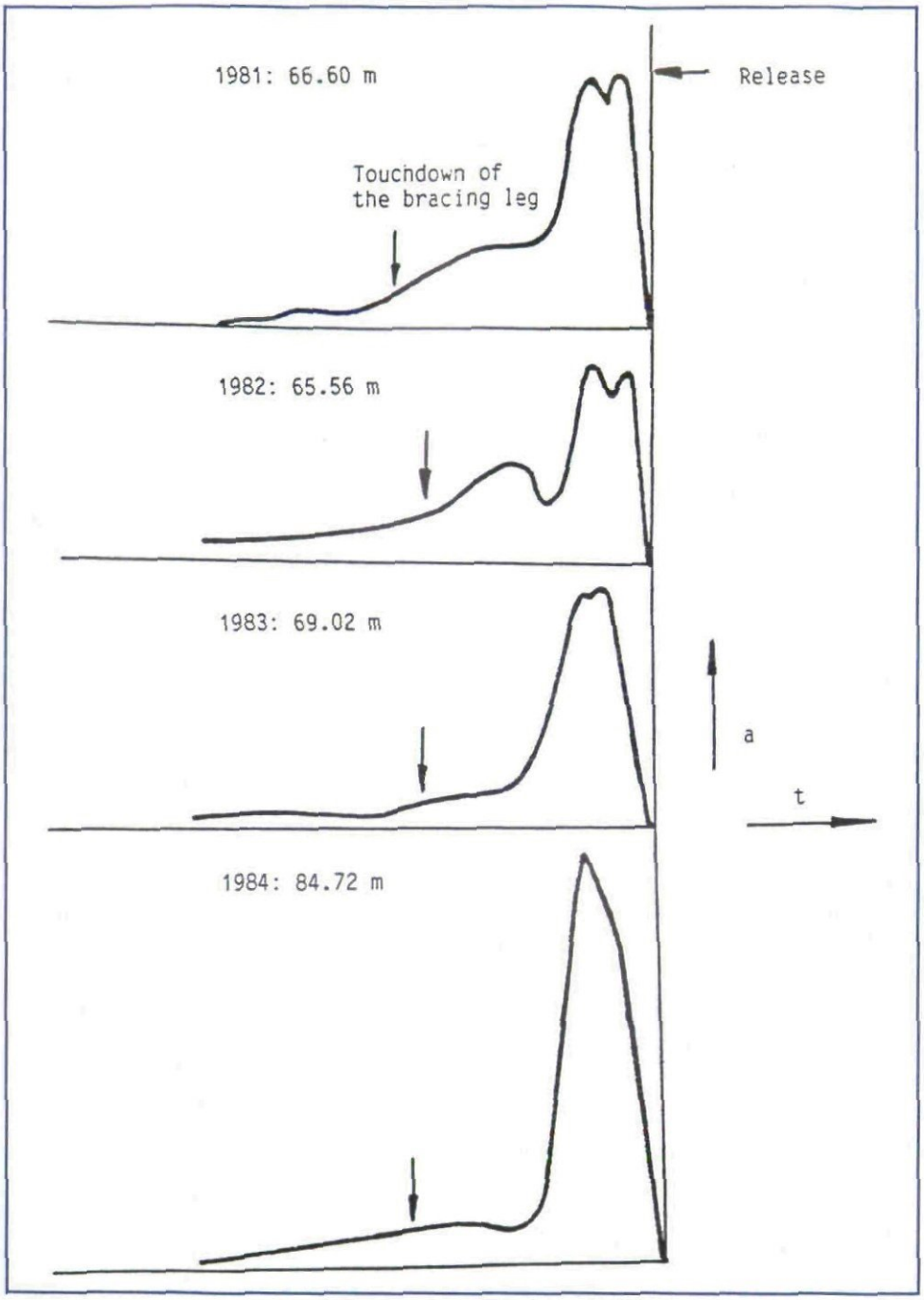

Figure 4 - Development of the acceleration-time-curves of the javelin movement over four years as an expression of the javelin-specific technical development (throws by P. Felke)

