Here are some pages from the book Strength Speed (Jan Melén), most of which dealing with sprinter technology and how it can be trained with the Powersprint. However one chapter is also about the advanced long jump technique. It describes among other things the technology, characteristic for the sprinter speed long jumper Carl Lewis.

To understand the book’s complexity, despite the moderate number of 88 pages a list of the contents also have been included here. The long background behind the book you also could take part of in the foreword at p.7

The first part of the book is about scientific mechanical and physical basics. Key to later understandings of the Technology and Training. In addition, there is a chapter with an exercise storage for both general and specific strength training. One page describes a sprinter training program, with a training model from Tom Tellez, Houston, USA -99. Each page is illustrated with simple educational drawings by the author, as you see in the Pdf-file

Note! From the chapter about sprint technique in the book, here is some pages with colour. The Paper book is in only black-and-white print but with practical spiralbindung. The last pages with large drawings is shown just here (Note! Not in the book!) a certain time.

The book have also complete examples of sprint programs with modern periodizing.

Some times some pages are shown here. But by the reason of the big complexity the content should foremost be studied in the printed text book, which with warm is recommended

Powersprint machine. Price, eventually Offer, contact: Jan Melen
jan@powersprint.space2u.com
Strength  Speed

Technology and training for sprinter speed and long jump. A new type of specific strength training for speed called Powersprint is presented. Muscle strength - Scientific basic.

Jan Melén
Drawings and photos
Author

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CONTANT

Foreword 7

1. SPEED - Important factor behind many sports performances 8

2. VARIOUS TYPES OF SPEED 9
   2.1 Elementary speed 9
   2.2 Komplex speed 10

3. SPEED - MUSCLE STRENGTH 11
   3.1 Muscle strength, biological bases 11
     Musculature
     Muscle structure 11
     Muscle elastic properties 12
     Muscle fiber types 13
     Nerve - muscle systems 14
     Motor unit 14
     Muscle sensory organs 14
     Control of muscle, strength model. Stretch Reflex. 15
     The regulation of muscle force (Nerve-muscle coordination) 16
     Variation of pulse frequency 16
     Variation of the number of motor units 16
     Coordination of motor units 16
     Other properties due to muscle structure 17
     Muscle Power -speed connection 17
     Muscle Power - Muscle length 17
     Muscle energy metabolism 18
   3.2 Muscle strength, mechanical grounds 19
     What is muscular strength? Definition 19
     Muscle Force / Capacity 19
     The relationship between body weight and relative strength 20
     Internal and external moments 21
     The importance of the internal torque. 21
     The importance of the external element 21
     Different types of lever arms 22
     Specific strength (motion angles, speed, technology). Powersprint® 20
   3.3 Strength, different concepts 24
     Different ways for the muscle to work and types of contractions 24
     Types of strength - various definitions 24
     Summary of strength forms and components of strength development for speed 25
   3.4 Strength training for speed 26
     General. What happens to the body at strength training 26
     General principles of training planning 26
     The load and recovery. Pulsation 26
     Planning of training periods 28
     Examples of planning periods, the main content. 28
     Examples of periodization 29
     Planning Periods for elite 29
     Maximum Strength 30
     Muscle hypertrofy, period I 30
     Nerve-muscle coordination, period II 31
     Speed Strength 32
     Competition / match preparation, period III 32
     Reactive strength 33
     Strength Exercises 34
     Summary table: Muscles - exercises 42
     Strength training programs for speed 43
4. SPEED, SPRINT RUNNING

4.1 Technology Model, 100m sprint.

Acceleration
- The start - Acceleration Phase
- Acceleration Phase 43 - max speed
- The right feeling of sprinting

Maximum velocity
- Feeling for the maximum velocity

The start.

Significance of arm action. The concept of Impulse

What muscles are involved and how they work in the 100m-race?
- I. Starting phase + accelerating
- II. Acceleration phase, gradually raised position
- III. Max. phase.

The rod as technique model for sprint and jump

Body posture of the maximum speed. The Pelvis. Sprint models.

Biomechanical studies of sprint technique
- Maximum velocity, comparative biomechanical analysis of world-record holder,
- international average level and U.S. College Sprinter.
- Max speed, biomechanical force for a world class sprinter
- Film Analysis of 100m races at the Tokyo World Championships -91
- E.D. Lemain & D.G.E. Robertsson
- A.O. Korneljuk, National Coach U.S.S.R-81
- Ralph Mann and Paul Sprague
- G. Tidow and K. Wiemann
- German EMG analysis of sprint running

Wheel model of sprinter running

Vector Force Analysis

Important conclusions by biomechanical research of sprinter running. Trainings forms

4.2 POWERSPRINT®, Tactics example for 100m. Sprint models. Pelvis posture. Specific strength training for sprint and jumping.

Powersprint exercises

4.3 Training programs for sprinter running

Training planning
- Forms of running training
- Sprinter training, program. Training model Houston, USA

4.4 Program for sprinter running, with powersprint strength training

5. SPEED, LONG JUMP

5.1 High longjump
- Bob Beamon 1968 8.90m
- High long jump, approach.
- High long jump, last step and take off
- High long jump, special variant
- High long jump, take off. Analysis
- High long jump, discussion

5.2 Sprint long jump
- Carl Lewis
- Sprint longjump, mechanics, muscle work.
- Sprinterlångdhopp, nybörjare och medelgoda hoppare (6.50-7.20)
- Biomechanical study of the long jump 2007

5.3 Program for sprint and long jump, with Powersprint strength training.

5.4 Summary and manual

5.5 New swedish EMG analysis of sprint compared with Powersprint

Reference literature

Appendix 3 and 4 Training Plans for sprint / long jump (Program, section 5.3). page 76
Appendix 5 - 9. Exercises with the new Powersprint machine.
Foreword

Over the years, many articles have been written about new research findings about strength and speed. Among the coaches, it has existed great frustration to study all this scattered knowledge. In order to support their training. “Track and field general training learn” by Rosenberg have gratefully been received by a broad readership, which also is represented by other sports. 1985 was “Strength of the sport” published with very illustrative example by Alf Thorstenson and Bengt Saltin. In recent years, the dossier produced in book form by writers like Jonny Nilsson / Jan Seger, Janne Carlstedt, Per Tesch, Hatfield United States, Germany Grosse and others. Articles in Leichtathletik, 90-99 years, then was valuable sources. During the 2000s, then, in addition to the internets amount of information, writers like Frank Bosch, Tudor Bompa and Nick Newmann added essential “pieces”. In addition, all the advices I have been privileged to receive by both Swedish and international coaches, got me to finally complete this work.

Year 2010 the book has been complemented with a chapter about longjump technique and with a special training program for powersprint. The periodizing in this program has been updated in 2012 with great inspiration from Nick Newman’s book “The Horizontal jumps”.

This and later provided Tudor Bompas new edition of Periodization Training for sports and mainly Håkan Andersson uniquely well-planned workout template as valuable data for now new training plans for Sprint and Long Jump. It is with gratitude I think back of the support and help with the theoretical by Hakan over the years. I am also very grateful for interesting dialogue with Magnus Warfvinge, Varberg GIF from 2013, which has contributed to my ideas to document the modern Sprint training and technology and how to use Power Sprint, as technology developing strength training.

Jan Melén - October 2016

Introduction

This compilation of facts in the book’s introductory section is intended as a contribution to knowledge of the concept of strength and speed. Chapter 1-3 (page 8-43) then deals with speed from a general perspective-tive, with different strengths concepts, training principles, planning and exercise storage, which can also be read separately. Then the book covers mainly the technology of sprint and training (Chapter 4, pages 44-67) but also the long jump (Chapter 5, 68-78), as examples of an athletics branch with large elements of both strength and speed.

Henrik Olausson has with great interest and perhaps not so little patience, helped me to describe Tom Tellez technique model (page 44-48) and training program (page 61-64). At a visit in Houston -99 talks offered with Tom Tellez, and the opportunity to film a world elite sprinter, Mike Marsh. This resulted in significant contributions to the essence of how the sprinter speed can be developed.

