General and event-specific considerations in peaking for the main competition

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12:2-3; 75-86, 1997

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Starting from the well-known fact that success in international athletics is determined to a large extent by the ability to perform at peak level in the major competition of the season, this study presents basic considerations for peaking the performance after the first competition series, illustrated with models for the throwing events. Because most of the work on this subject relates specifically to the Northern hemisphere, this study also examines the problems of the Southern hemisphere. The importance of a high and stable performance level during the first competition period as a key indicator to success in the qualifying round of the main competition of the year is underlined. It is also shown that peaking as the climax of the entire preparation cannot be produced independently and that the effectiveness of the peaking period is determined by that of the preparation as a whole.

1 Introduction: peaking under specific conditions

It is desirable to design the training programme so as to reach maximum performance at the main competition of the year. Although there may be difficulties in achieving such a result under the circumstances of the main competition (e.g. stress, climate, distractions) it is nevertheless essential to develop an effective strategy for doing so.

In the European Championships in 1982 and the World Championships in 1983 only 5 of the 42 medallists in the throwing events recorded their season best performance in the main competition (HINZ/BARTONIETZ 1985). More than 10 years later the problem remains the same: At the World-Championships in 1995 only 17 of the 84 finalists recorded their season's best performance in the main competition (BARTONIETZ/BORGSTRÖM 1996), but still only 9 of the 21 medallists (43%).

As shown by the data in *Table 1*, the problem is not confined to the throwing events but also applies, for example, to the jumps and hurdles.

Also, in other sports with an objective performance judgement such as swimming, weight-lifting and shooting, only about 20% of all qualified

Table 1: Effectiveness of the preparation for the World Championships 1995 in selected events – WC results versus season's best performance

Event	Number of athletes	WC better than season PB	%
all throws (finalists)			
– men	48	8	17
– women	36	9	25
high jump			
– men	33	6	18
– women	35	9	26
triple jump			
– men	43	7	16
– women	32	8	25
110m and 100m hurdles			
– men	47	13	28
– women	32	8	25

Note: Wind-assisted attempts at the WC are not included. Other variations in external conditions are not taken into account.

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athletes reached their season's best result at the Olympic Games (LEHNERT 1994). Of all the finalists in the 1996 Olympics, the medallists showed the results of the most effective training. In the throwing events, 8 of the 21 medalists (38%) reached their season's best result during the Olympic finals. In addition, 4 athletes (the gold medallists Kumbernuss, Barnes, Riedel, Kiss plus Sadova and Zvereva) reached such a high level of performance 2 to 7 weeks before the Olympics that an average decrease of about 2% did not detract from their leading position. In summary a successful training process is noted for about two thirds (67%) of the medallists. The training of the top athletes seems to be characterised by a higher training efficacy compared with the results reached 13-14 years ago.

According to ZATSIORSKY (1995), the efficacy of the whole preparation can be judged with the help of an "efficacy coefficient":

$$\text{efficacy coefficient} = \frac{100\ ^*}{\text{the total number of athletes}}$$

(*The number of athletes who achieved their best performance during the main competition.)

According to ZATSIORSKY (1995), for Olympic teams an efficacy coefficient of about 85% is considered excellent, 75% is considered good and 65% is considered acceptable (e.g. for the medallists in the throwing events in 1996).

Coaches and sports scientists have long recognised the problem of performance peaking, see, for example:

VERCHOSHANSKY 1988	elite sports, general
SCHNABEL/HARRE/BORDE 1994	elite sports, track and field events
BOAS/OSBORNE 1981	track and field events
SCHMOLINSKY 1983	track and field events
OZOLIN et al. 1989	track and field events
BONDARCHUK 1992	track and field events
BALYI 1996	track and field events
HAMANN/SCHOTTE 1979	throwing events
HINZ/BARTONIETZ 1985	throwing events
YINGBO 1994	throwing events.

The art of peaking was based mostly on the experience of leading coaches and was a part of the "secret knowledge" of, for example, Eastern German coaching (therefore it was not included in the textbooks of BAUERSFELD/SCHRÖTER 1979, HARRE 1982).

Until now, there has been a lack of knowledge about peaking (see e.g. GAMBETTA 1989, SCHNABEL/HARRE/BORDE 1994). This study will present basic considerations for performance peaking, illustrated with models for the throwing events. Because most of the work on this subject relates specifically to the Northern hemisphere, this study also examines the problems of the Southern hemisphere.

The problems associated with the peaking process vary according to the preparation environment. At least the following variations in conditions can be identified:

- Selection in season: The requirement to record a qualifying performance (e.g. Germany) or to contest a selection trial (e.g. USA) and the timing of such requirements.
- Selection out of season: The practice of selection at the end of the domestic season in the Southern hemisphere (e.g. Australia, New Zealand).

The peaking process requires optimal interaction of organisational factors and biological laws of adaptation and development:

- The competiton period in which qualification is required is subject to the long-term training effects of the realised training loads. A maximum performance normally can not be achieved under these conditions. If an athlete does record his season's best performance at this time he has probably peaked unintentionally (e.g. perhaps this could be the explanation for Zelezny's season's best of 98.40m in May 1996).
- Given that the peak performance is the end result not only of the peaking period but of the entire preparation it is unlikely that further improvements can be produced simply by repeating the same process. Therefore, peaking for the selection procedure and then again for the major competition cannot be expected to produce a higher performance.

