Increasing the effectiveness of special strength training for the discus throw using the discus strength training machine (STM-Discus)

by Manfred Losch & Gerhard Böttcher

Special strength training has become an important part of training in the throwing events. Especially modern, specific strength training machines have proven to be very effective for practice. From a mechanical point of view the high effectiveness of the Strength Training Machine for the Discus (STM-discus, see photos left and on p82) as compared to other special throwing exercises is caused by a higher output of kinetic energy as well as by a higher maximal acceleration achieved. In this article selected investigation results concerning the effectiveness of the STM-discus in the training of the German elite discus thrower Ilke Wyludda are presented.

1 Introduction

Special strength training exercises are the main means of improving performance in the throwing events, through the development of the muscle groups specifically concerned with the necessary movements.

Because of its increasing importance, special strength training has become an independent part of training. This is shown by the significantly increased proportion of this type of training within the total training and by the systematic integration of these exercises into the training programmes of the best female and male athletes.

It can be taken for granted that improved performance in competition is always linked with an enhanced movement ability. This means that higher acceleration forces must be produced during shorter periods of time. Therefore, it is essential to increase the power available for the specific movements required for the event. This objective includes specific modes of strength training and specific forms of muscle contraction. The duration and/or intensity of these contractions should be above the demands of the actual competition.

In this context, the use of modern, specific strength training machines becomes increasingly important (cf. Dorr 1989, Kölnner/Dorr/Wiese 1989, Losch et al. 1992).

The developmental concepts of such specific strength training machines are based partly on experience, but mainly on the following theoretical propositions:

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(Translated from the original German by Jürgen Schiffer)
the ability concepts of VERCHOSHANSKI (171, 1988),

the structure analysis of strength as a motor ability by SCHMIDTBLEICHER (1984),

the findings of BOSCO (1985), concerning the stretch-shortening cycle (Bosco 1985) and

the findings of GUNDLACH/HOCHMUTH 1982, regarding the strength/movement structure of sport exercises.

From the above it follows that

- a further increase in the effectiveness of strength training is based on the integrated structure of muscular strength and technique. Therefore, strength training should not be viewed only from the point of view of physical condition and energetics; it should also be seen as technique-oriented training. The basic prerequisite for a more effective special strength training is the consistent orientation of the exercises to the actual movements of the event itself.

- The development of the special strength necessary for the competition movement, together with the securing of the underlying neural adaptation processes, requires a high total volume of the exercises and an increase in their speed of movement (the execution of the movement should guarantee a high final velocity).

- At the beginning of the phase of special strength development, in the course of the training year, the emphasis is placed on the general development of the main muscle groups concerned with movement. As the development continues, the proportion of special strength exercises more closely related to the competition movements is increased.

Training experiments made so far with special strength training machines for the javelin, shot and discus (first prototypes) have shown that these machines are very effective.

When training with the strength training machine for the discus (STM-discus), for the effective development of the special type of strength applicable to the structure of the competition movement, the following demands must be met:

- An increase of the training stimuli for the development of great strength in the prime movers;
- Adherence to the basic structure of the throwing movement (or the main phase);
- reduction of the bracing and stabilizing function of the muscles of the throwing arm and the shoulder girdle during the preparation for the delivery, in favour of higher acceleration forces;
- the guarantee of a greater stimulus density and therefore greater load volumes;
- immediate information about the characteristics of the movements produced (for example the velocity and acceleration course using typical biomechanical procedure);
- increased possibilities of specific strength diagnosis.

Adherence to the basic requirements mentioned above, during training with the strength machine, can be verified by experiments conducted by LOSCH et al. (1992), in which there was only very slight deviation from the desired agreement with the structure of the competition movements. It has been shown that the special STM-discus is an effective means for the development of the special strength abilities of a female top athlete. The STM-discus is more effective mechanically than other special throwing exercises, because of the higher output of kinetic energy produced and the greater maximum acceleration achieved.

However, it should be noted that a sliding carriage with a weight of 8.5kg or more
will lead to considerable deviations from the dynamic and kinematic structure of the discus throw. These deviations are

- the early reaching of maximum acceleration;
- a significantly lower maximum acceleration;
- execution of the exercise with too much emphasis on the upper body;
- too much flexion in the bracing leg during the follow-through movement.

These deviations require an extension of the time between the use of these exercises and competition.

On the following pages, selected results will be presented of investigations into the effectiveness of the STM-discus in the training of Ilke Wyludda and conclusions will be made concerning the further use of this machine.