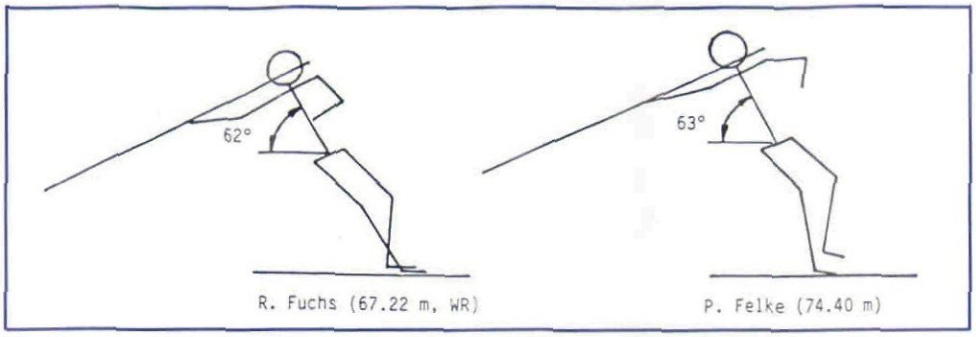

Figure 5 - Backward lean of the body at the touchdown of the pressure leg

— The deformations lead to an increase in air resistance. It has been shown in experiments that the increased air resistance can cause a reduction in the theoretically possible throwing distance by up to 20%.

The importance of the run-up has been underestimated for a long time. We are of the opinion that in the run up a broad spectrum of individual variants should be tolerated. However, the following conditions must be fulfilled:

1) The complete run-up, i.e. both cyclic and acyclic part, must be rhythmical and impulsive.

It must be a unified movement, and it must be developed and trained as a whole.

2) The velocity must be increased up to the impulse stride or the last stride change.

In doing so, a backward lean of the body of about 60 to 65° must be brought about by the impulse stride or the stride changes (Figure 5).

This backward lean is a prerequisite for generating the power for the release by the legs, for utilising an optimal long acceleration path and for creating a maximum "bow tension".

3) For better performances a higher run-up velocity is necessary.

With many athletes, a deterioration of technique caused by the increase in run-up velocity leads them to sacrifice the advantage of a higher run-up velocity and thereby also the development of a greater amount of kinetic energy:

$$(E_{kin} = \frac{m}{2} V^2)$$

of the whole system.

In connection with the timely touchdown and activaction of the bracing leg a high amount of kinetic energy ensures optimal conditions for the creation of the necessary tension for the flail-like throwing of the javelin.

4) The run-up must create the conditions for the achievement of the optimum coordination of the movements of the individual parts of the body as far as time and speed are concerned.

The optimum coordination of the movements of the individual parts of the body is achieved if the athlete realises a velocity-time-curve which resembles the one shown in Figure 6.

In conclusion, we want to emphasize once again that in beginners' training the teaching of correct technique is the

most important prerequisite for successful development in later years.

The aim, even for beginners, must be to successfully learn the fine form of the javelin-throw technique.

We call the first training phase "talent identification training". The quality of the throwing technique achieved is an essential element of this selection process.

A premature development of conditional capacities – particularly maximum strength – leads to limited performance development at top-level age.

We are of the opinion that technique or technical perfection must be worked on all year round. It must, however, be remembered that there are certain elements of movement technique whose quality depends on the state of the development of the conditional capacities.

The spatial structure of the movement, i.e. the coordination of the movements of the parts of the body, is indentical in November and in June or July. Rhythm is also the same.

However, the dynamic structure of the movement depends on the athlete's form. For this reason, during the whole preparation period, throwing distance plays only a minor role in our concept, while technically correct execution of the movement and movement rhythm are extremely important.