2 Main principles for peaking the performance after the first competition series: throwing events

2.1 Northern hemisphere

Following the selection process there is a compact repetition of the preparation period (i.e. mini-prep of 6 to 8 weeks, cf. *Figures 1 and 2*, *Table 4*) during which the contents of the whole preparation are repeated with the following characteristics:

- Weekly *training volume* of about 70-80% of the weekly maximum volume during the preparation period (e.g. see *Figure 1 and 2*, also the data of LOSCH/BÖTTCHER 1994).
- *Maximum loading* in relation to the main competition (according to LEHNERT 1994 and SCHNABEL/HARRE/BORDE 1994)
  - general training 5-4 weeks before,
  - maximum training volume 4-3 weeks before,
  - special training 3-2 weeks before,
  - maximum training intensity 2-1 week before.

In summary, the maximum training loading is reached 3-2 weeks before the main competition.

This shows the need for *intensity control* together with the gradual decrease of training volume. It is a fact that many world class throwers limit their throwing intensity to 90-95% of the maximum 3-7 days before competition (YINGBO 1994).

With throwing training intensity we are concerned not only with the weight of the implement and the distance thrown but also, to a substantial degree, with the *quality of movement execution* and the mental work.

- *Maximum strength training* is characterised by a low number of repetitions at high intensity for a maximum recruitment of motor units.
- *Special throwing training* focused on technique and movement quality, developing special performance and including the limited use of light implements (see 2.4).
- High level of *technique* based on maximum flexibility for full range of movement in the main joints.
- *The best training results* of the preparation are achieved during the taper.
- Replication of the main competition time in the throwing sessions, stable ritual during the final days, especially the last 4-6 days (warm-ups and workouts, meals, regeneration). Coaches should consider avoiding total rest days because of the need to maintain all body systems at a high level of activity, especially the central nervous system.

The data in *Table* 2, taken from an unpublished study of 1979, shows the principles of implement distribution during the entire preparation with the peaking period as a substantial part. The various loadings represent the training philosophy current at that time. Although current trends place less emphasis on high volumes of maximum

Table 2: Distribution of throws with implements of different weight during throwing training [%] (adapted from HAMANN/SCHOTTE 1979)

Event	Implement [kg] Men / Women	Men prep.	Men comp.	Men peak.	Women prep.	Women comp.	Women peak.
Shot put	7.26 / 4	62	85	87	48	55	52
	8.25 / 5	27	8	7	37	29	31
	6.26 / 31	6	7	6	10	10	10
	9.25 / 6.25	4.5	3	3	5		
	>9.25 / >6.25	0.5	2	3	2		
Discus throw	2 / 1 discus	51	86	77	53	73	54
	>3 / >2 shots, sticks, rings	19	10	12	23	19	27
	2-3/1-2 shots, sticks, rings	16	2	5	21	6	18
	2-3/ 1.5-2 discus	13	2	4	2	2	1
	1.75 / 0.75 discus	1	2	1			
Javelin throw	0.8 / 0.6 javelin	33	61	58	30	78	55
	0.8-1.5/0.6-1.0 shots	23	19	23	24	9	16
	>1.5 / >1.0 shots	14	7	6	23	5	14
	<0.8 / <o.6 shots, stones	12	7	6	13	4	6
	0.9 / 0.7-0.8	11	5	4	6	3	5
	0.6-0.7/ 0.5 javelin	7	1	3	4	1	4

prep. = preparation period; comp. = competition period; peak = peaking period

[1] An increase in the range up to 6.75kg and 3.5kg would allow a greater volume of throws with light implements because the movement pattern would be closer to that used with competition implements.

Table 3: Training volume of the mesocycles during the preparation period (taken from DEUTSCHER LEICHTATHLETIK-VERBAND 1991, p. 82)

Event	Complex of training	Mesocycles 1	2	3	4	5	6
Shot	maximum strength	3-5	11-13	17-19	29-31	21-23	13-15
	special strength	1-3	13-15	17-19	22-24	30-32	11-13
	throwing	3-5	9-11	13-15	19-21	22-24	28-30
Discus	maximum strength	2-4	15-17	28-30	20-22	17-19	12-14
	special strength	2-4	13-15	24-26	31-33	20-22	4-6
	throwing	3-5	11-13	18-20	18-20	28-30	16-18
Javelin	maximum strength	5-7	29-34	24-26	15-17	11-13	10-12
	special strength	2-4	18-20	23-25	20-22	19-21	12-14
	throwing	2-4	11-13	14-16	22-24	26-28	19-21
Hammer	maximum strength	5-7	26-28	21-23	14-16	15-17	13-15
	special strength	9-11	26-28	21-23	14-16	15-17	13-15
	throwing	4-6	12-14	15-17	15-17	29-31	19-21

Sum of the entire preparation period = 100%

strength training, nevertheless the general idea of the loading structure remains viable.

Table 3 gives an example of how to distribute the entire volume during the mesocycles.

The performance development of Astrid Kumbernuss shows the effect of a well-constructed double periodization, while Stephanie Storp shows a similar level of improvement albeit from a significantly lower base. Each reached the seasons best performance during the taper although not in the main competition (see *Figure 3*). When interpreting training data such as in *Figure 3* there is always the possibility that some of the discussed results could have been affected by other factors such as injury or illness, however we have to assume a normal uninterrupted preparation.

