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An examination of speed endurance

Gary Winckler

Starting from the premise that sprint training and performance should be considered as a complex interplay of bioenergetic, biomotor and biomechanical parameters, the author defines and examines the relationship between speed, maximum speed and speed endurance. He uses tables to clarify the types of training which develop speed endurance, incorporating the work-loads into a periodized plan. He concludes with a training matrix intended to help focus the many variables involved.

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1 Introduction

Sprint performance should be considered as a complex request made of the body involving the participation of different but strictly related and integrated muscular and nervous systems. Figure 1, on the following page, shows the relationship of the key ingredients of sprint performance.

Too often coaches will think of training in terms of the evolution of distinctly separate qualities which can be trained in isolation. This demonstrates a lack of understanding of the interplay of all the biomotor qualities, and of their mutual development. Training is a complex process, and each training unit will usually contribute to the overall development of the athlete in a multilateral manner.

Such is the case in the development of the qualities of speed and speed endurance. This paper will be an attempt to provide a description of the relationship between speed and speed endurancce; an explanation for why speed endurance is important in sprinting; how it should be developed methodically, without sacrificing speed and technique; and how we can develop a means of communicating it both to athletes and to other coaches for the establishment of a more effective training infrastructure.

2 Speed

In simple terms, stride length and stride frequency determine speed. To improve

Table 1: Stride length and frequency determine speed

	Stride length	Stride frequency	
Initial speed	6 ft	3/sec.	18 ft/sec.
New speed	5 ft	4/sec.	20 ft/sec.

speed, an increase in one or both of these parameters must occur within the context of sound technique. The coach must bear in mind that it is possible to increase speed by improving one parameter to the detriment of the other. This is illustrated by an example in Table 1.

Stride length and frequency can be improved through the development of co-ordination and speed, strength, technique, specific endurance and flexibility. These factors all work together, blending to produce a better sprint performance. A balanced programme and a sound teaching sequence will improve both stride length and frequency, developing them - and therefore speed - holistically.

Within this framework it is mandatory to clarify the technical, biomechanical and bioenergetic sprint model in order to approach training in the most appropriate manner. Knowledge of the precise roles played by each of the various muscle groups has improved, now serving much more effectively to orientate the development of strength in the sprinter's lower limbs (i.e. the importance placed for several years upon the development of the quadriceps has now been replaced by a more rational emphasis upon the gluteals, hamstrings and gastroc/soleus complex).

Recent studies by biomechanists have brought to light some of the more critical areas of technical development which must be mastered. Moreover, within the last few years, examination of work done by sport scientists has aimed to clarify the relationship between speed, speed endurance and good performance. I will now examine this relationship a little more carefully.