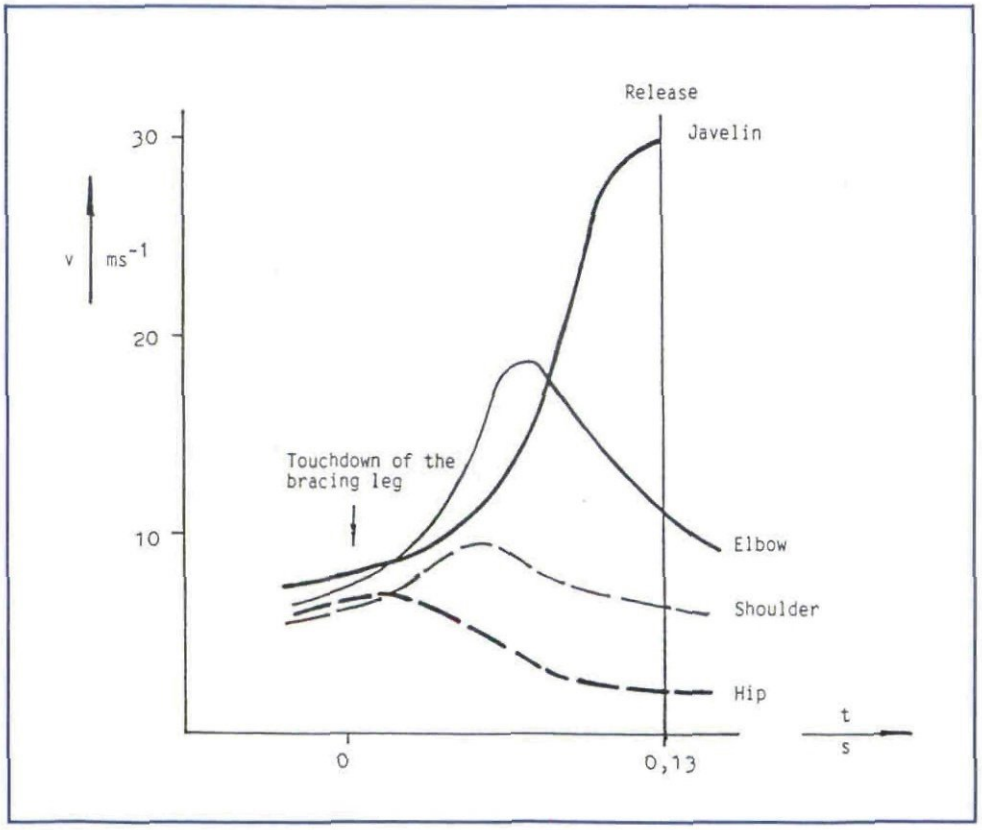

Figure 6 - Velocity-time-curves in javelin throwing (D. Michel, 89.10m)

4. Performance structure of the Javelin throw

The term "performance structure" is very differently interpreted in the existing literature. By performance structure we mean the underlying structure of the competitive performance as far as the development of the conditional capacities and movement technique are concerned.

As already mentioned above, we believe that neither technique nor skills can be seen in isolation. The competitive technique, i.e. the perfectly correct movement technique, can only be executed on the basis of a corresponding high level of conditional capacities. The conditional capacities, on the other hand, can only be developed by using training forms with clearly defined intensity and scope.

In the following, we illustrate our theoretical position through concrete examples. In doing so, we draw the attention to the fact that the performance structure is both a result of a preceding training process and genetically determined conditions.

In the following tables, the performance structure of the most successful javelin throwers of the GDR at the time of significant leaps in performance are shown.

Table 3 - Performance structure of R. Fuchs

Parameter	1970	1972	1976	1980
Age	23	25	29	33
Training age	9	11	13	17
Height	1.69m	1.69m	1.69m	1.69m
Weight	64.0kg	66.0kg	67.0kg	70kg
Competitive implement	60.60m	65.06m	65.94m	69.86m
800g javelin	48.24	53.20m	57.12m	59.32m
Snatch	65.0kg	77.5kg	87.5kg	92.5kg
30-m-sprint (flying start)	3.67s	3.28s	3.24s	3.29s
3 hops	8.22m	8.80m	9.52m	9.35m
4kg shot throw backwards	14.64m	16.00m	18.24m	19.30m

Table 4 - Performance structure of P. Felke

Parameter	1977	1981	1985
Age	18	22	26
Training age	4	8	12
Height	1.72m	1.72m	1.72m
Weight	63.5kg	63.5kg	63.5kg
Competitive implement	61.24m	66.60m	75.40m
800g javelin	—	50.50m	59.00m

Table 4 - Performance structure of P. Felke (cont.)