2.2 Southern hemisphere

The competition season in such countries as Australia, New Zealand and some of the island

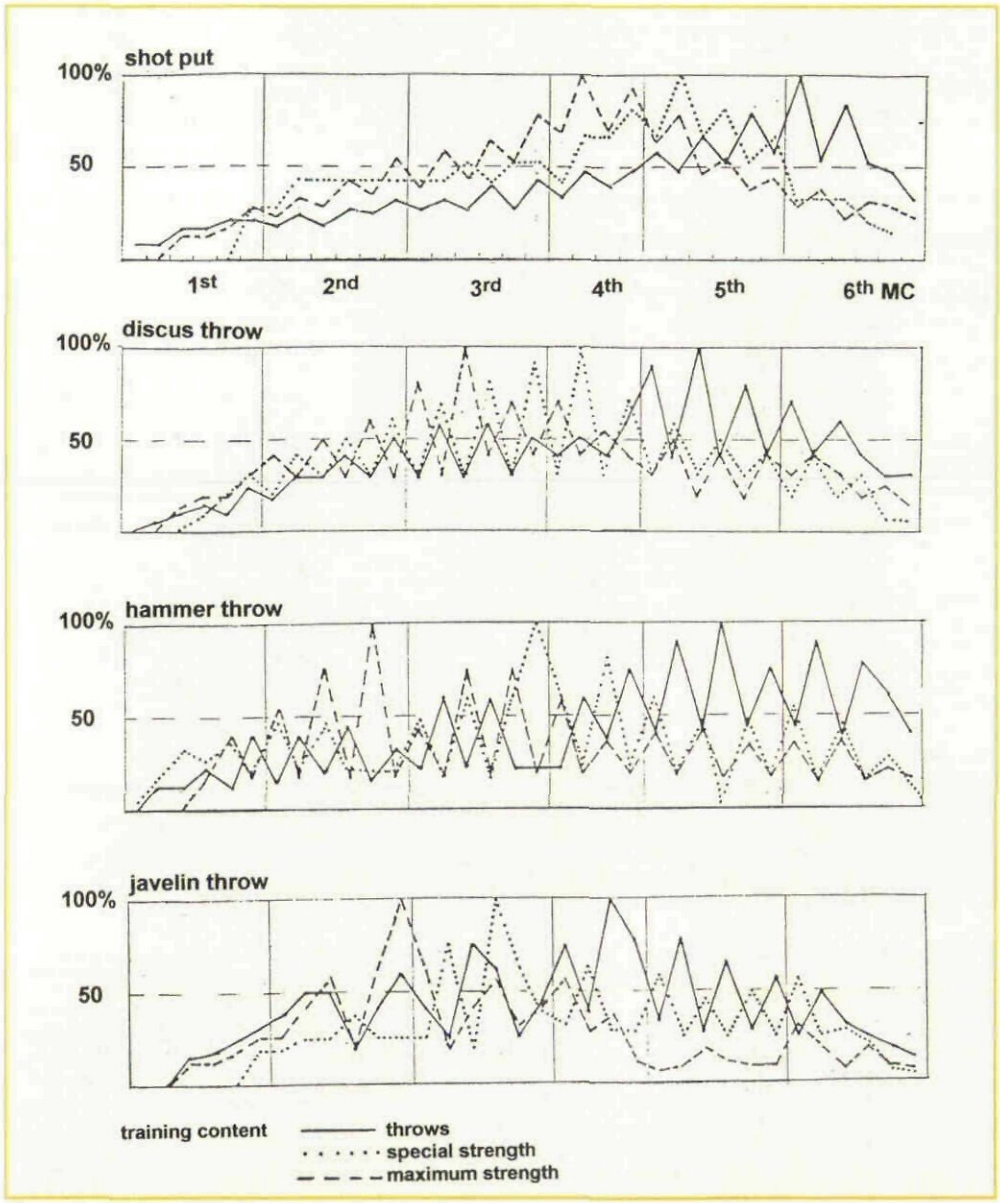

Figure 1a: Loading in the main training components during the preparation period for single periodization (according to HAMANN/SCHOTTE 1979)

states of Oceania has its climax in March and selection for Olympic Games and World Championships generally takes place in about April – anything from 18 to 23 weeks prior to the main international competition. In this case, instead of a mini-prep of 6-8 weeks, there is available enough time for a full preparation. This gives a decided planning advantage but also has its disadvantages. Selectors have no guarantee that athletes selected in April-May will reproduce this level of performance in an entirely new preparation. In addition, the time-lag involved multiplies the possibility of injury to selected athletes.

To overcome this problem the Australian Federation, for example, has developed pre-departure standards which selected athletes must reach before leaving the country (*Table 5*). However this does not necessitate a mini-prep as the standards set are low enough to be achieved during the preparation period. Nevertheless, a mini-prep is still recommended for those elite athletes who