Following summary of sprint technique (pages 49-59) with the help of several biomechanical studies is an attempt to document the ideal technology model, which eventually leads to the recommendation of a new development of strength training for speed using a so-called Power Sprint® Machine. The machine as a first simple prototype has been tested by Hakan Andersson on 1990 - century Swedish best sprinters Peter Karlsson and Torbjorn Eriksson before, they at Indoor European Championship 1996, both won a bronze medal each on 60m resp. 200m. Hakan still use this machine, mainly for the development of the basic muscle strength of the glutes and hamstrings, hip-extending function in the sprinter step. In recent years, Hakan has coached Stefan Tärnhuvud, best Swedish 100m sprinter from 2008 to 2012, and together with him, 100m champion in 2013-15, Tom Kling-Baptiste.

- **Gluteus maximus** (6)
- **Gluteus medius** (6a)
- **Hamstring** (4)
- **Adductor magnus** (5)
- **Quadriceps** (3)
- **Tensor fasciae latae** (7a) (fig 77)14
- **Gastrocnemius** (1a)
- **Soleus** (1b)

The leg seems, mainly with help of hamstring, as a driving elastic (“rigid”) rod where the quadriceps, glutes and calf muscles in the front support phase has a dampening effect on the high vertical reactive force at touchdown. More detailed description see pages 45, 47, 50, 54, 58-59.

16b. **Powersprint®** (Author). Exercise for sprint model PPT-APT mode “Short alt. long rotation in the hip.” Also particularly suitable exercise for quadriceps dominant sprint model with very isometric muscle work performed by hamstring. (See also the technology description on page 45, 47, 50, 54, 58 and 59)

- **Erector spinae** (10)
- **Psoas major** (19a)
- **Iliacus** (19b)
- **Iliopsoas** (19)

Erector spinae and the strong iliopsoas of the free swing leg with their branches (19a, b) in front of the hip joint is tilting Pelvis, as an additional lever forward toward ATP-mode (page 50), in interaction with that the femur is rotated backwards.

17a. **Powersprint®, general total basic exercise**

Basic training for primarily important höftsträckare gluteus and hamstring. The exercise corresponds Roman Deadlift (RDL), but this can be performed with high security and also with extension of the ankle.

- **Gluteus maximus** (6)
- **Gluteus medius** (6a)
- **Adductor magnus** (5)
- **Hamstring** (4)
- **Gastrocnemius** (1a)
- **Soleus** (1b)

Note Important to keep your back straight (easy ATP position) in the entire movement. The eccentric movement can be performed as an isolated exercise to prevention and as rehab training after injury.

17b. **Powersprint®, “Plyometric” RDL-exercise**

With ballistic eccentric performance it will develop perfect strength in the posterior chain. Possibly preventing the hamstrings injury (Author)
As an example of maximum speed performance in sport, we will now process sprinter running. We begin by highlighting sprint technique, with a technique model\(^1\) for the track and field’s classic 100m sprint.

Today’s top sprinter, among others characterized by a long acceleration distance of the 100m race, the whole 60m before the maximum speed is reached.

**The start and Acceleration I**

From the start block the pushing force is directed from the foot through leg, hip and the body’s center of gravity in a straight line with slope of about 35-45° inclination against the track. Start angle must individually be selected depending on the sprinter stage of development. (Fig. 96a, b). Sprinter puts in the foot with “stiff”, usually about 90 ° angled ankle-joint,\(^*\) behind the center of gravity. The push off from the starting block and in the first two steps is usually done with full stretching of the knee joint. The stretching of the ankle, knee and hip, then takes place in the beginning of the race, which we here call Acceleration I, with a gradual steepening inclination of lower leg until the angle to the track is 90 °.

During acceleration I the running occurs, with concentration of both the large range of motion in the hip joint (\((\text{See also pages 46-49 and 58})\) as high step frequency.\(^2\) This seems to characterize today’s elite sprinters at the expense of push offs knee extension, usually over the course becomes something incomplete (Fig 97-100).\(^3\) The running becomes more “fluid”, which also characterizes good technique. The work is done with higher power output, ie large force during the short contact time. It utilizes a better SSC (stretch shortening cycle) (stretch reflex, elastic energy, see page 15) from the hip extensors - mainly hamstring for the production of larger horizontal force.

Favorable may also was an earlier forward swing of free leg.\(^4\)

---

\(^1\) Many details of this technology model is according to Tom Tellez (coach of C. Lewis, L. Burrell),

\(^2\) Acc. John Smith, UCLA, Los Angelos-89 (a talk with the author)

\(^3\) Ralph Mann -85. (See page47)

\(^4\) Mike Marsh, the Olympic gold medalist in the 200m -92 (only one hundredth of the world record in the semifinals).

\(^5\) EMG values have also shown very low - perhaps negligible - from the push off force just before the foot leaves the track.
Acceleration II to maximum speed
After acceleration I, the distance of 15-25m, depending on the speed level, posture become more up-right. (See fig.99 and page 58). From this position, we talk about acceleration II. The touchdown now usually occurs slightly in front of the body’s center of gravity (fig.99a). The heel is then pressed downwards and for a “milli-second” it’s easy touching the track (fig.99b). In fig.100, Mike Marsh is analyzed with so-called stick figures. Among others here is a enlarged detail of the ankle at touchdown (a) and at the heel contact (b).

Fig. 99 Mike M., is accelerating, at training in Houston in February -99

Both - c: Reflexively knee is flexed further under uplifting of the heel. Here possibly hamstrings, biceps femoris “actively” can contribute with force. Gluteus take part in hip extension powerful but seems at the front phase together with the quadriceps mainly elastically damping of the high vertical reactive force.

2.1.6 Tailor’s movement

Note: The last ground contact in the position (f) with clearly incomplete extension of the knee and hip (see also biomechanical analysis of the sprinters, p. 51). All sprint models can be excellent trained specifically with Powersprint. Important! Movement = The rotation in the hip joint must be clearly accelerated.

1) Tom Tellez model (Houston -99). It should, however, be the personal feeling and experience which is crucial (Author).
2) (Tom Tellez -99)
3) This is a very important technology details. “The pelvic side is moving in an oval-shaped moving, and the hip is pressed far forward”. (John Smith told the author at a visit, UCLA-89. Medical parlance: = Pelvis Pelvis, will continue to be used.
4) Note! The circled. The short ground contact and subsequent uplift of the foot (b - c) takes place so fast that a normal video recording rarely can show this. The common perception is that the foot contact is always on toe without the heel contact.
Fig. 101 The feet edge insertion. Prestressed of ankle (“elastic steel shank”). Extension with “catapult effect”

Fig. 102 The direction of the take off’s force

Fig. 103 Biomechanical analysis of the ground phase in the sprint stride (also page 51) shows motion technique, and vertical and horizontal “reaction force” from the track during ground contact, the so-called ground phase. During the front of ground phase, before the vertical line of center of gravity is crossed, there is a braking. Therefore, we are talking about a braking phase during which, among other things, the elastic energy is loaded (“steel stick - bent and stretched” when the muscle is stretched (stretched). The latter results in the stretch reflex, which together with the elastic energy is starting the push off action. During the rear ground phase the take off is accelerating and as long as the horizontal acceleration energy is greater than the braking force the acceleration takes place.

The initial contact with the runway makes the edge of the ball of the foot (Fig. 101C), then during “a micro second” the heel (Fig.99-101). Elastic energy, stretch reflex and muscle power then extends the ankle, which helps boost the power. This power is also affected by will, with the exception of the ankle’s extension. Foot arch - lower leg (Fig.101, a-c) can be likened to a biased elastic steel strip, which at the touchdown is bent and clamped together followed of a “catapult” effect.

The right feeling in sprinting
- The take off from starting block occurs with perfect extensions directed through the trunk (Fig. 102 a and b). Already in the early stages of the race most of the sprinters characterized with a more imperfect extension in the knee joint, providing a more propulsive force. The inclination of trunk becomes progressively more upright (Fig. 102c). The final push off occurs with an inward rotation of the leg in the hip. After the foot’s edge-insertion and heel contact, the leg is pushed backwards and inward rotated over the big toe.

