The development of stride length and stride frequency in sprinting

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10:1; 51-66, 1995

by Alessandro Donati

Running speed is the product of stride length and stride frequency. Athletes achieve their maximum speed only by adopting a specific ratio between length and frequency of stride and any significant alteration in the length or the frequency will cause a reduction in speed. A study was made of 25 (15 male and 10 female) high level sprinters. Each one was required to run a number of times over distances varying between 60 and 100m, with adequate rest periods between the runs. Stride length was changed at each run and data were plotted in a graph. A point at which two lines meet was used to indicate the time and the number of strides that the athlete should, in theory, be able to achieve. Samples of effective training methods to improve performance are given.

User friendly software has been produced to help coaches process recorded data and highlight possible errors. This has also been tested for the women's 100m and the men's 110m hurdle races.

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(Translated from the original Italian by Sandra Lombardi)

Graphics by Riccardo Corradini, Software "Sprint Test" by Emanuele Donati. Further information on the software is available from the author, c/o Via dei Campi Sportivi 48, 00197 Roma, Italy.

1 Introduction

The training methodology and the evaluation system which I propose to present were developed in the field and not in a laboratory.

The first simple idea that came to my mind, during the years spent coaching sprinters and middle distance runners, was the starting point for the development of a real methodology.

Everything started in the Autumn of 1981. The Italian Athletics Federation put me in charge of the short middle distance events, which, for many years, had been obtaining very little success. I had just had three year's experience with the 400m National Team. In 1980 the 4x400m relay athletes committed to me won the bronze medal in the Moscow Olympic Games and, in the European Cup of 1981, they finished ahead of the Soviet Union, Great Britain, East and West Germany. In consideration of my past experience as a middle distance runner, the Italian management hoped that I could supply new and more efficient training systems for this speciality.

During my first experience with them, I realized that Italian middle distance runners were lacking in speed.

The best of them ran the 100m, during training, in 11.5-11.6sec, the slowest even in 12.3-12.4sec. It was clear that this serious lack of speed did not result from a lack of stride length, which was adequate, but on a poor rate of striding.

Assuming that excessive endurance training was responsible for this, I introduced *two exercises to increase stride frequency*:

a) 40 rapid run back kicks;
b1) 20 rapid high knee pick–ups with the right leg.
b2) 20 rapid high knee pick ups with the left leg.

The first exercise was aimed at the muscles at the back of the thigh and the pelvis, while the second was directed to the front thigh muscles and, especially, to the muscles moving the feet. This may surprise some coaches but the exact performance of this second exercise is actually based on foot flexibility: the raising of the thigh becomes, in this way, a natural consequence of the elastic upwards push of the foot. Later, when the athletes had learned how to manage this exercise, I introduced another one, similar but more complex: 40 fast strides with a high knees lift, aiming, also in this case, at the flexible use of the muscles acting on the feet. I used a stopwatch to measure the time taken to perform these exercises, in order to motivate the athletes to do their best. The first four weeks saw a remarkable improvement in the athletes' stride frequency.

I then considered whether an improvement in these exercises, which reproduced only a small part of the running stride, should not mean, automatically, an improved stride frequency in sprinting itself. Accordingly, I studied this hypothesis with Riccardo Materazzi, one of our best middle distance runners. I asked him to run *100m with extremely short strides at maximum frequency*. He ran the distance in 18.52 seconds with 83.5 strides. At this point, I asked myself how I could compare this data with the results of the frequency exercises described above. One problem immediately came up: while the biomechanical definition of the exercises was evident, and the results comparable to it, the manner in which the runs were performed, with short, fast strides was subject each time to variations.

It is, actually, highly improbable that one athlete should be able to keep the same stride length under different conditions. Therefore I could see no way of comparing the result of a run using short, fast strides with the result of another run, in which the athlete adopted a different stride length.