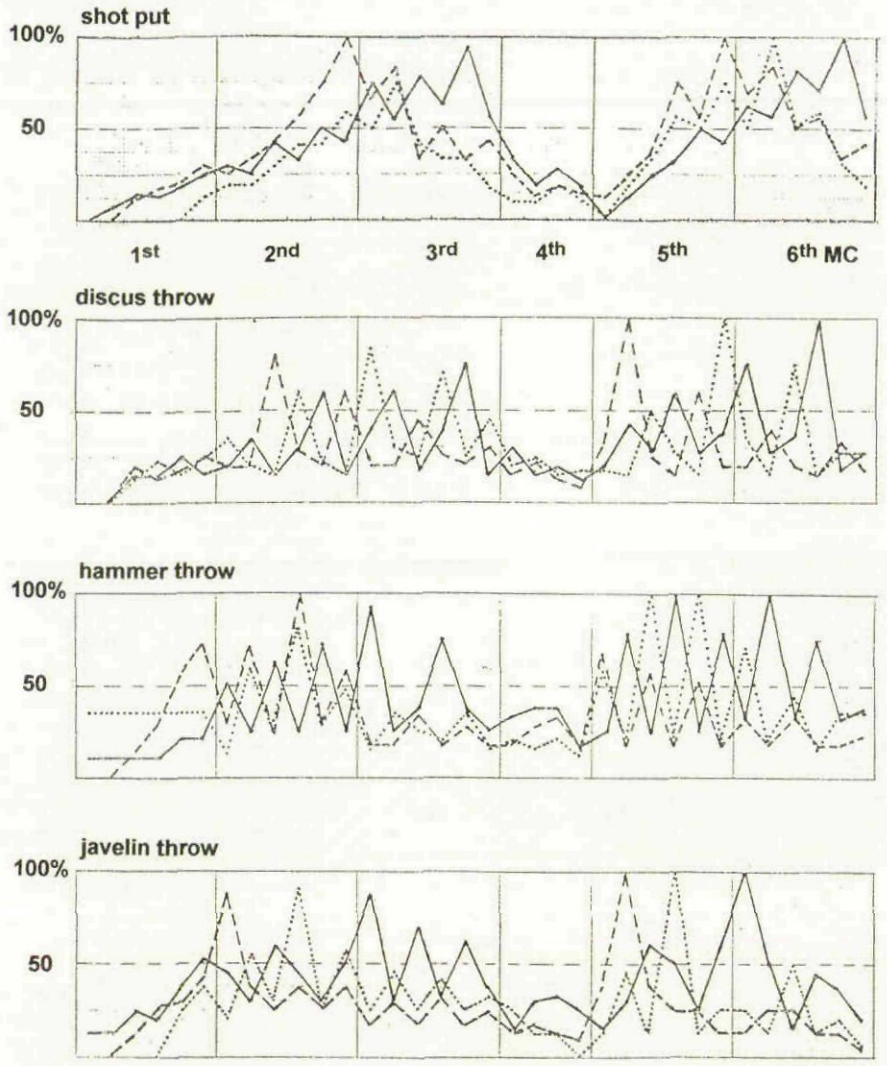

Figure 1b: Loading in the main training components during the preparation period for double periodization (according to HAMANN/SCHOTTE 1979)

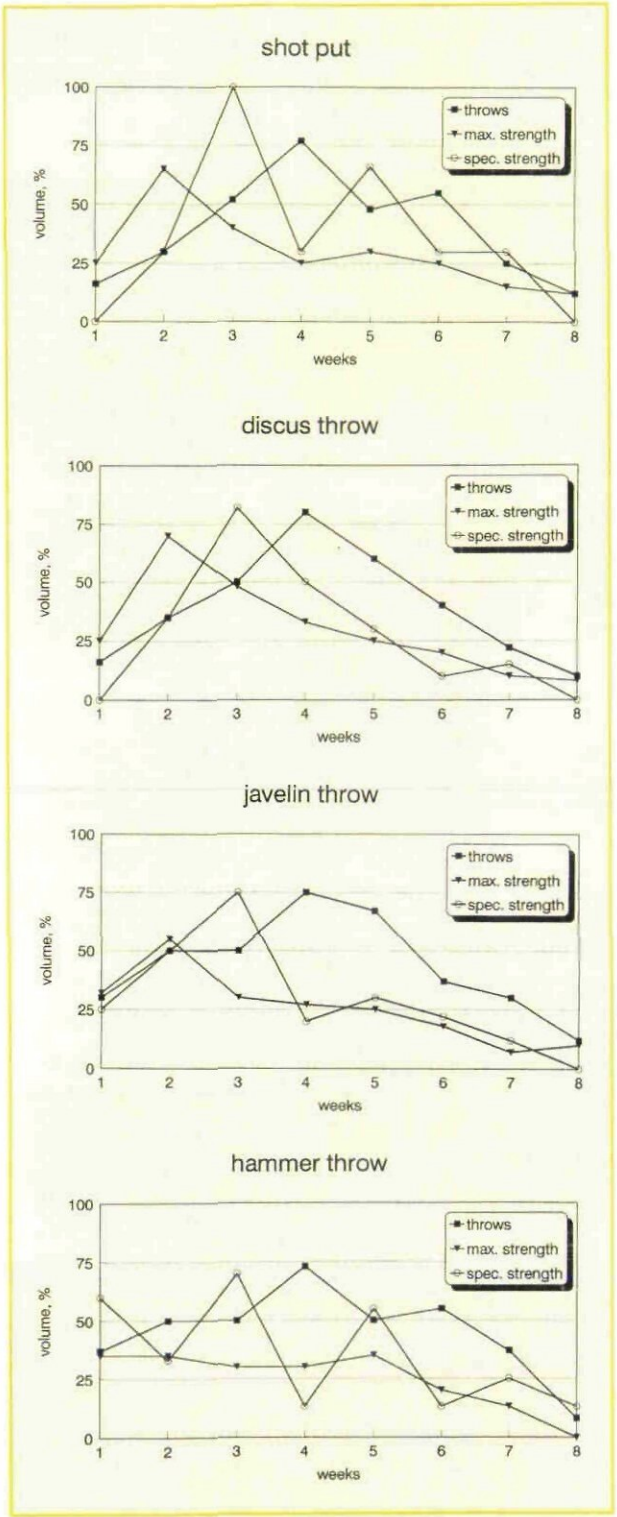

Figure 2: Loading in the main training components during the peaking period (according to HAMANN/SCHOTTE 1979)

need to reach a high level of performance early so as to be competitive early in the Northern season (see the recommendations in 2.1).