- The touchdown is done with a feeling of “wait for” the ground pliable as frequency and speed increas. Important the sprinter does not force a stamping action from a high position into the ground. At low altitude (Fig. 101C) the explosive take off process is starting with muscle prestressed to add the elastic energy (“steel shank catapult” is loaded). The foot then is rotated downward-outward which creates edge insertion. The challenge is to find the right location at touchdown ie. just right high center of gravity in which the foot hits the track gradually longer in front of CG. During the continued acceleration of the race (Acceleration II) and at maximum speed, front foot optimal landing whereby the highest power could be developed during the SSC (stretch shortenings cycle) (p. 15)

- Quadriceps is absorbing the shock at touch-down and possibly extends the knee and hip with help of the hamstrings antagonistic function. Individually, the rotation of the hip joint of the leg during the stance phase also take place with muscle force from hamstring. This will be described more in detail later for example (p. 54, 58-59). The whole pendulum phase, also called recovery phase, with heel kick, knee lift and forward swing occurs, however unconsciously, as a result of total relaxation in the knee, largely with help of mechanical elastic energy.

Acceleration I, II and Maxfas.
- Technology and muscular demands. See Figure 103. During acceleration the run takes place “driving” in a slightly deeper center of gravity with the torso leaning forward and with the knee joint in the front support phase naturally more flexed. At this stage during the initial stages it is great demands on muscle power from the quadriceps and gluteus. (See also page 54). Gradually, the angle of the knee joint will be greater concurrent with the stature of the torso.

- In the acceleration II and maxfas force from Quadriceps must provide enough elastic “stiffness” in the knee joint, and to withstand the increased vertical reaction force ** (see Figure 103 and the data on page 51), and also to use the leg, as a long stable torque arm, rotating in the hip joint with power from hip extensors - mainly hamstring. the “Catapult” of the Ankle must be ended with Pelvis in the forward tilted position (ATP) ** - individually short or far behind the hip. (Pelvis function. See pages 50, 58-59).

---

1) Stick figure caution
2) Processed from Ralph Mann Leichtathletic train. 12/99, 24 and Schöllhorn -98, 45.

** At the back tilted Pelvis (PPT) any backward movement of the femur is restricted..
Maximum speed

Figure 104 and 105 shows a sprint stride in maximum speed. Already after acceleration I (“Drive Phase”, international designation) is the posture usually in the nearest or close fully upright. During acceleration II until the maximum speed is reached at 50-70m (elite) can still too many sprinters in the world elite of the videos see the hint of a slight, but still somewhat further upraised posture. The picture shows Henrik Olausson (pers.rec. 10.43) such a typical posture. A top sprinter can today with relaxed coordination and an extreme endurance implement the entire 100m race with minimal speed reduction. See more details at page 58.

The challenge is to complete the 100m race at top speed with the concentration of detente. The muscle energy is discharged (page 18) but good speed endurance coupled with mental concentration makes it possible to maintain the speed. The sprinter must concentrate on a long acceleration distance. Often starting speed over-emphasized at the expense of the very long acceleration.

That during the first third part of the 100m race achieve high step frequency, the second third part obtain maximum speed and during the last third maintain momentum with speed endurance might be a good tactic. ¹

Focus 1: High step frequency and “float” with the help of large horizontal “driving force” from the beginning.
Focus 2: Accelerate to maximum speed, while maintaining high frequency, but with a powerful shoulder and hip work² (See Figure 105 with text.) produce drive force in harmony with a “big wheel” - that is, long levers - Pelvis + the whole the rotating leg in the hip joint (More about this on page 59)
Focus 3: When the maximum speed is reached, try to maintain it, without too large speed reduction, with fast endurance ability. During this final phase of the race, may relaxation also be extremely crucial. Among other things, to exploit the elastic energy and the stretch reflex (SSC, see page 15)

1) John Smith, interview (Author-89). Without losing focus on a job well done hip work with the large range of motion ("Ovals", (Author))
2) According to John Smith. important technique detail (Author-89)
3) Magnus Warfvinge 151212 (Described for the author, which enthusiastically confirmed iaktagelsen. Common conclusion: “A neglected technical detail.”)

Note again! The circled. The short ground contact and subsequent uplift of the foot (b - c) takes place so fast that a normal video recording rarely can show this. The common perception is that the foot

Fig. 104 Film sequence on Henrik Olausson during maximum speed sprint
Note: Location (a) is just before touchdown (Fig. 105(a) below)
The rod as a lever and technology model in jumping and running

In some positions in ground phase of the sprinter’s stride and the take off in longjump the legs and the body together is like a springy rod (fig. 114). The rod is a lever with its support point of the ankle. The force from the ground through the rod during the rotation forward-upwards, gives both a braking and by means of elastic energy, an accelerating force. Upper parts of the rod have higher operating speed (V1) than the lower (V2) at the same rotational speed (so called angle speed). This would mean benefits with a high center of gravity position to make better use of the pole of rotation. The figure also shows the vertical and horizontal reaction force from the ground. The sprinter / Jumper creates among other things, increase in the external lever (see page 22) and higher CG position by that left shoulder is lifted higher when the right foot is landing in the ground and the opposite relationship right shoulder and left foot (see also fig.100, p. 45). Furthermore the pelvic posture is important for the same reason. This especially true for sprinter model B (see below) with typically tall posture which creates long levers.

Previously, the view was that it should creates a body posture in neutral position (Figure 112a). Only with slightly forward tilted Pelvis (“APT” (Anterior Pelvic Tilt)). This couldn’t be the whole truth given the presence of world elite sprinters with significantly APT mode. With respect to Pelvis stance and the push-off leg motion during we can distinguish these two sprint models:*:

A. APT mode. “Long rotation in the hip joint”, *(mostly incomplete knee extension).* (fig 112b, detailed description p 58)

Advantages:
1. Long distance between muscle attachments of the hamstring gives the possibility to high horizontal force in the ground phase.
2. Contributes to a more “floating” running - an important basic principle for all sprinting.
3. Ability to extreme improvement of hamstrings horizontally force production.

Disadvantage: Requires, which many lack, extra specific strength in the hip extenders, with a very well developed posterior chain. May be possible by training specific technically with Powersprint®

B. PPT-APT-mode. “Short-long rotation in the hip joint,”

Hamstring (Tidoff, Wiemann) alt.

\textit{Quadriceps- dominance. Hamstring, isometric antagonistic. Pelvis first backward-tilted, PPT-mode (Posterior Pelvic Tilt) (Fig.112c)} Then individually to APT mode. Description p. 59).

Advantage:
1. Tall posture with long levers is created (see above)
2. Energy saving way to develop great horizontal force, both during acceleration and maximum speed, as in final phase of the race.

---

**Fig 111** At the touchdown in fast running and jumping, leg and torso together can be like a springy rod

**Fig 112a** Previously, the advise mostly has been an attitude for a neutral stance with slightly forward tilted pelvis.

**Fig 112b** Sprint Model: APT mode, “long rotation in the hip joint”

**Fig 112c** Sprint Model: PPT-APT mode. Here “short rotation in the hip joint” (Long rotation, see p. 47 and 59)
Biomechanical studies of sprinter technology

Extensive research has been conducted in the United States to determine biomechanical differences between performance level equivalent:
1. World record sprinters (Green, Lewis, Burrell and others (9.8s / 100m),
2. Average international elite (10.3)
3. American College printers

We shall now briefly summarize what is characteristic for max speed running of these groups.