On the basis of these reflections, I asked Riccardo Materazzi to perform a second test run over 100m, with a stride slightly longer than the previous one but nevertheless much shorter than his normal stride.

The athlete then achieved a time of 16.32sec with 72.7 strides. The comparison between the two tests revealed that the athlete would run faster with a slightly longer stride and a lower rate of striding but it did not show much more. I asked Materazzi to run a third and last test, requiring him to run with a yet longer stride, but still shorter than his normal one. He recorded a time of 15.30sec with 68.0 strides.

Writing my data down and making a graphic representation on the cartesian axis, I realized that the data gave non random results. A connection between the variation of stride length and of speed actually became evident. The same strategy applied to other athletes gave the same results in terms of graphical representation (*Figure 1*).

Riccardo Materazzi

Tirrenia, 6.11.1981

I run	**83.5 strides**	**18"52**
II run	**72.7 strides**	**16"32**
III run	**68.0 strides**	**15"30**

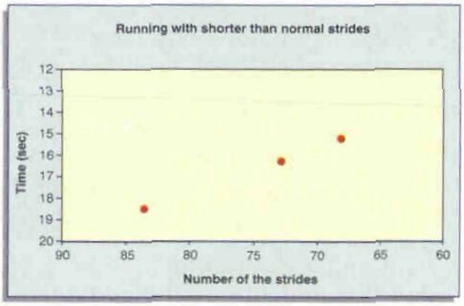


Figure 1: Data sample of Riccardo Materazzi

After some months practice of both the frequency exercises and the short, fast stride running, the athletes' maximum speed greatly improved. Yet with some substantial differences: those who ran with adequate stride length during the frequency exercises, improved their speed significantly, while the athletes who ran with an inadequate stride length got less benefit from the frequency exercises.

Therefore, it occurred to me that the exercises for stride frequency improved *only one* of the two components indispensable for the development of running speed. The other component was, of course, stride length and, whenever it turned out to be inadequate, some device had to be found to improve it. Therefore I introduced some exercises to improve this second component and asked the athletes to *perform test runs with longer strides than normal.*

As a first reference point, I considered the number of strides each athlete took to run the 100m. at maximum speed and, as a second reference point, I considered the number of maximum length, bounding strides the athlete needed to cover the *100m*.

In fact, since most of the athletes found it very difficult to execute the desired movements properly, I had to abandon this project

Stefano Mei

Ostia, 6.12.1981

I run	41.8 strides	14"12
II run	43.0 strides	13"47
III run	44.5 strides	12"73

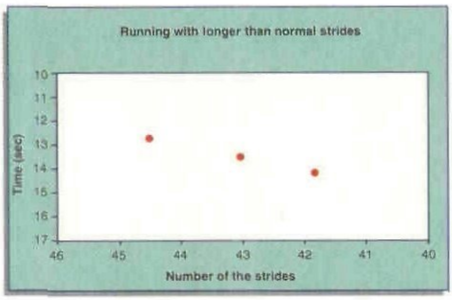


Figure 2: Data sample of Stefano Mei

temporarily, until the athletes learned to master the correct action.

Consequently, I conceived the following exercises:

1) Springy running, either on the spot or with a slight forward movement with a flexible foot action,
2) Running with a high knee pick up,
3) fast alternate bounds of less than maximum length.

In this way, it was possible, after a couple of weeks, to perform the test runs again with a longer than normal stride, but only as training, without collecting data on time or number of strides. I started recording these only when each athlete was able to perform the movements properly.

The subsequent training sessions showed that running with strides longer than normal again followed a trend similar to the one described above for running with strides shorter than normal.

For example, the athlete Stefano Mei, who at that time was a 1500m runner but who, later, became European Champion in the 10.000m, recorded the following results:

1) 41.8 strides in 14.12;
2) 43 strides in 13.47;
3) 44.5 strides in 12.73.

The graphic representation confirms a linear trend similar to that seen in the run with shorter than normal strides (*Figure 2*).