Australian javelin throwers Joanna Stone (5th WC) and Louise McPaul (2nd OG) provide good examples of effective preparation in 1995 and 1996 respectively (seasons PB at the main competition of the year, see *Figure 4*). Hammer thrower Sean Carlin was able to reach better than 99% of his domestic season best within 10 days of the Olympic Games but his performance base was too low to be competitive. In contrast, Andrew Currey set an Australian National Record of 84.92m in the 4th week of 1996 and was at 98% of this 23 weeks later but by 27 weeks (OG) he was back to 91% (Jan Zelezny also could only manage 89.6% of his season's best but was still able to take the gold medal.). Similarly, the female Australian discus throwers peaked about 9-10 weeks early and New Zealander Beatrice Faumuina failed to approach her best domestic result (64.04m).

Figure 5 underlines for one of these athletes the hypothesis that the effectiveness of the taper is determined by the entire preparation period. The significantly higher performance level during the 1996 domestic season (61.30m vs 57.14m) resulted in a higher starting level in the first northern competitions. Athough the level of performance fell during the taper period in both years, the fall was fifty percent less in 1996. The level of performance stability was was also higher: The standard deviation from the average value was ±3.10m in 1995 and ±2.42m in 1996 by a significant difference between the average performances' values at the 99.9%-level.

2.3 Considerations for the peaking process when the main competition is in the Northern hemisphere (e.g. Atlanta 1996, Athens 1997)

Because of the negative effects of travel, including jet-lag, coaches and their athletes in the Southern hemi-

Table 4: **Planning of the entire training year (double periodization) and contents of the mesocycles for young shot putters**
(taken from DEUTSCHER LEICHTATHLETIK-VERBAND (1993), p. 91, adapted)

Week of the year	Meso-cycles	Training period	Contents
41 42 43 44 45	1	general training	general athletic base: - conditioning - general strength abilities (trunk muscles) - co-ordination
46 47 48 49 50	2	maximum strength training	bar bell training (snatch, clean and jerk, squat, bench press)
51 52 1 2 3	3	throwing training	main load in shot put: - technique-orientated strength development, - mostly use of the competition implement and of heavy implements
4 5 6 7	4	indoor competitions	development of form alteration load-rest
8 9 10 11 12	5	general training	see 1st preparation period
13		intensification	increase of training intensity
14 15 16 17	6	maximum strength training	high intensity
18 19		special strength development	focus on technique
20 21 22 23 24 25	7	weekly throwing maximum beginning of the first competion series	complex development of technical goals (final acceleration) form development
26 27 28 29 30	8	competition series, qualification for the Junior WC	increase of training intensity, alteration load-rest
31 - 39	9	peaking main competition, e.g. Junior WC	mini-prep

Table 5: **Qualification standards (qs) and pre-departure standards (pds)for the Australian Olympic team throwers in 1996 broadly based on IAAF B standards**

	Men		Women	
Event	qs	pds	qs	pds
Shot put	19.50	18.50	18.00	16.60
Discus throw	62.00	59.50	60.00	56.50
Javelin throw	80.00	74.50	60.00	56.50
Hammer throw	74.00	69.50		

sphere must pay serious attention to the timing of their relocation to the Northern hemisphere where this includes a substantial shift in longitude (Southern hemisphere to Europe or North America, and between Europe and North America). The optimal timing of the relocation should be at least as early as the first week of the taper to minimise the negative effects of travel on high intensity training and competition. The first part of the taper is characterised by work of a more general nature (see *Figure 2*), which is less sensitive to these effects.

2.4 Considerations for the peaking process when the main competition is in the Southern hemisphere (e.g. Sydney 2000)

This situation poses new problems. Does the athlete travel to the Northern hemisphere for competitions or not? If he chooses to travel he faces all of the problems noted above (jet-lag

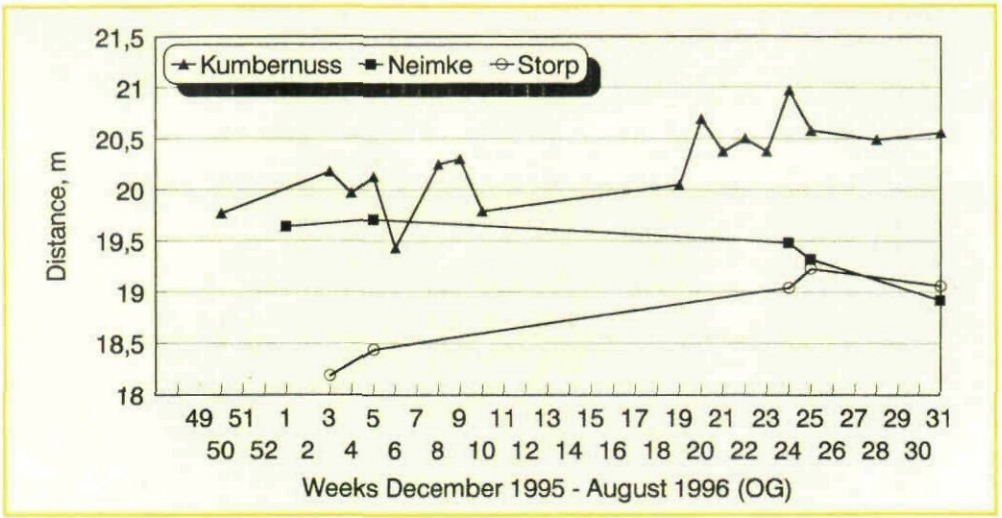

Figure 3: Performance development in 1996 of three female shot putters (double periodization)