These investigations were based on the hypothesis that the positive results, achieved when training with the special strength training machines for the javelin and the shot, should also be attained by top level discus throwers with the STM-discus, fitted with measuring apparatus. A test model of this machine can be seen at the Olympic training centre in Halle.

2 Investigation method

A single case analysis, using one elite athlete, was used. The work hypothesis was verified by means of a course analysis, including the computer-supported processing of values measured on the STM-discus and three-dimensional video picture analysis.

The examination of the movement technique, when training with the STM-discus, was conducted in Halle on March 3, 1992; the special throws were checked, in the framework of a performance diagnosis, in the test hall in Leipzig on March 31, 1992.

A separate record of the basic data and special training performances was made by the athlete and her coach.

The following information was recorded on computer:

- maximum velocity of the sliding carriage ($v_{\text{max}}$)
- maximum acceleration ($a_{\text{max}}$)
- acceleration path ($a_{\text{path}}$)
- maximum acceleration force ($F_{\text{max}}$)
- mean acceleration force ($F_{\text{avg}}$)
- mean acceleration performance ($P_{\text{avg}}$)

Additionally, the parameters $v_{\text{max}}$, $a_{\text{max}}$, $F_{\text{max}}$, and $P_{\text{max}}$ were presented in the form of typical curves. The parameter "kinetic energy ($E_{\text{kin}}$)" was calculated manually.

Using three-dimensional video picture analysis, 15 body points and one point for the throwing implement were recorded in the main positions (power position, right knee in throwing direction, release of the implement).

3 Analysis of the training of Ilke Wyludda during the Olympic year 1991/92

3.1 General aspects

- Ilke Wyludda's main objective, during the Olympic year 1991/92, was to improve the special strength required for the development of technique, on a foundation of a superb general athletic ability together with a solid development of maximum strength. In order to realize these goals, the volume of special strength training was increased and the STM-discus was used.
- The basic structure of the training year consisted of a single periodization programme, which comprised 7 mesocycles, each of six weeks duration. The first mesocycle was a six week phase of pre-competition preparation, with the emphasis on general training and the volume of all-round strengthening work, as a preparation for the two subsequent phases of maximum strength development; the 4th mesocycle emphasised special strength development; the 5th mesocycle stressed
special throwing training; the 6th mesocycle aimed at the development of performance for the early competitions; the 7th mesocycle was the pre-competition preparation phase. The systematic structure of the sequence of the main training contents is shown in Figure 1, which depicts the course of the training loads during the preparation, development and stabilisation of the individual training means.

In spite of occasional injuries to her right pectoral muscles, she was able to fulfil almost all of the planned training programme and develop an optimal level of performance, right up to the end of her pre-competition phase.

3.2 Evaluation of special training

Table 1 and Figures 2 and 3 show the high standard of performance achieved by Ilke Wyludda in the areas of special training and maximum strength, during the Olympic year 1991/92.

At the beginning of the second mesocycle, for example, she achieved a throw of 61.10m. During the pre-competition phase this was increased to 69.70m, in spite of unfavourable tail wind conditions and, during her preliminary competitions, she reached 70.96m.

A few days before the start of her event at the Olympics, Ilke showed that she had reached her peak of physical condition and was still able to maintain a stable technique.

Her best performances in the standing throw were, with the competition implement, 60.30m; with the heavy (1.5kg) discus, 48.60m and with the 2kg stick, 43.10m. The highest release velocities on the STM-discus were, with the 8.5kg carriage, 10.1m/s and, with the 10.5kg carriage, 9.4m/s. Her best performance in the overhead/backward shot throw and in the snatch (105kg) were achieved during the phase of special throwing training (5th mesocycle). She also achieved 105kg in the snatch during the 4th mesocycle and during the pre-competition phase.
Table 1: Mesocyclic course of important test parameters during the Olympic year 1991/92