Parameter	1977	1981	1985
Snatch	42.5kg	70.0kg	100.00kg
30m sprint (flying start)	3.5s	3.58s	3.47s
Succession of 5 jumps	—	17.60m	20.02m
4 kg shot throw backwards	12.90m	16.26m	20.00m

Table 5 - Performance structure of D. Michel

Parameter	1972	1975	1980	1983
Age	16	19	24	27
Training age	3	6	11	14
Height	1.84m	1.84m	1.84m	1.84m
Weight	80.5kg	85.5kg	94.0kg	96.0kg
Competitive implement	75.80m	84.58m	90.98m	96.72m
600g javelin	84.60	94.00m	93.00m	—
900g javelin	—	—	75.20m	78.50m
800g ball	67.00m	75.60m	83.00m	—
Snatch	82.5kg	95.0kg	125.0kg	—
Bench press	80.0kg	90.0	115.0kg	140.0kg
Squat	130.0kg	160.0kg	200.0kg	190.0kg
30m sprint (flying start)	3.34s	3.17s	3.27s	3.33s
3 hops	9.10m	9.72m	10.02m	9.96m

Table 6 - Performance structure of U. Hohn

Parameter	1981	1982	1984
Age	19	20	22
Training age	6	7	9
Height	1.98m	1.98m	1.98m
Weight	100.0kg	107.5kg	115.0kg
Competitive implement	86.56m	91.34m	104.00m
600g javelin	92.24m	99.36m	—
900g javelin	65.10m	78.50m	76.00m
800g ball	—	95.40m	104.00m
Bench press	95.0kg	120.0kg	130.0kg
Snatch	107.5kg	110.0kg	115.00kg
Squat	(from 1981 to 1984 no squat tested)		
30m sprint (flying start)	3.44s	3.31s	3.41s
3 hops	9.25m	9.92m	10.12m

5. Main training contents

The development of top-level performances is a process of 8 to 12 years. In javelin throwing, the period of the highest performance capacity begins at the age of 24 to 25. Today, the performances of the winners at European or World Junior Championships are almost as good as the performances of the world-best senior javelin throwers. For the development of such performances, the coaches and athletes have 4 to 6 year time if the systematic training process begins at the age of 13 or 14. Table 7 shows the high level of the junior athletes' performances.

5.1 Beginners' training

Beginners' training serves the identification of talents. Within the framework of talent indentification training, the technical process is an essential element of talent selection.

The following main training contents are characteristic of beginner's training:

1) Development of javelin throw technique.

After 2 to 3 years, the athlete should master the fine form of javelin throw technique.

2) Development of the technique of those training exercises which are used as main training contents in the further training process.

Training contents:

- sprint and hurdling;
- high jump, long jump, multiple jumps;
- barbell exercises.

3) Training contents which are part of the many sided training or which are used as compensatory exercises in the further training process.

Training contents:

- training in sport games (basketball, team handball, volleyball;
- floor gymnastics;
- swimming;
- cross-country skiing.

4) Development of the conditional capacities.

The focus is on the development of high movement frequencies, movement speed, explosiveness, jumping power, etc. These conditional capacities are developed by means of a multi-event oriented training centred

Table 7 - Results at the European, and World Junior Championships since 1981 (in 1986* the new men's javelin was introduced)

Championships	Men			Women		
	1st place	3rd place	1st-6th	1st place	3rd place	1st-6th
European Junior Championships 1981	86.56	72.26	77.14	64.12	58.04	57.15
European Junior Championships 1983	80.88	74.84	75.13	62.04	50.08	57.89
European Junior Championships 1985	79.92	75.68	75.78	61.70	55.92	56.16
World Junior Championships 1986*	78.84	74.22	74.37	62.86	59.92	57.88

around sprint and jump loads. Strength is developed either by throwing itself or by using one's own body weight.

The total load in this age group decisively depends on the athlete's biological age. Each year, an increase in the volume of training (main training contents only) by 10 to 15% should be striven for.

It must, however, be taken into account that during the main growth periods the loads must be carefully planned. Athletes of this age group need sufficient time fo *natural* regeneration after training loads.