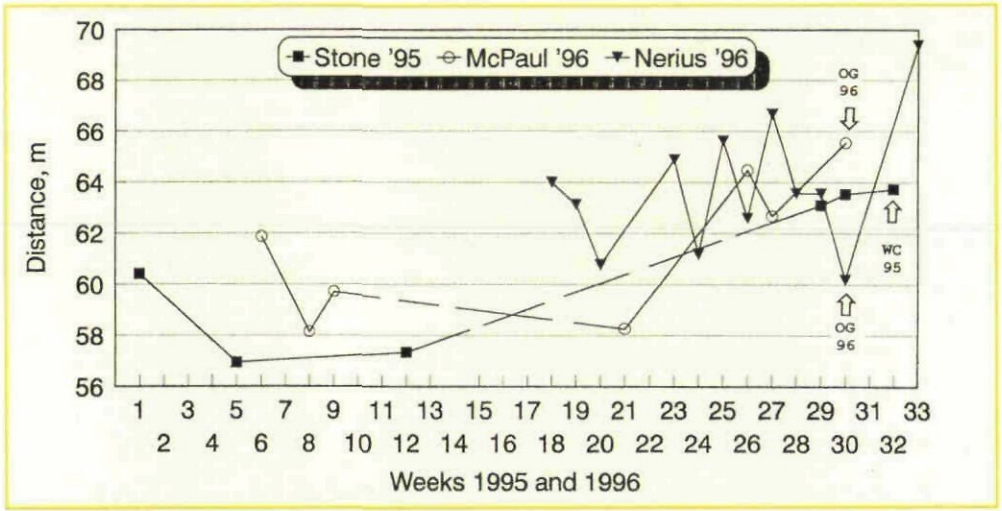

Figure 4: Performance development of 3 female javelin throwers in 1995 and 1996

etc.), twice! The process of adaptation must be repeated on his return to Australia. The advantages of having the main competition in the South will therefore be considerably reduced. The alternative of remaining at home can only be viable if satisfactory opportunities for high level competition are available (e.g. a pre-Games competition season involving high-ranking opponents from the Northern hemisphere). The later scheduling of Southern hemisphere Games (e.g. Sydney / September, 2000) provides additional time for a full preparation.

2.5 The importance of a high and stable performance level during the competition period

- One study (LARSEN 1995) has suggested that a *high performance level during the first competition period* is a key indicator to success in the qualifying round of the main competition of the year: At the 1995 WC only athletes with season's best performances of more than 77m qualified for the hammer throw final.

With few exeptions the results of the 1996 Olympic throwing finals support this view. Only hammer throwers with a season's best of over 78m qualified. Of the 70 top ten ranked athletes in the seven throwing events 58 qualified for the finals (between 8 and 9 per event on average). Only Vadim Chersonzev missed the hammer final, Gavin Lovegrove the men's javelin final and Oxana Ovchinnikova and Silke Renk (one isolated top 10 performance) the women's javelin final.

- The major influence in filling the top places was the *ability to improve* on the season's best performance (LARSEN 1995). At the Olympic Games this finding was the case of 3 javelin medallists (Backley, Räty, McPaul) and 2 hammer medallists (Deal, Krykun). However, in determining the final order of the medal winners there was considerable variation between the throwing events. On the one hand the gold medal at the WC and OG was won with the first throw (WC: javelin and discus throw women, shot put men, OG: all 3 women's events) and on the other hand with the last throw (WC: hammer throw, javelin throw men, OG: shot put men).

The *high intensity throwing training* has to be directed to the ability to fight for better results right through a series and also up to the end of a workout. During training, normally the first throws are more relaxed and technically good than the last, but efforts have to be directed towards maintaining a high technical level up to the end of the session so as to finish the session with a technically good throw.

Competing several times during the taper without special preparation in accordance with the planned training contents can result in a decrease in performance due to the effects of training load on the level of event-specific skills and abilities. *Figure 6* shows the interaction between training load and performance development during the taper period. The increased number of throws with heavy implements (22nd week) and of special strength exercises (23rd week) seems to be related to an improvement in the competition performances during this time interval.

- Successful peaking requires *objective information* about the technical level. A comparison of "debit" and "credit" is necessary to figure out the actual training goals (comparison between actual and required value, see *Figure 7*).
- *Positive orientation* with motivational effect, *clear goals* for the workouts (*Figure 7*).

Carry out a competition analysis 1-2 days after each competition. The results of this analysis have to lead to an optimal attitude for the following workouts:

A good performance has to be used to build up confidence and the positive thinking of the athlete. The data on which *Figure 7* is based were used for this reason (by comparison with a photo sequence of the event's leading athlete). The positive elements of technique which have key functions for performance should be reinforced by special drills and simulations, using the interaction between speaking, thinking and moving.