<table>
<thead>
<tr>
<th>Test exercise</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>Pre-comp.</th>
<th>Olympic</th>
<th>Grand Prix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competition implement (standing position)</td>
<td>54.40</td>
<td>56.40</td>
<td>59.20</td>
<td>60.30</td>
<td>59.00</td>
<td>59.50</td>
<td>62.12</td>
<td>68.20</td>
<td></td>
</tr>
<tr>
<td>Competition implement (turn)</td>
<td>61.10</td>
<td>65.60</td>
<td>70.10</td>
<td>69.50</td>
<td>72.00</td>
<td>(68.82)</td>
<td>(70.96)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavier Comp. implement (standing pos., 1.5kg discus)</td>
<td>45.60</td>
<td>46.50</td>
<td>47.80</td>
<td>48.60</td>
<td>48.00</td>
<td>47.60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavier Comp. implement (turn)</td>
<td>50.80</td>
<td>53.66</td>
<td>55.30</td>
<td>54.40</td>
<td>55.50</td>
<td>55.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2kg stick (standing position)</td>
<td>40.80</td>
<td>42.40</td>
<td>42.70</td>
<td>43.10</td>
<td>41.60</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2kg stick (turn)</td>
<td>47.60</td>
<td>50.50</td>
<td>51.80</td>
<td>51.10</td>
<td>49.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2kg shot (standing position)</td>
<td>39.30</td>
<td>41.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5kg shot (turn)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>54.00</td>
<td>55.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STM 8.5kg [(\nu_0)]</td>
<td>9.5</td>
<td>10.0</td>
<td>10.1</td>
<td>9.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STM 10.5kg [(\nu_0)]</td>
<td>8.8</td>
<td>9.2</td>
<td>9.4</td>
<td>9.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STM 12.5kg [(\nu_0)]</td>
<td>8.2</td>
<td>8.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snatch [kg]</td>
<td>97.5</td>
<td>102.5</td>
<td>105</td>
<td>105</td>
<td>105</td>
<td>105</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backwards throw of the shot [4kg]</td>
<td>19.60</td>
<td>20.30</td>
<td>20.76</td>
<td>21.74</td>
<td>21.31</td>
<td>20.60</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The constant improvement in performance with the competition implement and the special throwing implements, during the 4th mesocycle, was accompanied by an equally significant improvement when training with the STM-discus as well as an increase of maximal strength - cf. Figures 2 and 3 with the 8.5kg carriage there was an improvement of

Figure 2: Development of test performances (competition implement, snatch, STM 8.5kg and 10.5kg) in the course of the year
such clm

the release velocity from 9.5 to 10.0m/s (= 5.2%), and with the 10.5kg carriage there was an improvement from 8.8 to 9.4m/s (= 6.8%).

In spite of a three week interruption, Ilke Wyludda was able to increase her release velocity with the 8.5kg carriage to 10.1m/s during the 18th week. However, there was a significantly reduced performance with the 10.5kg carriage, because Ilke had not practised with this load for a period of six weeks (until the pre-competition phase).

Unfortunately, she could not repeat these excellent training performances at the Olympic Games (9th place with a performance of 62.16m). However, in the first post-Olympic Grand Prix meeting in Monaco on August 11, 1992, Ilke Wyludda confirmed her high level of performance again with a throw of 68.20m.

3.3 Load organisation during special strength and throwing training

Starting from a high level of basic strength (general and maximum), it was possible to increase her special throwing strength, in the course of the year, by means of strength machine exercises and other special strength exercises, together with the accentuated use of all types of throws. Confirmation of the effectiveness of the use of these exercises, integrated within the body of the main training programme, was provided by the methodical sequence of peak loads registered during special throwing training (cf. Figures 4 and 5), using sticks', heavy discs and competition implements and also during special strength training, which consisted of:

1) double-arm butterflies with 10 to 15kg barbell discs, single-arm flies with barbell discs, barbell turns into the power position as a first group,
2) training with the STM-discus, using sliding carriage weights of 8.5kg to 12.5kg and
3) reactive throws of a 2 to 3kg medicine ball from an inclined bench.

Figure 3: Performance development on the STM 10.5kg as well as in the special throws (competition implement, heavy competition implement, stick) from the 48th to the 15th week

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<table>
<thead>
<tr>
<th>Stick [m]</th>
<th>CI [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD [m]</td>
<td>STM [m]</td>
</tr>
<tr>
<td>47</td>
<td>54</td>
</tr>
<tr>
<td>48</td>
<td>53</td>
</tr>
<tr>
<td>49</td>
<td>52</td>
</tr>
<tr>
<td>50</td>
<td>51</td>
</tr>
<tr>
<td>51</td>
<td>50</td>
</tr>
</tbody>
</table>

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Competition implement (CI) - Heavy Discus (HD, 1.5kg discus) - Stick (2kg) + + + STM (10.5kg)
Table 2: Mesocyclic load volumes of the special training means during the Olympic year 1991/92