In Figure 116a-k, we can study:

- Velocity (fig. a)
- Stride length (fig. b)
- Stride rate (fig. c)
- Ground contact and recovery phase time (fig. d)
- Touchdown distance in front of the body (fig. e)
- Hip and ankle angle (fig. f)
- Knee angle (fig. g)
- Knee lift, angle thigh-back (fig. h)
- Rotational speed (thigh) (fig. i)
- Rotational speed (lower leg) (fig. j)
- Foot horizontal velocity (fig. k)

Max speed, biomechanical force for a world class sprinter

Fig 117 shows the vertical and horizontal so-called reaction force from the track for a world class sprinter. The contact time in the ground phase is only approx. 83ms and the vertical force as high as 450kp (= 4500N) in the tought down. There is a brief “power spike”, which shortly subsides followed by an increasing force to approx. 350kp. The forces are measured with the pressure plate.

Fig. 117 2) Max speed, vertical and horizontal reaction force from the runway.

The forces are measured with the pressure plate and This applies the world class sprinters with a contact time of only ca.83ms

---

1) Processed from Leichtathletic training 12/99-24, Fig 120j och k (Exercise and Sport, 84)
2) Drawings (Author.). Diagrammet processed from Ralph Mann, -Leichtathl. train. 12/99, 24
Sprinter technique is explained in a simple way of German bio-mechanics, mainly thanks to a new anatomical approach. It has been demonstrated that the posterior thigh muscles *hamstring (ha)* and *adduktor magnus (am)*, in a natural motion works as hip extensors and that these muscles in the take-off at the upright running position also could extend the knee joint. A comparative study (see page 55) between sports students without specific training and elite sprinters showed that, among other things.

Fig 117 shows a model of *gluteus maximus (gm)* and the posterior leg muscles hip extension function. You can metaphorically think of muscles as “reins”. If these be abbreviated, the leg is brought backwards and its rotational speed at touchdown increases (see page 53). This reduces the horizontal deceleration at the front ground phase (see detailed analysis, sid. 57). The movement is accelerating during the trailing phase and hamstrings is continuing its work with the help of stored elastic energy all the way up to ‘heel kick” after the take-off. When the foot lands in path *am* is disconnected while *gm* together with the front thigh muscles and ankle extensors are cushioning the impact and prevents excessive sinkage (ie. maintains “fluency”, author).

Recessed figure (Author.2): What an amazing design. Small leverage gives with short muscle contraction a relative large movement when the leg is rotated backwards. Large force is possibly produced because hamstrings also pennate design (biceps femoris and semimembranosis, unipennated).

Figure 118 provides a further description of muscle function. Here you can clearly see how *ha* and *am* are shortening (please measure by yourself with a ruler, author.) While the model shows the muscles that dominate the work. (Darker = more toned dominance). At the end of the stance phase (see also page 57) *am* is connected and help *ha* to extend in both hip- and knee joint. The front thigh muscles (*rf* and *vm*) take part only slightly, which overturns all previous ideas of an accentuated role of these muscles, as extensors in the upright sprint position (except first accelerating section of the 100m race (see page 51).

Fig 118 The figure schematically show the stance phase at maximum speed sprinter model Long “rotation in the hip joint” + “Push”. Pelvis tilted forward, the APT position (see page 50). The principle of the hamstrings and adductor magnus. The more gray muscles, the more it is activated. For example:
1. Hamstring with darker tone is active during touch down and the whole stance phase. Its muscular attachments approaching each other ie. muskeln shortened throughout stance phase. If you look at it as a simple mechanical machine it will feature:
   The whole leg, which forms a lever with hip as rotation axis, is and rotated (screwed) backwards by the muscle power.

2. Gluteus and quadriceps is active in beginning and adductor magnus in the late stance phase.

1) Processed from Die Lehre der Leichtathletik., -94, 8
2) modif. Wieman. Die Lehre der Leichtathletic, -89, 27
Wheel model for sprinter running

The wheel can be used as a model for the sprint race. With our previous sense of elastic rods that rotates in the hip and ankle made of elastically “feather steel” should we construct our model as Figure 121 shows. Higher situated wheel axle (h2) is equivalent to a higher center of gravity mode and multi-spokes higher step frequency (Fig 121b). The pendulum rhythm in sprinter running, with a rapid and accelerating touch down and ground phase followed by a calmly gathering pendulum phase *) (see p. 51, fig 113D) correspond to a gear wheel, som step by step cogs around. **) The figure 123a below shows occurrence of the brake force and fig 123b the importance of the pendulum leg impulse (Fp) and foot’s force (Ft) in the “touch down”. In fig.123c the braking force have been created by the weight resistance at specific training of strength for sprinter running. Figure 122a-d shows examples of such a strength training. The biomechanical researches about sprinter running from different countries like USA, UK, Russia, Canada and Germany, which we have treated here, have been consistent conclusions that:

- **Hip extensors and flexors are most important for the development of high speed running.**
- You should find specific training techniques to train the strength particularly in the posterior thigh muscle group (see example fig.122a-d and p.57-60)

**) Called. “Recovery phase”**: **bicycling movements”, “Naturally strike the ground”, “Wait for the ground”, “relax your shoulders and kneejoints” excellent teaching tips by Tom Tellez about the perfect pendulum rhythm acc. our

**Important conclusions by biomechanical research of sprinter running. Trainings forms**

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<tr>
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<td>Uphill slope</td>
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- $v_1$ = Rörelsekomposant

$F_y = F_{ty} + F_{py}$

$P_1 = P + P_1$

The horizontal braking force ($F_H$) has been replaced by a weight resistance ($F_{br}$) eg barbell weight in powersprint machine. Now the force torque from the leg’s rotation in the hip must be greater than the weight’s braking torque to create a running movement. With optimal load (maximum and rapid weight training, see page. 30-32, and 57) in a power sprint machine (Fig. 126-128) can mimic a sprint stride and effectively train the hip extensors specifically.

The wheel can be used as a model for the sprint race. With our previous sense of elastic rods that rotates in the hip and ankle made of elastically “feather steel” should we construct our model as Figure 121 shows. Higher situated wheel axle (h2) is equivalent to a higher center of gravity mode and multi-spokes higher step frequency (Fig 121b). The pendulum rhythm in sprinter running, with a rapid and accelerating touch down and ground phase followed by a calmly gathering pendulum phase *) (see p. 51, fig 113D) correspond to a gear wheel, som step by step cogs around. **) The figure 123a below shows occurrence of the brake force and fig 123b the importance of the pendulum leg impulse (Fp) and foot’s force (Ft) in the “touch down”. In fig.123c the braking force have been created by the weight resistance at specific training of strength for sprinter running. Figure 122a-d shows examples of such a strength training. The biomechanical researches about sprinter running from different countries like USA, UK, Russia, Canada and Germany, which we have treated here, have been consistent conclusions that:

- **Hip extensors and flexors are most important for the development of high speed running.**
- You should find specific training techniques to train the strength particularly in the posterior thigh muscle group (see example fig.122a-d and p.57-60)

**) Called. “Recovery phase”**: **bicycling movements”, “Naturally strike the ground”, “Wait for the ground”, “relax your shoulders and kneejoints” excellent teaching tips by Tom Tellez about the perfect pendulum rhythm acc. our

**Important conclusions by biomechanical research of sprinter running. Trainings forms**

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4.2 Tactics example for 100m. Sprint models. Pelvis posture. Powersprint®, specific strength training for sprint and jumping.

**Acceleration I**

Fig. 126 shows training of the acceleration phase in the deep position during the first two strides. The foot is inserted just behind the center of gravity with trunk in 35-45° inclination. Typically the foot hits the track easily turned outwards, with so-called “Skating” (see color image), the foot sole first meets the track with the inner edge (Note the gradual foot insertion to the outer edge toward the midline). The push-off occurs first with the leg, after the foot edge insertion and heel contact, is inward rotated over big toe possibly help of the adductor magnus. Pelvis tilts backwards explosively to PPT position (see page 50). Muscle work is switched to the quadriceps, which ending the push off with hamstring as antagonist (acc. Wiemann works hamstring here isometrically. (Page 49). In this very short and rapid steps (a-b) the stretch-shortening phase function works (see page function 15) in which the elastic energy together with stretch reflex and muscle-specific force brings about the “start force” in the push off. During acceleration I (15-25m), the following running strides occur with the foot insertions gradually closer to the lower body center of gravity (Fig. 127). The following occurs from the second step gradually:

1. Opening the angles in the knee, hip and ankle joints.
2. Lower leg angles to the track are moving towards 90°, i.e., vertical position.
3. The upper body is lifted to a raised position.
4. Pelvis tilted more towards the APT mode in the push off, which already from step two is done with relatively incomplete knee extension, (page 44, 50)
5. The hip extensors, primarily hamstring gets progressively more dominant function

**Acceleration II and Maximum speed.**

Sprint model: APT-mode. “Long rotation in hip joint”.