5.2 Training of advanced athletes

Basically, the principle of many sided and general training is maintained. The following elements, however, are new:

— strength training with barbells;
— training with specific implements for the development of throwing strength.

Furthermore, the training of advanced athletes is characterized by an increase in volume.

At the centre of strength training is the snatch, which should be executed with maximum velocity and as a movement of the whole body.

Apart from the snatch, bench pressing and squats are used to a small extent.

The following table shows the training volume (guiding values) and the performances which should be achieved in the main training exercises.

The performance structures of the GDR javelin throwers (see Tables 3 to 6) clearly show that in youth training no heavy javelins and balls are used. In this age group, technique training should be done with the competitive implement and with javelins which are 20% lighter than the competitive javelin. For the development of throwing strength medicine balls are used (one-armed throws with 1.5kg balls and two-armed throws with 4.0 kg balls). The medicine balls are thrown against the wall in series of 5 to 10 throws.

Table 9 shows both the yearly number of throws within the specific

Table 8 - Volume guiding values (yearly sums) and required performances in the strength training of adolescent javelin throwers

Age goup	Volume	Snatch	Required performance Bench pressing	Squat
16 male	2.400-2.600	75.0	80.0	140.0
17 male	2.800-3.200	80.0	85.0	150.0
18 male	3.400-3.800	92.5	90.0	160.0
19 male	4.000-4.200	105.0	95.0	170.0
16 female	2.400-2.600	50.0	55.0	110.0
17 female	2.800-3.200	55.0	65.0	120.0
18 female	3.400-3.800	65.0	70.0	130.0

Table 9 - Number of specific throws per year and required performance values

Implement	Men				Women		
	16 y.	17 y.	18 y.	19 y.	16 y.	17 y.	18 y.
Competitive javelin	2.700	3.200	3.500	4.000	2.800	3.300	3.700
Light javelin	600	600	500	500	400	300	400
Heavy javelin	—	—	700	1.000	—	50	800
Competitive javelin	64.00	68.00	74.00	78.00	50.00	55.00	60.00
Light javelin	69.00	73.00	79.00	83.00	55.00	60.00	65.00
Heavy javelin	—	—	60.00	65.00	—	48.00	53.00

throw training and the required performance values.

If Tables 8 and 9 are compared with Tables 3 to 6, it becomes obvious that the best GDR javelin throwers clearly surpassed the required performances, although in some cases their training was less extensive. This can be interpreted as follows:

1) The internationally most successful athletes had the best inherent prerequisites for javelin throwing.

2) All of them mastered an individually shaped, biomechanically efficient technique.

3) By purposeful training stimuli they achieved a high effectiveness of training.

We are of the opinion that the beginning of a highly intensive, competitive-sport oriented training is useful with 18 to 19 year old athletes who achieve javelin performances between 73.00 and 76.00m (men) or between 58.00 and 60.00m (women).

5.3 Training at top-performance age

Contrary to beginners' or advanced athletes' training, which is characterized by a complex use of the main training means, training at the age of top-level performances is characterized by the accentuated use of the main training means.

The following main training means are used in our training system:

— general training (GT);
— maximal strength training (MST);
— specific throw training (STT).

Figure 7 is a schematic presentation of the use of the main training means in the course of the year.

In the GDR, the principle of the *accentuated use of the main training* means has been practised for more than 20 years.

The theoretical basis of accentuating the training is the finding that the adaptation of biological system to training stimuli can be expressed by an exponential function.

Apart from the accentuated use of the main training means, training at top-performance age is characterized by the process of *specialization* and *intensification*.

Independent of this qualitative characteristics it is necessary *to increase the volume of the main training means by 10 to 15% each year.*

Furthermore, the training process at

top-performance age is characterized by a steadily increasing individualization. In the individual planning of the training the performance structure achieved and the athlete's loadability are taken into account.

Table 10 (on the following page) shows a framework for the yearly planning of training loads.

The attempt to apply loads which have not been systematically prepared inevitably leads to injuries or imbalances within the performance structure.

If only the training volume realised by U. Hohn is compared with the average training volume of the GDR throwers, it becomes obvious that the world record holder trained significantly less.

The load model presented is a *possible framework* for the development of top-level performances; in any case it should only be a part of an individually organized training process.