The highly positive results obtained with the middle-distance runners brought a question to my mind: since their evident improvement could be explained by their *low level* of maximum speed, which was fairly *easy to improve*, what would be the result, if I used similar exercises for 400m runners or even for *sprinters*?

With this in mind, I started to examine the effect of this method of training on a few sprinters.

In particular I used it with the 400m runner Roberto Tozzi, a former European Junior Champion, whose performance had depreciated to the point of only 47.20sec. After some months of training, he succeeded in winning the silver medal for the 400m at the Indoor European Championships in Gothenborg. He himself, a graduate in Statistics, helped me to develop the methodology, from a mathematical point of view, to a true, complete evaluation system.

2 Development of stride frequency and stride length

The training of both sprinters and middle-distance runners appears to be most effective when all the following groups of exercises are practised:

a) running exercises;
b) strength development exercises;
c) technique improvement exercises.

These exercises can be practised in different combinations, according to the speciality. For instance, strength development and technique improvement exercises play a more important role in sprint training than in middle distance training and running exercises are of less significance.

Every group of exercises consists of a number of categories. For example, running exercises can be divided into five main categories, each concerned with the development of:

a1) speed
a2) speed endurance
a3) lactacid endurance

a4) aerobic capacity

a5) aerobic endurance.

The role of each category varies according to the running speciality (*Figure 3*).

The exercises for the development of strength can be divided into two main categories:

b1) exercises for the development of speed strength,

b2) exercises for the development of endurance strength.

The importance of speed strength is greatest in sprinting and decreases as the running distances get longer. On the other hand, strength endurance is more important in the longer distances.

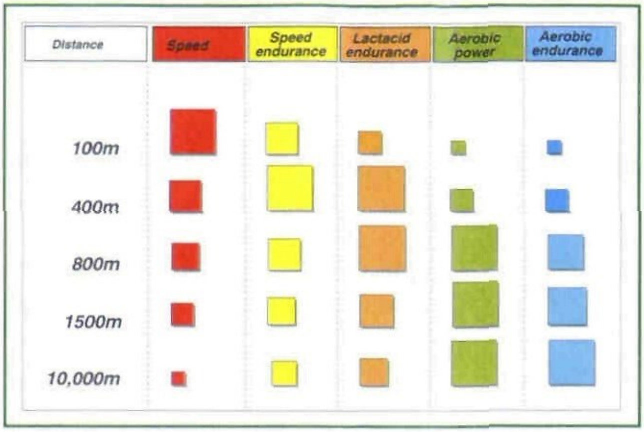


Figure 3: Importance of each of the 5 factors in given distances

Both speed strength and endurance strength can be enhanced by means of five groups of exercises (some exercises for the improvement of technique can be included in this group, e.g. the running elastic drills – *Fig. 4*).

The first group consists of what may be described as 'preparatory' exercises, generally using only the body weight, although belts, weighted with not more than 10% of the body weight, can also be used. The use of these belts does not change the way the exercises are performed.

The second group of exercises are carried out with loads weighing from 50 to 300% of the body weight, according to the exercise.

The third category consists of multi-bounds of various types: alternate, in quick succession, for height, with double foot take–off, for speed or for distance. Bounds, as part of the preparatory training, play a major role in the training of a runner, because their movements resemble that of the running action. They can be practised with belts or light weights (not more than the 10% of the body weight).

The fourth category includes the elastic running drills, high-knee running, both on the spot or with a slight forward movement, high bounding runs and "circular" running.

The fifth group contains all types of sprinting, with or without a weighted belt, on the flat or uphill.