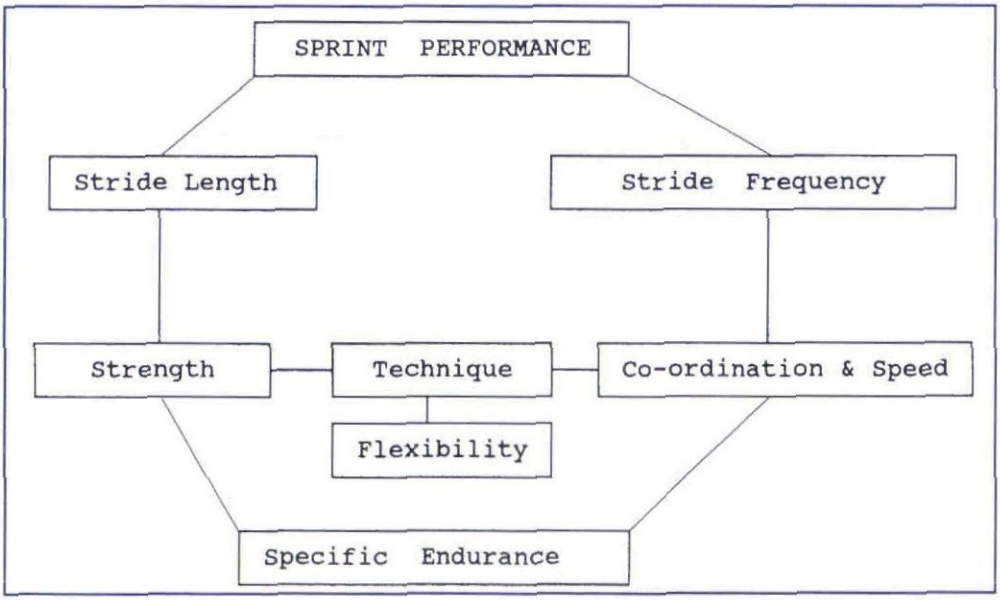

Figure 1

Table 2: Zones of energy requirement

Zone	Duration of work	Level of intensity	System producing the energy for work	Ergogenesis %	
				Anaerobic	Aerobic
1	1"-15"	Up to limits	ATP-CP	95-100	5-0
2	15"-60"	Maximal	ATP-CP + LA	80-90	20-10
3	1'-6'	Sub- maximal	LA + Aerobic	70-40	30-60
4	6'-30'	Medium	Aerobic	40-10	60-90
5	Over 30'	Low	Aerobic	5	95

3 Speed endurance

I defined speed above and so now would like to provide a working definition for speed endurance. This is not an easy task, as literature and coaching terminology provide us with a wide range of commonly used definitions. Most coaches understand the quality of speed endurance to be the ability of the athlete to maintain high levels of speed for long periods of time. The workload prescribed as necessary for the development of this quality is enormous; the athlete must work at an intensity of 75-100 % of his maximum over distances of 30-600m. This involves several separate but related energy levels, defined briefly below.

3.1 Zones of energy requirement

The alactic anaerobic process is the basic bioenergetic process necessary for speed events (100 metres, 200 metres and 400 metres). During the last ten years the role played by the ATP-PC system has been clarified. Italian physiologist Dr Pasquale Bellotti (1986) points out the possibility of using phosphates (ATP and CP) to express the potential energy for a work-load of more than 7-10 seconds, as long as the relevant muscular involvement does not require the maximum potential power of the process.

3.1.1 Alactic power

Power is linked to the velocity of the biochemical responses regulating the release of energy. This biochemical velocity response is in turn related to the activity of enzymes. Therefore we can say that power is a function of the enzymatic activity of a system capable of self-transformation.

3.1.2 Alactic capacity

Capacity is linked to the available transformable substrates and therefore to potential chemical energy.

As the intensity of work increases, the energy cost of the external work performed grows exponentially. Thus also the decrease of energy-cost of work as a result of efforts below the maximum follows an exponential trend. From this we can conclude that a slight departing from maximum-work power can save a large amount of energy by using fewer muscle fibres. Thus for a work-load of less than 7-10 seconds we can maintain power, whereas for work-loads exceeding 7-10 seconds - or of less than 7-10 seconds but repeated once or several times at shorter time intervals - we shall use only a percentage of maximum power. This will allow us to keep active only some of the muscle fibres, and to consume less phosphates. Thus it becomes important to stress training methods aimed at improving the efficiency of this process from the viewpoint of power and capacity.

3.2 Maximum speed and speed endurance

In races where speed endurance is of importance (200 metres, 400 metres) good results will be determined by the athlete's ability to maintain quality speed performance throughout the race distance. This is nothing startling and is knowledge that every sound coach uses when training athletes over these race distances. However, what is not always understood in the training process is how to maximize this ability.

The key or basic ingredient will always be maximum speed. The higher the maximum speed the athlete can attain, the faster will be that athlete's speed when she/he is performing at sub-maximum efforts. Most athletes can only hold their true maximum speed for 10-30m. Thus for all but a few very elite athletes the role of speed endurance becomes important even in the 100 metres.

Statistics gathered from the II World Championships of Athletics, Rome, 1987, and the Games of the XXIVth Olympiad, Seoul, 1988, show that in the 200 metres the best athletes were those able to keep the time differential between the first and second halves of the race to 1 second or less. Likewise, in the 400 metres event, the differential between the first and second sections of the race was on average between 1 and 2 seconds for the most efficient performers. This demands the ability to run the first half of the 200 metres race at a speed of 97-98 % of their best for that race distance (i.e. the first 100m of the 200 metres is run at 97-98 % of the athlete's best 100 metres time) and 95-96 % of their best 200 metres time in the first half of the 400 metres.