Figure 128, 129a and b shows the technique in “Acceleration II” and Maximum speed with upright posture and lower leg in the vertical position at touchdown. Maximum speed is built up by that touch down is done with a sense of “waiting for” the ground smoothly while step frequency and speed increases. The foot should not be flogged from an elevated position in the ground. At low altitude starts the “natural strike” against the ground with muscle preload for imparting elastic energy (“elastic catapult” charging). At relaxed sprint the foot naturally is turned angled down and out and the edge of the foot meets the track first. It applies to during the Acc.I will find a position at touchdown ie with optimal Tpkt position where the foot successively meet under and finally in front of CG. During acceleration II to maximum speed (Elite: At 50-70m) and the rest of the race, foot optimally is landing in front CG. Muscle Work can now also occur as technology model: APT-mode. Long rotation in hip

1) Tom Tellez recommendatio. Individual deviation can probably also be useful
2) Individual touchdown may be slightly longer in the front CG. Applies Primarily to extreme hamstring strong sprinters

**Fig. 126**

**Fig. 127**

**Fig. 128**

**Fig. 129a** Sprint-model: APT-mode. “Long rotation in the hip joint”.

**Fig. 129b** Sprint-model: PPT-APT-mode. “Long rotation in the hip joint” (see also p. 47).
Sprint model: PPT-ATP mode. “Short or long rotation in the hip”.

This technology model (Figure 130, 131) can be described as follows:

f-g: In the swingphase Pelvis is backward tilted from APT to PPT mode in the touchdown (a-b). The movement provides a “Stretch Shortening Cycle (SSC)” in the hamstring for increased rotational (angular) speed.

a-c: In the touchdown (a-b) is also a SSC in hamstring which first is working isometrically with stabilization of the knee joint and the femur in connection to the pelvis. With a focus on PPT location it now will be a short slower rotation of the leg with Pelvis as an “extra extended” lever. The back (erector spinae) and gluteus driving the leg backwards, together with the pelvis forward tilt, as a high lever (With a high positioned axis of rotation above the pelvis).

c-e: The back and iliopsoas muscle work also causes that Pelvis is tilted even more towards the ATP position, the hamstring then will be stretched some (“as tightening a bow”) which again provides an SSC with a finishing accelerated rotation in the hip joint.

However, this backward rotation of the leg can also as an alternative be performed in a longer distance to produce large horizontal force.

a-b: Because of the the high pressure (see diagram fig. 130) that occurs when the machine is attacked the fixed ankle joint (should be seen as a “stiff” elastic steel shank) will be slightly compressed. The heel is (see the picture below) pressed against the track an touch it.

b-d: Pelvic that extra leverage, starts tipping forward toward the APT mode. The final push-off is done as previously during the drive phase, with that the leg, after the foot edge insertion and heel contact, is inward rotated over the big toe - this possible with help of the adductor magnus. A slightly more forward tilting of the pelvis now allows place in the hip joint for a longer accelerated rotation, where great power can be developed mainly by hamstring and adductor magnus. Important is a certain “locked knee-joint”, so that leg forms an elastic lever before final push-off. See Fig. 129 b and also page 47, fig.105, Note the “rocking” motion of the trunk as previously described on page 47.

Sprint model: PPT-APT-mode short*) alt. long rotation in hip, Quadriceps dominance. Hamstring, isometric antagonistic function.

The vertical pressure in touchdown and front support phase may also require a certain eccentric muscle work of the quadriceps. Fig. 131 shows PPT-APT mode with short rotation in power sprint training, but also that hamstring works isometrically, as an antagonist during the entire ground phase. In the drive phase then muscle work can be done by the quadriceps dominance in the extension of knee and hip in the push off. This technique has been most common in the US and is probably also the traditional, which most coaches still is teaching. It also corresponds well with the activation of the quadriceps in clean alt. snatch hanging. As Figure 130 shows, it also can be applying with Power Sprint excellent with the advantage that even coordination in the hip side can be trained specifically. Focus on the horizontal force also applies here with powerful isometric hamstring work.

*) Note! See pages also p. 50 and 53, which describes iliopsoas braking effect on the rotation of the femur in last part of stance (d-e). This results in the upper torso part is rotated forward with increased velocity (see page 50). Iliopsoas stretch even reactive which favors a quick knee lift after the toe-off. This technique should be particularly suitable for this sprintmodel.

**) Instead, it primarily is hamstring which extending the hip for today’s top sprinters, completely according Wiemanns theory (page 54) (which the author with this book attempted to describe.

Fig. 130 At touch down the heel is pressed quickly down by the high pressure (a’-b’-) and touches the track. Analysis of the maximumspeed. Sprint model: PPT-ATP mode.

Fig. 131 Sprint-model: PPT-APT-mode. “Short rotation in the hip joint”.

**)
Another typical example where speed is of most importance for performance is long jump. We shall now first analyze different variants of jump techniques. Usually long jump has been considered easy with only two requirements:
- Fastest possible approach speed
- Strong take-off with concentration on height of the jump.

Instead, it is faced with a complex technique with several variants. Of this, the following sections dealt specifically two types of jumpers, who after their characteristic style we call:
- High Long Jumper
- Sprinter Long Jumper

High Long Jumper seek primarily large vertical force, with a prominently marked “take-off.” Sprinter Long Jumper, however trying more to maintain speed through a flatter “uthopp”. This, done right, experienced by the jumper, as running out from the board.

We shall try to describe various ways to perform a long jump with optimal technology. This is possible using stick figures made from movies and data from various studies of jumps which have been performed with lengths from 6.50m to 8.90m.

Long jump Mechanics
A common way to explain längdhoppets mechanics is that use a so-called, vector parallelogram Fig. 140), which shows the size and direction of take-off velocity, V, and its horizontal (Vx) respectively. vertical (Vy) component. The diagram is an interesting beginning to an analysis of the long jump technique. Take-off velocity V and its direction (Take-off angle) is what primarily determines the long jump. The most important quantities, which are used in a long jump analysis is also shown by the table in Fig 151 page 73.

Jesse Owen, 1935 8.13m
Jesse Owen, the owner of the world record 8.13m between 1935 and 1960 was, judging by the pictures and videos, a typical sprinter long jumper (Author). He succeeded extremely well make use of a high approach speed.
5.1 “High Long jump”

Bob Beamon 1968 8.90m
At the Mexico Olympics in 1968 Bob Beamon USA, took the world with amazement at his amazing world record jump 8.90m. Here we present data from this jump. For several decades into the modern time, many have been inspired by Beamon’s powerful jumping technique.

Beamon’s jump was compared with the elite and it was found:
- Faster approach: 10.7m / s
- Incredibly powerful take off: Vy = 4.2m / s. With braking Vbr = 1.2m/s were obtained: Vx = 9.5m / s. The take off angle became α=24 ° (Tg = 4.2 / 9.5)
  Thus, steeper than normal for elite jumpers.
- Low center of gravity in touchdown on board, with jump leg’s angle against the ground at touchdown: β= 60°
- Early toe-off. Jump leg’s angle against the ground in take off: γo=78°.

- Beomons penultimate step measured 2.40m and the last step all over 2.57m. The explanation for this is Beomons technology with a relatively high knee lift in the last step’s push off, followed by a marked out oscillation of the lower leg. Hereby the jump foot had a very long acceleration when it was whipped in the board. The pressure against it must have been very high, but when the jumping leg’s motion direction was backwards compared the jump’s forward movement the braking was reduced significantly. Elite jumpers otherwise normal have a shorter last step.
- Beomons pendulum work with the free leg supports the jumping leg’s work with a peculiar rhythm and swing.