After an unsatisfactory competition performance, focus on the sources rather than just the indications for such a result (e.g. avoid repeated viewing of video faults). Athlete and coach must work together to identify appropriate corrective measures and build up confidence that problems are soluble.

- Attempts to make *major changes in technique* during the taper should be *avoided* (YINGBO 1994). The limited time during the taper necessitates the development of the "fine tuning" of the technique before the peaking period (using

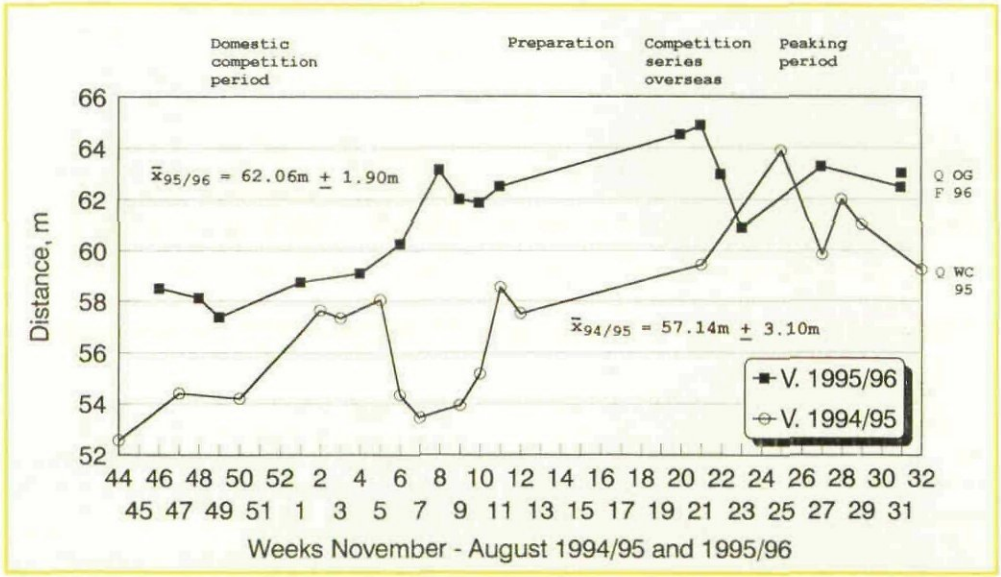

Figure 5: Performance development in 1995 and 1996 of a female discus thrower

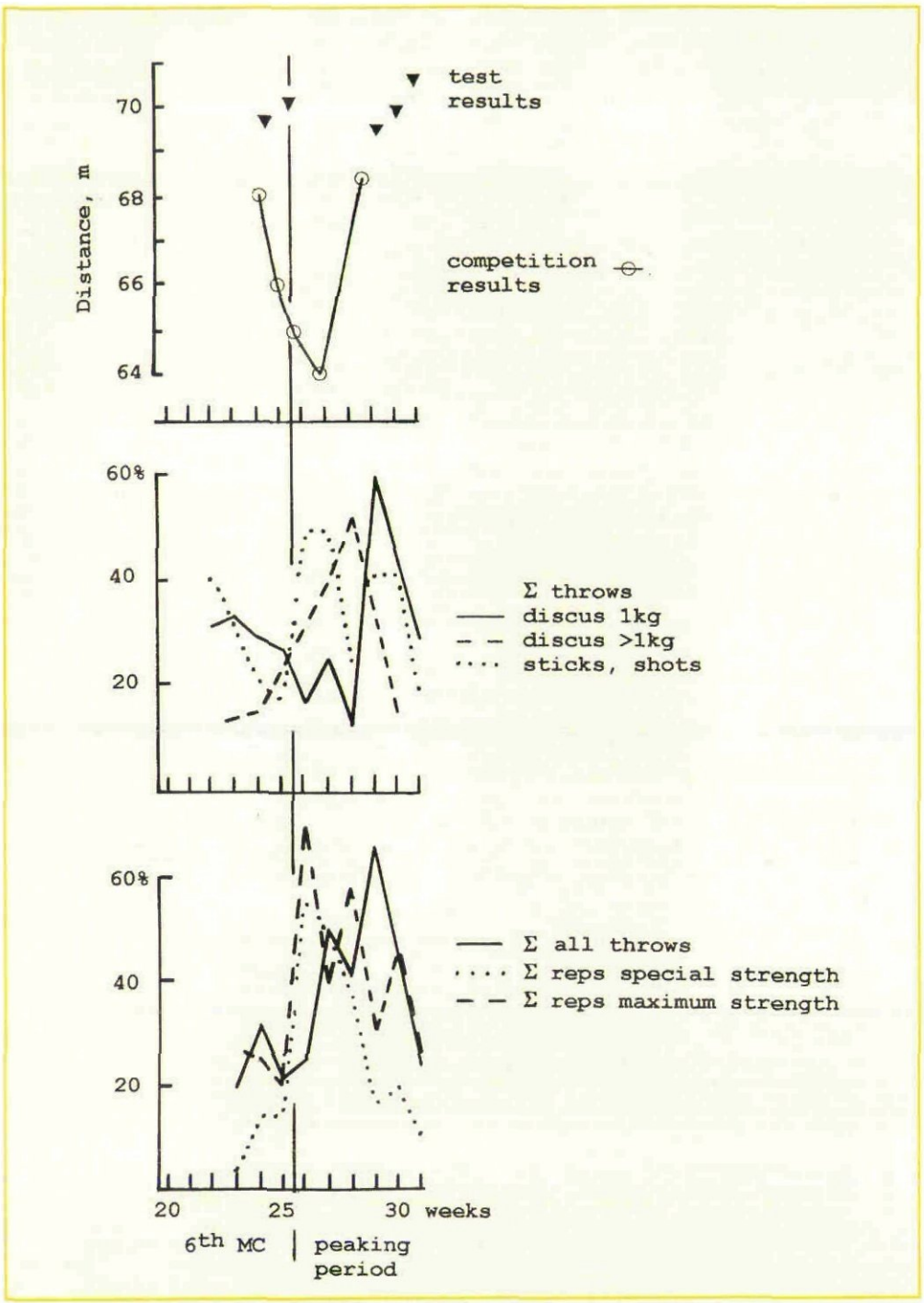

Figure 6: Performance development of Ilke Wyludda during the peaking period in 1992 (above) and the training load during the last weeks before the Olympic Games in 1992 (in %, related to the weekly repetition maximum of the preparation period)
– middle: parts of the throwing training
– below: sum of all throws, special strength and maximum strength training
(based on data of LOSCH/BÖTTCHER 1994, adapted and supplemented)

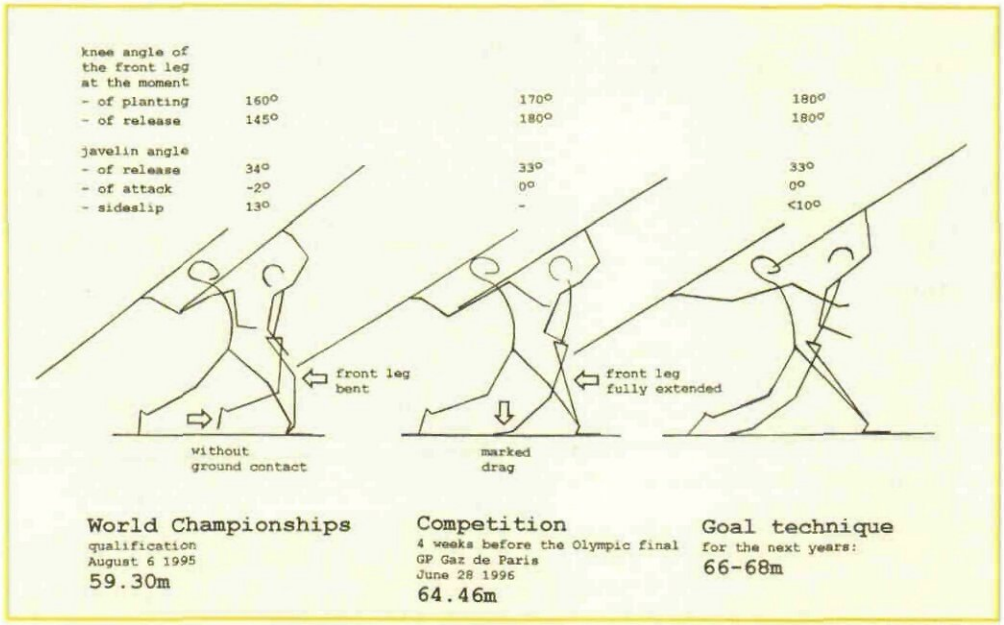

Figure 7: Body positions at the moment of planting the front leg and at the moment of release for a female javelin thrower

Left: In the qualifying round at the World Championships in 1995 (the athlete did not qualify).

Centre: Close to the technical demands at the competition during the peaking period. The athlete reached the Olympic final and won the silver medal (result of the AIS/Track and Field competition analysis).

Right: Necessary body positions to reach a higher performance level and to form a base for assessing the demands for the training of technique and special strength.

the competition period). If the technique-related problems are not solved in time, performance-limiting effects are pre-programmed for the main competition.

