Some reflections on maximum speed sprinting technique
by Winfried Vonstein

"Sprinting should no longer be regarded as just a simple, natural activity. Full speed sprinting is a skill, which has to be learnt; it is, therefore, a technical event.

Analysis of the sprint action of some of the top international sprinters of today, compared to that of top German sprinters, shows that there are significant differences in technique. These differences are discussed in terms of dynamic posture and the muscles predominantly concerned with full speed sprinting. Conclusions are drawn in reference to appropriate training methods.

1 Introduction

In this presentation I would like to reflect on the technical aspects of full speed sprinting and their effect on training. The emphasised aspects of sprinting technique seem to have changed slightly over the last few years.

It has become evident to me that the act of sprinting, with its individual components, is a highly complicated technical movement. That technique is of very great importance has also been recognised by our sport scientists. For example, Hess, in his publication "Sprint, Lauf, Gehen", in which the techniques of top-class athletes are discussed, suggests that any analysis of the progress of sprint performances must recognize the relevance of the technique factor (Hess 1991, p.43).

The importance of the maximum speed phase in sprinting is evident when one considers that it occupies 65% of a 100 metres race, with 30% taken up by the acceleration phase and less than 1% by reaction time.

Attention must, therefore, be paid to the development of maximum speed ability. This is not only a problem of developing physical condition but also, and perhaps more importantly, of developing the "correct" sprint technique.

Sprinting is not so simple as in the German saying: "Sprinting is quite easy, it's just running straight ahead!"

2 The sprint technique

In traditional training theory, at least in Germany, the emphasis is on the driving phase of the legs behind the body's centre of mass: in this way, the body is pushed forward by an extension of the hip, knee and ankle joints. Speed would, therefore, be limited mainly by the strength of the extensor muscles, especially of the thighs (m. quadriceps femoris).

This traditional approach disregards the results of technique and functional-anatomical analyses, according to which the phase before the centre of mass (usually called the "braking phase") is
more important in realising maximal sprint speed than the phase behind the centre of mass.

The appearance of today's top-class sprinters at maximum speed reveals a typical technique which is slightly different from that accepted by traditional training theory.

After watching/analysing top-international sprinters for many years and comparing them with German sprinters (who are not amongst the best at the moment) I realised the following:

The differences are measurable and are most significant in the maximal (high speed) sprint phase. Differences in acceleration are much smaller. My opinion is supported by the latest publication by TIDOW/WIEMANN (1994, pp.14-21) in "Leistungssport" and other non-published findings.

According to this, a detailed analysis of the maximum sprint phase shows that the differences seem to be related to technique.

- The body position is almost upright; the athletes have the appearance of being "very tall".
- From a relatively high knee action there follows a very active striking/clawing movement of the foot onto the track.
- The knee extension seems to be slight. However, the ankle and especially the hip joints, are fully extended.

This technique is called "sprint lift" in English publications (e.g. Dick 1987). It is well illustrated by Carl Lewis, who did not run the fastest times in the maximal sprint phases purely by chance. Other sprinters, such as the Olympic, World and European Champion Linford Christie, the European Champions Geir Moen, Irina Privalova, as well as Florence Griffith-Joyner in 1988, are or were using this technique (Figure 1).

Recognizing this technique as the one to aim at, we must orientate training towards it - and, of course, this includes youth training. The following is a summary of the technical "key features" of the leg action at maximum sprinting speed. As the leg movement is the most important one, I will concentrate on it and omit auxiliary phases such as arm action etc. in this short presentation.

3 The supporting phase – essential component of sprinting

It is through ground reaction forces that an athlete is able to run/sprint. This implies that only when the foot is on the ground (in the supporting = braking/driving phase) can forces act and thus influence horizontal speed.

Therefore, we have to answer two questions:
1) What is the effective technique during the support phase?
2) How should the preceding swing phase be executed in order to have an optimal effect on the support phase?

First of all, negative forces must be small and positive forces large. The legs and feet are the important components that do the work between the body and the ground. From a subjective point of view, as the body is moving forward the ground moves backward.

This implies that negative forces can be small only if an athlete succeeds in synchronizing his

Figure 1: “New” technique in sprinting (TIDOW & WIEMANN 1994, p.16)
leg/foot speed and direction with the "ground speed".

Therefore, we must consider the movement of the foot and the sort of curve this movement produces. We see that an optimal foot movement has a curve like a "kidney bean" (see Figure 2).

This movement (foot curve and direction) is closely related to the body's posture, which depends on the position and stability of the pelvis. If the pelvis is tipped backwards it hinders maximum speed sprinting. This position of the pelvis has a great effect on the action of the leg and foot – see Figure 3.

The evident effect of the position of the pelvis on the foot movement curve is illustrated by the "shaded" pelvis.