Fig 141 Bob Beamon’s 8.90m jump, as the pressure diagrams probably looks like (The author)
High long jump, approach.
The approach can be likened to a “loose” sprint start, with an slightly slower acceleration than in a 100m race.
A good planning of the approach described Mike Powell's approach (see figure 144). For example, at 16 or 20-step approach you count every two step (eg only the jumping leg as in Fig 144). The approach then consists of 8 respectively. 10 “cycles”. Then you divide the approach in four parts: “The drive phase”, “transition phase”, “attack phase” and “take off phase.”

Drive phase. You push off relatively powerful and about 45 ° trunk inclination in the starting step with head bowed. Now it’s full extensions particularly in the jumping leg with strong supportive arm- and leg-swings.

Transition phase's tactic is to slowly rise head and trunk during relaxed sprinter running. This is the long jumper’s characteristic easy “sitting” with high knee lift.
During the Attack phase the velocity is driven up to near max usually by increasing leg frequency. Hereby focus on pretension (“elastic steel rail”, “stiffness”).

Take off phase implies a special approach to rhythm and technique (see fig.147) where the first step is a normal sprinter step with concentration on the following important third step ahead of the board. The push off is done with incomplete knee extension, which is making that the jumper “float” forward more horizontally. The second step and last steps before the board is also done with incomplete extensions. The later is pulled out something. It is like waiting for the landing on the runway (Tom Tellez, “Just wait a little:). The last step is usually more shortened.

High long jump, last step and take off.
Ground phase of the last approach step, with special technique. We speak of the “penultimate step”, which suggests the technique of an “active” squats. You “pull” the track. Expressions such as “tearing”, “grab” describes the proper touch-down, which can be done in two ways:
A. A clear heel - toe rolling (Fig. 145)
B. Touch down on the front ball of the foot with easy heel contact (Fig. 141)
B. Gives less braking and admits as A further lowering the center of gravity. This is to meet the board in a deep position with the jumping leg at an acute angle to the runway, which is characteristic of the best high long jumpers such as Beamon 1968 and Salodino, 2007 (see p73). Carl Lewis used A. He compensated the braking with greater speed.
High long jump, special variant
High long jump can also be performed with a “lift” in the last step from a deep heel-toe roll in the penultimate step. The take off is then done as a “bounce” in an elevated position with shorter time on the board. The technology can fit explosive jumpers with good jumping capabilities. It reminds of the fast variant of Flop High Jump. See figure 146 and 147.

High long jump, take off. Analysis.
Upphoppstekniken beskrivs i det följande:
1. The foot is moved mostly in a low motion against the board. (T.Tellez: “Just put it down”). The foot finally meets the board relaxed with a downward - rearward movement, which reduces the braking somewhat. The whole sole of the foot is inserted flat, but the heel meets the ground a “microsecond” before. (So that the gluteus damps the pressure author. reflection)
2. For a brief moment (15-20ms) increases the pressure vertical force (see Figure 141). Then the jumper immediately sag in to knee and ankle. It is during this short time mostly of the vertical velocity increase.
3. The jumper now pivots forwards upwards. The motion first becomes flat rising.
4. Finally the “lift” is is performed by quadriceps, gastrocnemius/soleus and the gluteus which are extending completely in all the joints. Great influence comes from the “lead” leg because of its mass. It should perform a short pendulum movement until the thigh is parallel to the ground.

High long jump, discussion
High long jump technique is likely optimal only for the long jumpers of the highest elite (8m-jumpers). It is therefore inappropriate to young people trying to accomplish get height on the jumps by by violently “stomping” the board. Unfortunately, usually the following occur:
- You make technology training with short approach and then tries to jump a long way with the help of a power ful, “springy” stomping take off for height in the jump.
- With a full approach you could possible initially achieve outstanding good performance, but later usually a surprising stagnation occurs.
- Unfortunately, even serious injuries can occur because of too much strain on his leg jumping. (Possible high jump training leads probably to the use of special variant above (author))
In his youth also the 8m-jumper was told från coach:
- “Work long at the board,” “Push through the hips better ”,” strike the board “clawing”.
- Later after many years, coach tell you: “You not seem to increase your approach speed further. Now we must concentrate on a more powerful take off technique.
5.2 Sprinter long jump

Carl Lewis

It has always existed in the U.S. Long jumpers, who used their pronounced sprinter speed with technology, which completely differs from the high long jump. Such was Carl Lewis (Fig. 149, 150). It is more talk about a jump in direction outwards than upwards. In take off phase the last approach steps (see Figure 144) is a rhythm changing, which gives a first hint of a “lifting” the last step approach. Then the foot is naturally “whipped” in the plank (as an active “gripping”, with a very short first heel contact). The jump leg is slightly bent with pretension and with the feeling of a “volley kick” forward-upwards. Already during the attack phase (see page 70), with increased cadence, accentuated pretension (“stiffness”, “steel rail”) “amortisationen” was prepared (a-b). From position (b) rod force pivots the whole body quickly forward upwards (b-c) followed by the explosive push off (c-e).

This while free leg swings up and is blocked at parallel upper leg. The long deep penultimate step with a “lift” in the last step slows you down, but resulting in a less load on the jump leg. This can fit “sprinter runners” which often does not have the pronounced jump strength.

In the approach you sometimes can use a combination of “ATP” - and “PPT”-models (Author) (illustrated here and previously on pages 58-59) Often in an alternating step rhythm in harmony with the coordination of the last three strides and take-off.

Carl Lewis last approach step and take off. Notice the free leg movements. The figure shows a unique optimum coordination between the free leg movements and support phases. From touchdown on a plank, then the femur - the knee is vertically below the hip, the feeling being as a “volley kick” of the foot.

Note: Carl Lewis uses the right leg in his take-off. This drawing shows his technique schematically fairly accurate except that left here is take-off leg.

Lewis = 8.91m Powel = 8.95m
Vα = 11.06m/s Vα = 11m/s
Vx = 9.72m/s Vx = 9.09m/s
Vy = 3.22m/s Vy = 3.70m/s
α = 18.3° α = 22.1°
γ = 67.5° γ = 73.9°
β = 77° β = 71.8°
L1 = 1.88 L1 = 2.28
L2 = 2.70 L2 = 2.74
L3 = 2.23 L3 = 2.40

Analysis of Carl Lewis sprinter long jump. Data Comparison, Mike Powel - a more typical hight long jumper.

Fig. 149a
Fig. 149b
Fig. 150

Step rhym: “short”-“long”-“short”
“Feet Runs Underneath the body and then passing” (Auth. talk with Joe Douglas Stockholm -83).
Penultimate step: “Just wait a little” (Author’s conversation with Tom Teller, Stockholm -83) In contact with the ground and landing followed by a deeper (“pull”) with a clear heel roll. Lewis performs here also a small side step (was recommended author by Ralph Boston’s coach Tom Ecker, Stockholm 1962), with outward rotation of the foot, followed by an inward rotation (see page 59). The latter implies a “lateral lift” - a “side-nudge” (Author) with feeling of some relief before touchdown on the plank. Here probably it’s also obtained a horizontal-vertical speed boost. A contribution to this first vertical center of gravity increase is also a small “bending forward” and “rise” (See fig.) Jump The foot will now also be placed more in line with the center of gravity resulting in a more efficient take off. The foot touch down occur with a movement forward-downward with unchanged step rhythm in an arcuate movement at lower altitude just below the knee. The lower leg is brought forward out to slightly as in a sprint stride and “is naturally whipped” in the plank, with a backward gripping motion (with negative velocity). Touchdown is done with the whole ball of the foot, but with an initial brief heel contact. Legs and seat muscles are preloaded for eccentric work during the so called amortisation phase a-b. This pretension is accentuated, as mentioned earlier, already in attack phase. The “springy rod” force is rotating the jumper forward upwards b-c, followed by the explosive push off c-e. An interesting techniques detail - his right arm and shoulder is kept back in a low position at touchdown. It then occurs an elastic stretch of the hip side (which immediately is stretched, “as a rubber strap” (Author’s talk with Valeri Brum, an international training course in the long jump -94, “as secret behind the Russian long- and triple-jumpers”). Another detail is that Lewis performs an “outwards rotation over the toe”, probably with using adductors with higher force in the push off (See also page 75).
Sprinter longjump, mechanics, muscle work.