- In theory the use of *light implements* will achieve an increase in movement speed and neuromuscular co-ordination. In practice only a small number of throws with light implements is normal because of undesired effects on the movement pattern (see the data in *Table 2*: about 3-4% in javelin throwing training up to 6-10% in shot put training). In fact, light implements make lower power demands compared to their mass (BARTONIETZ 1987).
- Active rest intervals are necessary especially at the beginning of the taper in spite of the training load during the competition period (physical and mental tiredness) and also after the load peaks. According to LEITNER (1992), 10% of the tapering time has to be used for active rest (a taper of 8 weeks/56 days - 6 days planned for active rest).

3 Summary

1) Success in international athletics is determined to a large extent by the ability to perform at peak level in the major competition of the season.
2) Training programmes must be constructed so that this goal may be reached, and must take into account the peculiarities of preparation in the Northern and Southern hemispheres.
3) An effective training process has been diagnosed for about two thirds of the medallists in the throwing events based on the comparision "Season PB vs result at the Olympic Games". The training of the top athletes seems to be characterised by a higher training effectiveness if compared with the results reached one-two decades ago.
4) Peaking is the climax of the entire preparation and can not be produced independently. The effectiveness of the peaking period is determined by that of the preparation as a whole.
5) The main principle in constructing the taper requires a compact repetition of the preparation period (i.e. mini-prep).
6) It is clear that, in order to plan the taper period correctly, all details and loadings of the preparation must be adequately documented (training protocols).

7) The performance of the leading athletes in the throwing events is characterised by a high level of sporting technique as one inseparable part of the training efforts during the entire preparation process. Because abilities and skills exist in unity, the peaking period is characterised also by intensive technical work (mental preparation for the workouts, feedback).

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