<table>
<thead>
<tr>
<th>Number / repetitions</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Pre-comp. prep.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competition implement</td>
<td>220</td>
<td>280</td>
<td>290</td>
<td>635</td>
<td>480</td>
<td>450</td>
<td></td>
</tr>
<tr>
<td>Heavier Cl (1.5 kg discus)</td>
<td>130</td>
<td>250</td>
<td>480</td>
<td>305</td>
<td>145</td>
<td>285</td>
<td></td>
</tr>
<tr>
<td>Stick [2 kg]</td>
<td>340</td>
<td>310</td>
<td>380</td>
<td>168</td>
<td>170</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Double arm shot throws</td>
<td>340</td>
<td>670</td>
<td>910</td>
<td>938</td>
<td>1110</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td>Sum of special throws</td>
<td>170</td>
<td>170</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STM 8.5 kg</td>
<td>135</td>
<td>43</td>
<td>271</td>
<td>180</td>
<td>30</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>STM 10.5 kg</td>
<td>377</td>
<td>397</td>
<td>669</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STM 11.5 kg</td>
<td>348</td>
<td>282</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STM 12.5 kg</td>
<td></td>
<td></td>
<td>252</td>
<td>600</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum of STM exercises</td>
<td>860</td>
<td>974</td>
<td>1540</td>
<td>380</td>
<td>30</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td>Other specific exercises</td>
<td>1190</td>
<td>1110</td>
<td>1140</td>
<td>1080</td>
<td>780</td>
<td>665</td>
<td></td>
</tr>
<tr>
<td>Sum of specific strength exercises</td>
<td>1190</td>
<td>1970</td>
<td>2114</td>
<td>2620</td>
<td>1160</td>
<td>685</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4: Realized load curves during special throwing training (competition implement, heavy competition implement, stick/shot) of I. Wyludda in the Olympic year 1991/92

1 From the 20th week (5th mesocycle), stick throws were replaced by double arm shot throws (2kg for the standing throw and 1.5kg for the complete movement).

2 As this special strength exercise was not recorded separately, it was allocated to the first group (other special exercises).
Figure 5: Realized load curves during special strength training (STM, other specific strength training exercises) of Ilke Wyludda in the Olympic year 1991/92

Estimation of the effectiveness of the special strength training machine might also be made from the progressive records of other means of training, such as throws, other special strength exercises, maximum strength etc.

So the other special strength exercises, which require a gradual increase of the training loads, together with the stick throws, were carried out even after the peak load had been reached (during the 45th week), in order both to re-stabilise the level of special strength and also to prepare, in good time, for the use of the STM-discus. Further peak loads (100% intensity) in the other special strength exercises were reached during the third week (together with the peak load in maximum strength development) and in the 27th week (pre-competition preparation) (cf. Figure 5).

The selective use of the STM-discus took place in the period from the 5th (after the peak load in maximum strength development) to the 14th week, with altogether 2819 repetitions, in spite of an interruption of two weeks, during the acclimatization camp during the 11th to 12th week.

After a learning and habituation phase during the 48th and 49th week, with carriage weights of 8.5 and 10.5kg, the weight was increased to 11.5kg, and after the 5th week it was again increased to 12.5kg. From the 10th week (i.e. immediately after having reached the peak load in special strength training) the 12.5kg carriage weight was removed from the programme and increasingly lighter weights were used. The 3754 trials with the STM-discus during the preparation period (see Table 2) were distributed as follows:

- 8.5kg = 629 reps (17%)
- 10.5kg = 1643 reps (44%)
- 11.5kg = 630 reps (17%)
- 12.5kg = 852 reps (23%).

\(^1\) From the 7th week additional measurement technology was used.
Figure 6: Mesocyclic load volumes of the special training means (like Wyluada 1991/92 – special throws, sum of STM, other specific strength exercises)

There were altogether 1482 repetitions (= 40%) with a sliding carriage of more than 10.5kg. This meant that there were too many exercises for the development of special maximum strength (600 of these trials were made during the 4th mesocycle, which was oriented mainly towards special strength development – cf. Table 2).

It can be assumed that the main reasons for the above-average increase in performance with the competition implement, even during the phase of special strength development (4th mesocycle), are as follows:

- The beneficial effect of the methodical concentration of the exercises with the STM-discus during the 4th mesocycle (1540 repetitions) and the later refinement of these exercises during the 5th mesocycle, together with the peak training volume with the 1.5kg discus (480 throws during the 4th mesocycle) and the cumulative effects of other main training forms. (cf. Figures 6 and 7).
- The cumulative training effect produced by other special strength exercises, which assure the athlete’s development (1.080 repetitions during the 4th mesocycle), by the stick throws, which help to maintain the level of performance (168 trials) and by the maximum strength exercises.