We have also previously in sprinter technology-section used the natural “foot strike” naming the touch down. Put down the foot with a quick sweeping arcuate motion against the board, with slightly bent jump leg, in harmony with the free leg swing movement forward-upward. As in sprinter running the leg’s muscles are in pre tension to cope “amortisationen”. We shall now describe in more detail what happens:

**Take off**

The pretensioned leg and buttocks muscles at touchdown means that foot and knee are fixed (“locked”). The pelvis is backward tilted, with isometric- rically working gluteus and rectus femoris. At touchdown the leg is forming with the upper body, through the pre- tensed muscles a pretty solid unit, which is like a rod. When its lower end (foot) are trapped in the ground, the top (upperbody), gets an increased speed. The rod will thus rotate around its support point in the ground. This is what is meant by the rod - principle. By the rod seems a force. Fig 151 shows the forces during take off using a schematic pressure diagram. Force Fs, consisting of a braking component Fxµ in the horizontal direction and the accelerating component of FyN in the vertical direction, grows rapidly to a high value of up to 10 times the body weight of elite jumpers. The force operate with a high pressure at the board a very short time. Already after about 15ms, the pressure reached its maximum. (b) and then diminishes rapidly.

During touchdown a - c there is also the reaction force Fp+Fi in the jump (running) direction from the ground. The jumper should increase this force, and with an active (“strike”) Fi (“gripping”) and with a “swung- full” bone pendulum Fp. The braking is then reduced. Another positive effect by Fp and Fi is that force Fs will be directed more through the body’s center of gravity (Fig. 151). The torque around the center of gravity is then zero, so the jumper will be in better balance in the air with little forward rotation. Then one can jump great also with simple techniques in the air as hangstile. An important fact is that without the sum of Fp and Fp a dangerous force Fs1 would be produced and partly severely damage the jumper (Note: Serious bone fractures have occurred in long jump) and the jumper would get too strong forward rotation. In position c the pressure diagram shows that FyN again has risen to about 1/3 of Fs value. From here then the push off is completed c - e, as a powerful sprinter step, but in a more upward direction. Just before d correspond to the point where the vertical line from the body’s center of gravity is passing just above the foot. Fxp then is changed to acceleration in the horizontal direction.

In position e the pressure diagram shows that Fs value has increased to about 1/3 of Fp value. From here then the push off is completed e - c. Heiki Drechler was a female representative for sprinter long jump. In Figure 152 displays vertical and horizontal reactive forces in the two training jumps with the same jump length at different approach speeds. Interestingly, at higher speed she needs significantly less vertical force, which incidentally seems extremely short-lived. At World Cup 1991 jumps Heiki 7.29m with only angle 18.3° and compared to the other competitors (see table on page 75), with a significantly lower vertical jump speed.

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**Fig 151** Biomechanical analysis of the sprinter long jump

**Fig 152** Heiki Drechler's vertical and horizontal reactive forces in the two jumps with the same jump length 6.80m at different number of approach steps (AS) approach speeds 8.58 respectively, 9.23 m / s 

1) Modif. from Die Lehre der Leichtathletic number 22. -93
Analysis of long jump by an early 1970s study (Ballreich)

**Sprinter Long jump, beginner and intermediate level jumpers (6.50-7.20)**

These data with illustrations (author.) is based on an early 1970s study (Ballreich). It was scientifically carefully made and may was well worth to be presented even today. Reason for that this group of jumpers (20 males with jump lengths 6.50 - 7.20m with an average of 6.80m), can be included in the category of sprint long jumpers depends on the relatively flat take off angle 20 ° with a low braking of horizontal speed. A speed reduction of only 0.9 m / s.

**Properties:**
- The “Lift” in the last step relieves the load on the jumpleg. After the active touchdown, jumper can easily “float out” in the jump with a delayed ankle extension.
- The jumper is here totally focused on extension of hip, but less on the knee lift and trunk stability. The trunk “rocks” back slightly (typically for beginners eager to enter the hang-style directly in the jump, the author. refl.). The technology is probably optimal for this long jumpers capacity.

**Muscle work**

Study the schematic illustration in fig.153 with rectus femoris, vastus lateralis, gluteus, gastrocnemius, soleus och hamstring. Muscle work happens as follows:

- \( a_1 - c_2 \): \( gl, rf \) isometric. \( va, so, ga \) eccentric. 
- \( ha \) concentric.
- \( c_2 - e_2 \): \( gl, va, so, ga, ha \) concentric.
- \( rf \) concentric or eccentric.\(^1\)

**Fig 153 Muscle work at take off for a typical sprinter long jump \(^1\)**

_Here specifk Powersprint strength training_

1) Authors study of this article: The EMG activity and mechanics of the running jump as a function of take off angle. W. Kakihana, S. Suzuki (Journal of Electromyography and Kinesiology 11 (2001, 365-372)

Processed data also from Biomechanics of the long jump, Nicholas P. Linthorne

---

**DATA:**

- \( Va = 9 \text{m/s} \)
- \( Vx = 8,1 \text{m/s} \)
- \( Vy = 2,8 \text{m/s} \)
- \( \alpha = 20^\circ \)
- \( \gamma = 60^\circ \)
- \( \beta = 69^\circ \)
- \( L1 = 2,10 \)
- \( L2 = 2,28 \)

---

**Kent Nygren a swedish veteran world champion, here in a 6.50m jump, can be a good representative for this style. He, however, manage just fine with trunk stability**
In conjunction with the World Championships in Osaka in 2007, a biomechanical survey\(^1\) was made in respect of the best long jumper’s properties (see table below). It was found three types of jumpers. Depending on velocities in the jumps, one could divide the jumpers into three groups:

1. **Large vertical and horizontal velocity**  
   (First Salodino, 2nd Howe, 3rd Phillips)

2. **Large vertical and small horizontal velocity:**  
   (4th Lukashevych, 5th Mokoena)  
   In these two groups we have our “High Long Jumpers” (author)

3. **A small vertical and large horizontal velocity**  
   (6th Beckford, 5th Badji 6th Marzouq)  
   These two jumpers could be considered “sprint jumpers,” but far from Carl Lewis capacity (Author.)

<table>
<thead>
<tr>
<th>Salodino</th>
<th>Howe</th>
<th>Philips</th>
<th>Lukashevych</th>
<th>Mokoena</th>
<th>Beckford</th>
<th>Badji</th>
<th>Marzouq</th>
<th>Övriga</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.58m</td>
<td>8.47m</td>
<td>8.50m</td>
<td>8.25m</td>
<td>8.28m</td>
<td>8.20m</td>
<td>8.09m</td>
<td>8.04m</td>
<td>8.15+-0.17</td>
</tr>
<tr>
<td>Va 10.52m/s</td>
<td>10.87m/s</td>
<td>10.38m/s</td>
<td>9.97m/s</td>
<td>10.12m/s</td>
<td>10.63m/s</td>
<td>10.16m/s</td>
<td>10.22m/s</td>
<td>10.65+-0.19</td>
</tr>
<tr>
<td>Vx 8.90m/s</td>
<td>9.26m/s</td>
<td>8.96m/s</td>
<td>8.27m/s</td>
<td>8.33m/s</td>
<td>9.05m/s</td>
<td>8.83m/s</td>
<td>9.03m/s</td>
<td>8.77+-0.22</td>
</tr>
<tr>
<td>Vy 3.75m/s</td>
<td>3.46m/s</td>
<td>3.67m/s</td>
<td>3.78m/s</td>
<td>3.71m/s</td>
<td>3.25m/s</td>
<td>3.17m/s</td>
<td>3.01m/s</td>
<td>3.42+-0.26</td>
</tr>
<tr>
<td>(\alpha) 22.9°</td>
<td>20.5°</td>
<td>22.3°</td>
<td>24.6°</td>
<td>24.0°</td>
<td>19.8°</td>
<td>19.8°</td>
<td>18.4°</td>
<td>21.3°+-</td>
</tr>
</tbody>
</table>

From the table below with female Long jumpers from Osaka and Tokyo World Championships we have:  
High long jumpers: Lebedeva and J.J Kersee  
Sprint long jumpers: H Drechsler and Kotov (Author)

They filmed the touch downs and came to what here is described in point 1-3. (see Figure 155a):

1. In the penultimate step the touchdown is slightly from midline, about 10-20cm. This “slide-step” was already used by Jesse Owen but mainly by Carl Lewis (Author).