The most important regulation factor within a training process organised according to the presented principles is the proportion of throws to strength trials. According to our experiences, this proportion must always develop in favour of the throws.

6. Summary

The javelin throw is a complex technical event. In order to lead talented adolescent athletes to world-class level, a systematically planned training process of 8 to 10 years is necessary. The most important element of the performance structure is a movement technique which is efficient both from a sport-motor and biomechanical point of view.

The first phase of the long-term training process is the so-called talent-identification training. The objective of the training phase is to develop the fine form of javelin-throw technique.

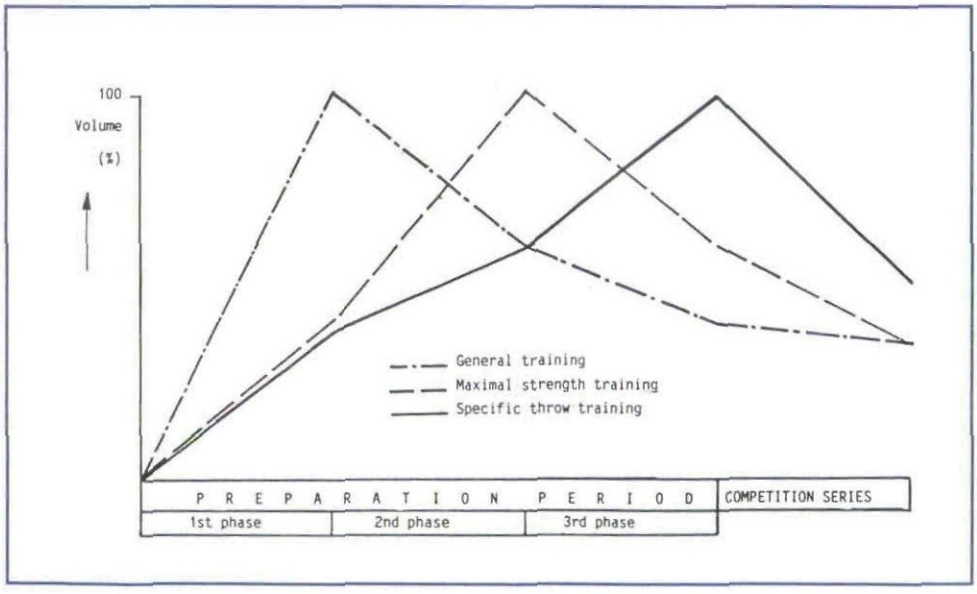

Figure 7 - Accentuated use of the main training means

Table 10 - Framework for the yearly planning of training loads

	Men					Women				
Age	**20**	**21**	**22**	**23**	**24**	**19**	**20**	**21**	**22**	**23**
Training units	400	425	...	...	500	400	425	...	...	500
Training time (h)	800	850	...	...	1.100	800	...	...	...	1.100
General training (h)	300	...	...	...	350	300	...	...	...	350
Sprint (km)	14.00	15.00	15.00	14.00	12.00	12.50	13.00	13.50	14.00	13.50
Jumps (repetitions)	4.000	4.200	...	...	5.000	4.000	4.200	...	...	4.500
Σ Maximum strength	6.000	7.000	...	...	9.000	4.000	5.000	...	...	7.500
Σ Javelin throwers	7.000	7.700	...	...	11.000	5.000	6.000	...	...	9.000
Competitive javelin	4.500	4.500	...	...	6.500	3.200	3.900	...	...	5.500
Heavy javelin	2.000	25.000	...	...	3.000	1.200	1.400	...	...	2.500
Light javelin	500	700	...	...	1.500	600	700	...	...	1.000
General throws	8.000	8.500	...	...	10.000	4.000	...	...	...	6.000

Training in this phase is many sided and general.

The objective of the second training phase is the purposeful promotion of young talents. The training of the best young javelin throwers should be oriented towards the European and World Junior Championships. Apart from the perfection of throwing technique, the development of the strength capacities by using barbell exercises and the development of throwing strength should be at the centre of training.

The third training phase (senior age group) is characterized by:

— an increase in training volume;
— intensification;
— specialization, and
— individualization of training.

□