This simple fact has far-reaching implications in the development of speed and speed endurance. If athletes are to achieve faster performances they must achieve higher maximum speed levels so as to allow for greater speeds at less than maximum efforts. From a practical coaching viewpoint, then, it makes for sound methodology to develop maximum speed qualities throughout the training year, parallel to speed endurance training. The speed endurance training should also take the form of distances and intensities which will support and complement the technical aspects of maximum speed sprinting. Traditionally, many coaches have developed speed endurance early in the preparation, neglecting the aspect of maximum speed development until late into the preparation period or even into the competition period. Such an approach jeopardizes the athletes technical skill development, thus removing from the racing arsenal the ability to express speed over the full distance of the race.

A rough progression designed to develop speed with endurance in a complex fashion might look as follows:

- Develop proper sprinting mechanics;
- introduce runs at higher intensity over shorter distances with the objective of technical improvement;
- work on speed development over distances of 10-60m;
- work on the development of speed endurance over distances of 50-150m;
- keep the intensity of the work between sub-maximum and maximum and only allow the athlete to run as far as their technique will allow.

Naturally, a sequence of this nature requires time. Such a development may take weeks, months or even years. However, for a young sprinter this type of progression could yield great results in a 4-6 year programme starting from the age of

13-14 and culminating in college or beyond. Of course, work over long distances is needed, particularly in the case of 400 metres runners. This is necessary largely from the standpoint of psychological preparation.

Series of repetitions such as 4x4x60m [2 min. & 4 min.] have been used successfully to prepare quality 200-400 metres athletes even at international level. Pietro Mennea (ITA) and Valerie Borzov (URS) are examples of athletes whose programmes contained large amounts of such work. Although they were primarily 100-200 metres athletes, Mennea on more than one occasion ran 44.45 for a leg of the 4x400 metres relay.

Table 3 might serve to clarify a progression of work leading to good development of speed and speed endurance characteristics:

With this delineation of terminology the coach can more easily devise the scheduling of work-loads and intensities in the

Table 3: The development of speed and speed endurance

Common terminology	Length of run	Component and description of objective	Energy system	% of best peformance	Rest reps/sets
EXTENSIVE TEMPO	< 200m	Aerobic capacity (AC)	Aerobic	< 69%	[< 45" & 2']
	> 100m	Aerobic power (AP)	Aerobic	70-79%	[30-90" & 2-3']
INTENSIVE TEMPO	> 80m	Anaerobic capacity (ANP) [Lactic acid capacity]	Mixed aerobic/ anaerobic	80-89%	[30"-5' & 3-10']
SPEED	20-80m	Speed (S) [Anaerobic power] [Alactic acid strength]	Anaerobic alactic	90-95% 95-100%	[3-5' & 6-8'] [3-5' & 6-8']
	30-80m	Alactic short speed endurance (ASSE) [Anaerobic power] [Alactic acid capacity]	Anaerobic alactic	90-95% 95-100%	[1-2' & 5-7'] [2-3' & 7-10']
SPEED ENDURANCE	< 80m	Glycolytic short speed endurance (GSSE) [Anaerobic capacity] [Anaerobic power] [Lactic acid capacity]	Anaerobic glycolytic	90-95% 95-100%	[1' & 3-4'] [1' & 4']
	80-150m	Speed endurance (SE) Anaerobic power Lactic acid strength	Anaerobic glycolytic	90-95% 95-100%	[5-6' & 6-10']
SPECIAL ENDURANCE I	150-300m	Long speed endurance (LSE) [Anaerobic power]	Anaerobic glycolytic	90-95% 95-100%	[10-12' & 12-15']
SPECIAL ENDURANCE II	300-600m	Lactate tolerance (LAT) [Lactic acid capacity]	Lactic acid tolerance	90-95% 95-100%	[15-20' & full]