2. Touchdown on the board is on the center line with the leg slightly tilted inwards. The researchers then concluded that the jumpers effective use abductors (gl.medius, gl.minimus, tensor fasciae lata) and extend the hip side. (Compare page 38 Figure 77 with the text “rubber-strap” (V. Bunin)).

3. Salodini had a large shoulder rotation, which coordinates with the stretching of the hip side in accordance with above point 2. See also p.70, fig 149a. Carl Lewis pulls hastily back shoulder before the touch down and this is resulting in a elastic stretching of the hip side. (Author refl.)

In the penultimate stage Carl Lewis has a “slide-step”\(^1\) after a typical inward rotated leg 1-2 and in the touch down also a well-accented inward rotated 3-4. The foot is put in a straight line on the board followed by an outwards rotation 5-6, ie. Outward rotation of the sole of the foot over the big toe during simultaneous inward-turning of the heel over middle line. Muscularly it’s likely adductor magnus and vastus medialis, which primarily is engaged for Carl Lewis push off. This will prolong and enhance the accelerating force in the take off.\(^2\)

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\(^1\) Author. \(^2\) Magnus Warfvinge from filmstudies -2014
5.4 Training with Powersprint

Summary and manual

**General total exercise and RDL for hip extensors**
Basic exercises for maximum and “explosive maximum strength” primarily important hip extensors gluteus and hamstring, but also good training for the calf and Achilles tendon “carapul” similar of push-off. One leg “Roman Deadlift (RDL), with Power Sprint provides gentle load on the low back. As eccentric exercise, to prevent and / or rehabilitate hamstring injury. The “Plyometric”ballistic exercise as shown in the figure is an brilliant strength exercise for posterior chain. Possibly very effective to prevent hamstring injuries. (Author)

**Speedstrength and explosive maximum strength**

**Acceleration I Blockstart**
The exercises for accelerate I are training explosive maximum strength and speed strength for the technology of the starting steps. the exercise for block- start is training specific technique from an inclined platform. Is used primarily as a speed strength exercises. The machine has been supplemented with a platform (ramp) and also a bench with inclined planes. In essence, specific explosive maximum and speed strength of the quadriceps, hamstrings and the gluteus, but also for extending the ankle with soleus and the gastrocnemius. In the acceleration I in addition is also training hip side and adductors. (See text and graphics on pages. 58-59). The posture and movements of Pelvis is very much a secret of sprint running (Author). Mainly the quadriceps and gluteus are engaged, but for driving the body forward flat, hamstring is required to “resist against”. ie acc. Wieman hamstring then is working isometric ((See p. 49 Fig. 109).

**Explosive maximum strength and speed strength**

**Acc II and Maximum phase**
Training of technical details for the Acceleration II and the various individual max phase sprint models (see pages 58-59 can be done as a basic exercise, but is primarily used to train explosive maximum strength (NMC “explosive”) and speed strength. Might as well as other exercises, such as take-off (see page 72) for the long jump, strongly contributing to improved technology. advantage).

**Manual for Powersprint:**
1. Grip with the palm upward (“Curlfattning”) and pull gently against the body so that the support plate is in contact with abdominals.
2. The support plate should lightly touch the belly.
3. The pressure should be distributed on several points. Use not only the support plate, but to work actively with the upper body. Feel the pressure is distributed on abdominal, chest muscles, shoulder and back muscles. Try also on the feels good to angle the elbows slightly against the oblique abdominal muscles.
4. In addition to the platform (ramp), the machine has been supplemented with a bench with inclined planes for block start (see Fig.) and various exercises.
New swedish comparative EMG analysis of sprint with Powersprint (2016)
EMG test studying muscular effort during sprint and Powersprint. The test was performed on a Swedish female junior elite sprinter. Analyzed data received from the test is presented below. 1

SPRINT
Recovery phase 1-3:
Activity from Semitendinosus (St)* in the beginning of the recovery phase. Biceps femoris might also be activated*
Recovery phase 4-5:
Activity from Adductor magnus (Am) and Gluteus maximus (Gm) just before the foot strike. St and Vl are pre activated with subtle isometric muscle tonus.*
Ground contact phase 6-8:
activity from Gm and Vl working hard to resist great vertical forces. Am is activated during the rotational movement of the forefoot after foot strike (see page 59)
Ground contact phase 8-9: St and Am activation shows that the muscles are working hard in the final stage of the push off. This is probably typical for the Sprint model PPT-ATP mode. “Short-long rotation in the hip”*. (Page 59). This corresponding to the Wiemann-Tidow study.

POWERSPRINT
Ground contact phase 6:
Activation mainly from St and Am showing great response in the beginning of the movement. St is the main muscle working during the “clawing” movement over the surface. Am is activated during the rotational movement of the forefoot after foot strike (see page 59)
Ground contact phase 7:
Activity from Gm and Vl working hard to resist great vertical forces. The knee is slightly angled, either active or by vertical load forces.
Ground phase 8-9:
Activation from St might be an expression that St either extends the knee or perform an isometric exercise* probably in this case isometric as an antagonist, while Vl extend the knee and hip, described at page 59. The final alternative correspond to the sprint model PPT-APT-mode Quadriceps dominance, Hamstring, isometric* antagonistic function. Gm is not involved in the push-off similar to what sprint EMG showed. St is active near the end of the ground phase making complete knee extension impossible.

Powersprint EMG data table. In comparison with conventional exercises for sprinters.
As an exercise machine designed to improve sprint and speed, the data from this EMG study shows that compared to the most commonly used strength exercises in this area the Powersprint is a fantastic alternative. Semitendinosus (St) in the hamstring group* seems to be much better activated in Powersprint than in Olympic lifting. Powersprint shows equal muscle activity as Olympic lifting concerning the other measured muscle groups in this study.

By studying this EMG data you will notice that the Powersprint is a versatile super tool to improve sprint and speed. Next page 81 shows the test person in the studied exercises.1

*) NOTE: The electrodes were placed over the semitendinosus. However, the risk of crosstalk. Statement: Is there reference which prove this?

1) The authors text reviewed and processed by Magnus Warfvinge.
Powersprint max. sprintphase

Max. sprintphase

Reactive jumping

Squats

Lunges

Clean and jerk

Snatch

Cleans
Exercises with the new Powersprint machine.
(This is in the pioneer stage, why the author here first shows the exercise along with the principle drawing).

Powersprint, general one-leg exercises for Gluteus and Hamstring

Powersprint RDL I, Concentric (I) - eccentric (II)

Powersprint RDL II, Eccentric (I - II)

In this exercise it could be recommended to mount on the “heel” to simplify the start of the moving.

Powersprint RDL III
Concentric - Eccentric

Powersprint RDL IV, “Plyometric”
Powersprint, general one-leg exercises for Quadriceps

One leg squats for Quadriceps
Powersprint, specifik one-leg exercises for sprint speed

Block start
Advanced start with newly constructed Powersprint machine

Acc 1, 1:a and 2:a step
Acc I, higher position  "Heel"

Acc II - max phase, ATP-Sprint model
Max phase, PPT-Sprint model

Long jump take-off (Speed longjump technique as Carl Lewis) –

Long jump, penultimate step.