This action can often be seen in younger athletes, who try to run faster by leaning forward. Unfortunately, they fail to do so, since this biomechanical modification merely causes an increase in negative forces.

The aim must be to achieve the "unshaded" foot movement curve and, as a result, the related position of the pelvis.

When coaching this action, the following points should be emphasised.

1) The athlete should be encouraged to acquire the correct conception of the movement.
2) The stability of the pelvis must be developed; i.e. the relevant muscles must be strengthened.
3) All runs/sprints, including those for of speed endurance, must be carried out with the correct technique.
4) Similarly, the correct technique must be emphasised while carrying out sprint ABCs or drills.

From the above it is clear that, in training, the athlete should concentrate on:

- running tall;
- keeping the pelvis upright;
- maintaining a good tension in the abdominal and dorsal muscles;
- moving from the hip and knee joint with an active striking/clawing action.

The coach should take note of:

- the position of the pelvis;
- the foot movement curve;
- the direction of the foot touch down;
- the athlete's "tallness".

4 Strength – a basic requirement

The force applied to the ground is equal and opposite to the force that propels the athlete forward, and the size of this force naturally depends on the available power of the athlete. Therefore, questions of strength training must be considered, such as which muscles must be strengthened, besides the abdominal and dorsal muscles already mentioned.

Figure 2: Foot movement curves in sprinting (JOCH 1992, p. 161)

Figure 3: Effect of the position of the pelvis on the foot movement curve (JOCH 1992, p. 162)
Horizontal speed in human locomotion is mainly produced by the following action of the support leg:
1) extension of the ankle-joint,
2) extension of the knee-joint, and
3) extension of the hip-joint.

Analysis of cinematographic diagrams of the support phase shows that the knee and ankle angles change only slightly - 165° to 150° to 162° and 130° to 100° to 135° respectively. The hip angle (the angle between upper body and thigh) changes from 148° to 203° (Figure 4).

Due to this fact, the knee extension must be of minor priority and is hardly of importance in producing speed in the specific maximum sprint movement (although it was taught for a long time and still is nowadays). In addition the ankle extension cannot be decisive for horizontal speed. Consequently, the extension of the hip (through about 50°) must be of the greatest importance.

In maximum speed sprinting the following muscles are responsible for hip extension: the gluteal muscles (m. gluteus maximus), the adductor muscles (m. adductor magnus), the hamstrings (m. biceps femoris, m. caput longum, m. semitendinosus, m. semimembranosus). Although the gluteal muscles are very strong hip extensors, their influence on horizontal speed is only a minor one: At the moment of touch-down in sprinting, the hip-angle is already so obtuse that the gluteal muscles cannot contribute much more to the development of horizontal speed.

Thus the primary hip extensors in that specific movement are the hamstrings!

This can be illustrated by a diagram of the electrical activities (EMG) of some muscles in different movements (Figure 5). This diagram supports the contention that the hamstrings are the main extensor of the hip and, as such, are the primary muscles responsible for producing maximum horizontal speed in sprinting. Also, the pulling action in maximum speed sprint training is preferred to the pushing action.

5 Conclusion

In this presentation I have endeavoured to draw attention to the fact that technique in sprinting is as important as it is in the so-called technical events.

Because of this, the correct sprint technique should be developed very carefully in youth training.

Training forms, drills, and sprint ABC-exercises used should possess the important elements of the optimal sprint technique and thus assist in developing it.

Strengthening of the hamstrings should be given adequate attention.

The achievement of a technically correct sprinting technique must be one of the main aims of sprint training and cannot begin too early in youth training.

REFERENCES

DICK, F. (1987):
Sprints and Relays. London

HENSEL, F. (1990):

Sprint, Lauf, Gehen. Berlin

JOCH, VJ. (Hrsg.) (1992):
Rahmentrainingsplan für das Aufbautraining – Sprint. Aachen

Der Sprint. In: Magglingen (Journal of Eidgenössische Turn- und Sportschule)

Figure 4: Cinematographic diagram of a single sprint stride (Wiemann 1986, p. 27)
Figure 5: EMG of the support phase in (a) walking, (b) sprinting, and (c) jumping  
(WIEMANN 1986, p. 30)
(tib = m. tibialis anterior; tri = m. gastrocnemius; bic = hamstrings; vas = m. vastus medialis)


WASER, J. (1985):  
Zum Techniktraining beim Laufen. In: Leistungssport 1, pp. 34-38

WIEMANN, K. (1986):  
Die Muskelaktivität beim Laufen. In: Leistungssport 4, pp. 27-31

Die ischiocruralen Muskeln beim Sprint. In: Die Lehre der Leichtathletik No. 27 and 28, pp. 783-786 and 816-818

WIEMANN, K. (1990):  

Präzisierung des Lombardschen Paradoxons in der Funktion der ischio-cruralen Muskeln beim Sprint. In Sportwissenschaft 4, pp. 413-428