Table 4: Emphases in an annual plan of preparation for a sprinter

GENERAL PREPARATION	SPECIAL PREPARATION	COMPETITION
Major emphasis General endurance Aerobic capacity (AC) Aerobic power (AP) General strength Flexibility Co-ordination	Major emphasis Specific endurance Anaerobic capacity (ANC) Alactic short speed endurance (ASSE) Speed (S) Specific and general strength	Major emphasis Speed (S) Specific endurance Speed endurance (SE) Glycolytic short speed endurance (GSSE) Long speed endurance (LSE) Lactate tolerance (LAT) Tactics
Minor emphasis Speed (S) Anaerobic capacity (ANC)	Minor emphasis General endurance Aerobic power Aerobic capacity Flexibility	Minor emphasis General and specific strength Flexibility Aerobic power

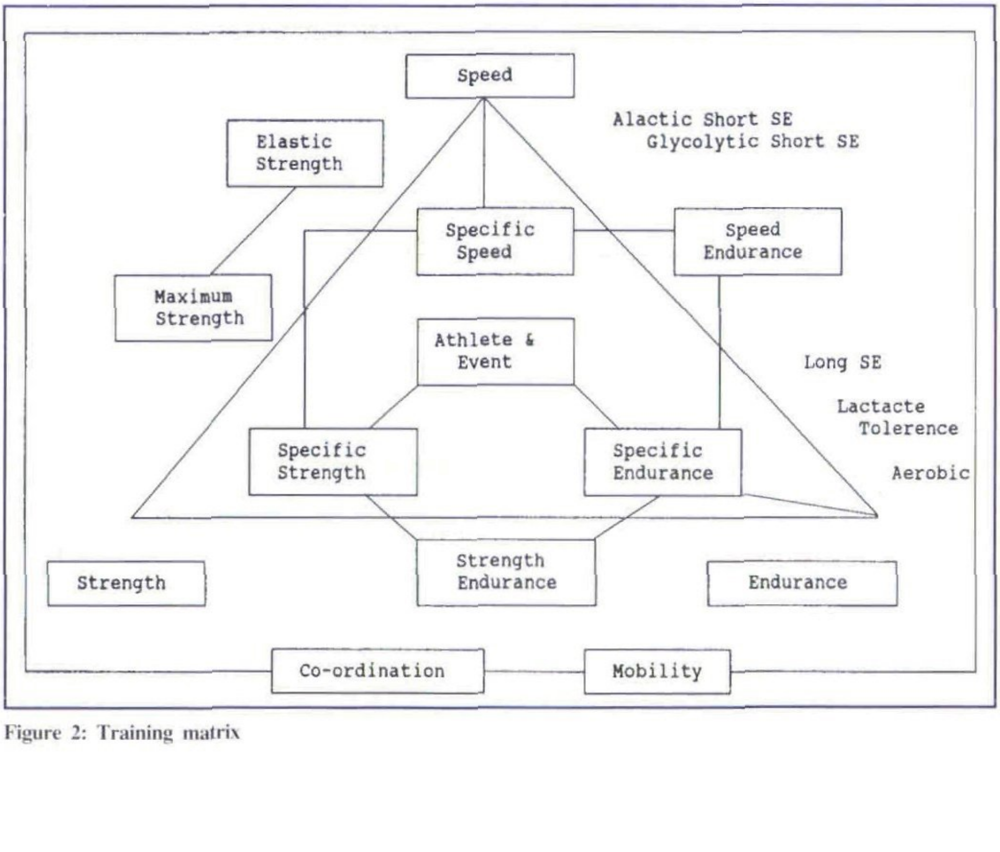

 Figure 2: Training matrix

annual plan of preparation. A very general scheme might take the form of the following, where the general preparation period is strictly pre-season, and the specific preparation period encompasses late pre-season and early competition (see Table 4 on the previous page).

Training is never an easy task for coach or athlete. It is important to understand the various means and methods of developing all of the biomotor qualities present. Yet the total picture and the central theme of that picture should never be too far out of focus. The development of the qualities mentioned here and others is very complex and must be given great thought and skilful application. The following may help to focus the subject at hand and the many variables to be blended in that aspect of coaching which we refer to as 'the art'.

□

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