This was essentially a confirmation of the working hypothesis formulated at the start. However, it is worth considering whether a more strength-oriented type of training should be carried out during the competition period, using short microcycles.

As far as the organisation of the microcycles is concerned, it has proved effective to use the STM-discus as a transference phase from maximum strength to the special throws training. 50 repetitions per training session are very effective, with sets of 7 repetitions...
changing to sets of 5 repetitions from the 5th mesocycle on.

As far as her performance with the competition discus and the special throws is concerned, after having reached the peak load with the STM-discus, the resulting transformation times for Ilke Wyludda were:

- two weeks for the stick throws
- a minimum of three weeks for the competition discus and heavy discus (cf. Figure 7).

Further findings could be obtained concerning the performance decrement after a discontinuation of training with the STM-discus. The experiences of the training year 1991/92 have shown that an interruption of the exercises with the STM-discus for 2 to 3 weeks (after a previous emphasis on this training form) caused no reduction of performance in these exercises. In fact, after a three weeks acclimatization training camp from the 15th to the 17th week, there was actually an increase of the maximum velocity with the 8.5kg carriage to 10.1m/s. Contrary to this, the discontinuation of training with the STM-discus during the competition phases 4 led to an obvious decrease of the release velocities (with the 8.5kg carriage to 9.8m/s = -3%, with the 10.5kg carriage to 9.1m/s = -3.2%).

In order to avoid such a reduction of performance, training with the STM-discus should be continued until the competition period. The intensity of this training should at least guarantee the maintenance of the level achieved. This requires the use of a lighter carriage as well as a more pronounced consideration of the technical requirements.

4 Conclusions

- In general, it can be said that, in spite of the limitations imposed by the deviations from the competition technique, training with the STM-discus, in combination with other types of training, is an effective method for developing special strength in the discus throw and its use should be continued.

  4 The maintenance of the speed level of strength during a 6 week competition series still seems to be problematic (because of the time spent for travelling to the competitions and the resulting reduction of training).
The following facts endorse the use of the STM-discus in the training of top athletes:

a) From the point of view of mechanics and energetics, the kinetic energy output is much higher than with other special strength exercises and the power output of the parameter $F_{\text{max}}$ is also higher (except for stick throws).

b) From the point of view of load and training methods.

A high stimulus intensity and volume can be achieved, with short recovery times.

The training stimulus is intensified through the instant information provided by movement and performance parameters.

However, because of the sometimes considerable deviations from the competition technique, there is a need for the further optimization of the exercises, particularly with regard to

1) the low forward drive of the trunk and pelvis during the phase of the highest development of tension, in combination with a significant turning and swinging movement over the right leg, which is loaded for a longer time.

2) a more effective use of the bracing leg and the sequence of movements of the body segments (right knee, right hip, shoulder and throwing hand).

In addition, the combination of STM-discus training with other appropriate technique-oriented strength exercises (e.g. the cable pull machine) should be examined, in order to avoid a possible negative transfer effect to the structure of the event movements.

Because of the resulting decrease of efficiency, heavy carriage weights (12.5kg) should be used only to a limited extent, or not at all, during the phase of maximum strength training.

For the determination of the optimal load for training with the STM-discus, the parameter $E_{\text{kin}}$ should be used, besides the most important mechanical performance parameters $F_{\text{max}}$ and medium $F_a$. A load should never be used which is heavier than that leading to the maximum output of kinetic energy.

The number of exercises mainly developing special maximum strength was too high (altogether 1482 repetitions = 40% of the total repetitions when training with the STM-discus). In future, it is recommended to aim for equal proportions of the volumes of the different loads.

It is soon enough to start training with the STM-discus in the phase of maximum strength training. After a habituation phase, with a gradual increase of the carriage weights, the volume of exercises with the STM-discus should not be increased until achievement of the peak load during the phase of maximum strength training.

Thus, overstrain can be avoided. The phase of special strength training is especially appropriate for training with the STM-discus. Here the focus should be on optimal carriage weights. In order to maintain the level of performance, training with the STM-discus should be continued during the phase of special throws and up to the end of the series of preliminary competitions. A lighter carriage weight should now be used and greater attention paid to the technical requirements of the event.

Training with the STM-discus should also be carried out while preparing for the more important competitions, when the emphasis is placed on the technique of the event. Because approximately three weeks are needed to transfer the effects of STM-discus training to the discus throw itself, the peak volume of STM-discus training, during the pre-competition period, should be planned to occur 3 to 3.5 weeks prior to the competition highlight. However, it may be assumed that these transfer periods differ from athlete to athlete and should, therefore, be determined individually.

As far as the microcycles are concerned, it is recommended that STM-discus
training should be performed after maximum strength training and prior to special throwing training. In order to guarantee effective STM-discus training, the athlete should perform no less than 50 repetitions per training session (in series of 5 to 7 repetitions). As the athlete approaches the preliminary competitions, the weight of the carriage and the number of repetitions per set must be reduced.

Further prospects for the use of the STM-discus within the framework of long-term development.

The use of the STM-discus should be examined in terms of its value for increasing the intensity of special strength training for decathletes.

In accordance with the current knowledge and practical experience of training with the STM-discus, the following premises may be used as a basis:

• Although STM-discus training, as a highly effective link between maximum strength training and special throwing training, should be reserved for top athletes, the special training loads entailed should be planned for the later development periods, as the athlete enters the second stage of build-up training. This is in agreement with the main tasks of this phase, which are namely:
  - a methodical increase of the general and special load tolerance (especially in terms of a regular increase in the volume and intensity of special training);
  - specialization of training, approximation of the training exercises to the requirements of the competition technique, use of highly specialized training forms and means;
  - on a long-term basis: “an increasing orientation of strength training to the special movement performance while maintaining muscle flexibility, looseness and stretchability” (Schubert, B. et al. 1993).

Because of the currently available carriage weights of 8.5 to 14.5kg and the high specificity of this training means, STM-discus training should not be used before the age of 17 and not without careful consideration of the individual athlete’s level of performance.

• During the phase of build-up training, it is imperative to lay a foundation of general strength development, as a preparation for the special strength training exercises; an essential prerequisite for high-quality work with the STM-discus is the creation of muscular stability, especially in the area of the shoulders, hips and trunk.

• Strength training, especially during the build-up phase, should be regarded as “learning training”. Therefore, the size of the external resistances to be overcome should be less important than the technically correct execution of the exercises. Because of the guided movement of the carriage on a defined orbit, the learning of the technique of STM-discus training is relatively simple. It generally takes only two or three practice sessions for the athletes to train correctly with the machine.

• Once a release velocity of 10m/s has been reached, the weight should be increased by 1kg, in accordance with the principle of progressive resistance. However, in our experience, the basic weight of the carriage should not be increased until the second year of training with the STM-discus and then only slightly at the beginning. However, the use of a lighter carriage (5.2kg) makes it possible to lessen the resistance and to realize higher acceleration and velocity values.

• A training set should consist of no more than five repetitions and these should be reduced, as the athlete approaches the preliminary competitions. Finally, the athlete should perform single trials with optimal acceleration and maximum velocity, in order to facilitate neuromuscular adaptation.
As far as the periodisation of training with the STM-discus is concerned, the following principles should be followed:

- The STM-discus should first be used at the end of the phase of maximum strength training, so that the athlete is physically prepared to use this highly specific training means.
- After a volume-oriented phase (4 to 6 weeks), there follows a phase of intensive training. Now the weight of the carriage and the number of repetitions per week are reduced. Two sessions of training with the STM-discus per week, each with 30 repetitions, are recommended. In the peak load week, there should be a maximum of three training sessions, with 80 to 100 repetitions.
- If double periodization is used, which is typical of the second stage of the build-up phase, training with the STM-discus should be used only from the 44th week to the 7th week and from the 13th week to the beginning of the preliminary competitions.
- Training with the STM-discus should be supplemented by other special strength training exercises (barbell turns, flies, trunk turns) and attention should be paid to the maintenance of the requisite condition of the abdominal and back muscles. Training with the STM-discus should never be viewed in isolation but should always be combined with other forms of special throwing training, in order to ensure a close connection with the discus throwing action and thus achieve the necessary transfer effect.
- In our opinion a suitable addition to STM-discus is the cable pull apparatus, which is currently being tested. In this apparatus, the compulsory path of the sliding carriage has been replaced by the cable pull apparatus, so that the athlete can determine the movement path himself. This should provide a closer correspondence with the technique of the discus throw.

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