In the development of endurance strength each of the five groups has different characteristics: the duration of the exercises and of

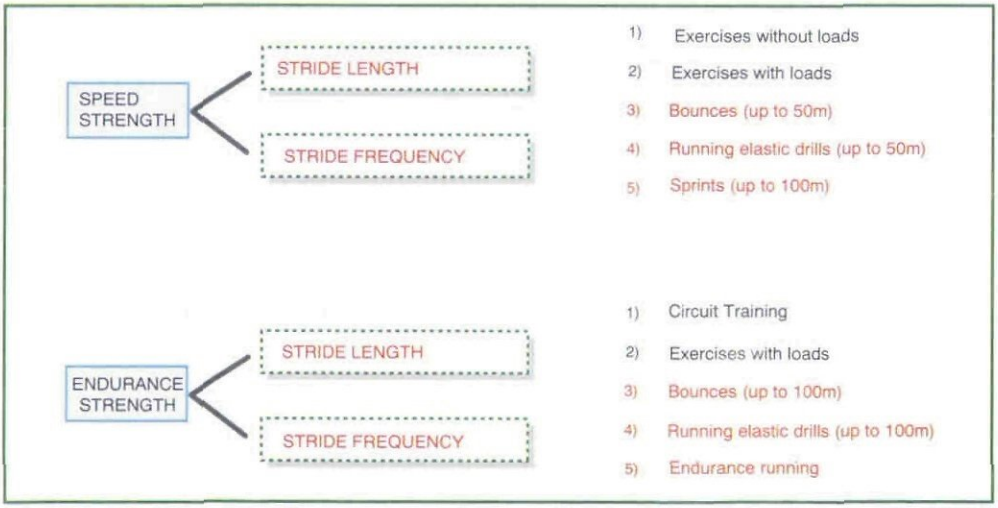


Figure 4: Relationship between the 5 categories of exercises and the 2 parameters of the stride: length and frequency

the recovery pauses changes, as does the method of performing the exercises.

For instance, all the exercises listed can be practised in the sequence described above or else in the form of circuit training.

In strength and technique training, three of these five groups of exercises are more specific, in that they are based upon the running action itself; they are directly connected with the two main parameters of stride length and frequency. They also form the main phase of the training, the other two types of exercises being complementary. They can be modified in regard to the relationship between stride frequency and length and between horizontal and vertical motion. These three groups are as follows:

- bounds (especially alternate bounds);
- elastic running drills;
- running (in order to improve technique and also as a conditioning means, to develop speed and endurance strength).

Alternate hops can be practised, emphasising height, distance or speed (*Figure 5, top*).

Alternate bounds can be practised in the same way; bounds help one to measure both speed and distance (*Figure 5, bottom*).

Fast running can be made more interesting by making the strides shorter and faster or longer than normal (*Figure 6*). These exercises can be learned by means of specific training. *Figure 7 (left)* shows the learning progression for "circular running".

Learning to run with strides longer than normal is more difficult but there are some fundamental steps to follow; these are illustrated *Figure 7 (right)*.

3 Aims of the Study

Running speed is the product of two parameters: stride length and stride frequency. Two athletes having a different length/frequency ratio may develop the same speed.

For example, athlete A may run the 100m race in 50 strides (mean stride length 2m; mean stride frequency 5 strides per second) with a time of 10.00sec; athlete B may achieve the same time in 45 strides (mean stride length 2.2m; mean stride frequency 4.5 strides).

This length/frequency ratio is, therefore, the differentiating factor between the two athletes. Apart from technique, this ratio is essentially dependent upon the length, power and elasticity of the individual athlete's lower limbs.

Consequently, for each athlete, the achievement of maximum speed depends on a specific length/frequency ratio; a different ratio would produce a lower speed. In the case of maximum speed performances, this can be assumed as a biomechanical rule but it is true only over the short term, a few hours or a few days, during which an athlete's physical condition, power, elasticity and technique are comparable.

Over the long period, each one of these features may be influenced, improved or impaired by training and this will, therefore, cause variations in the length/frequency ratio.

It is difficult to give a clear definition of the relationship between training and each one of the two parameters of running speed, because the parameters are independent and yet, in some ways, also

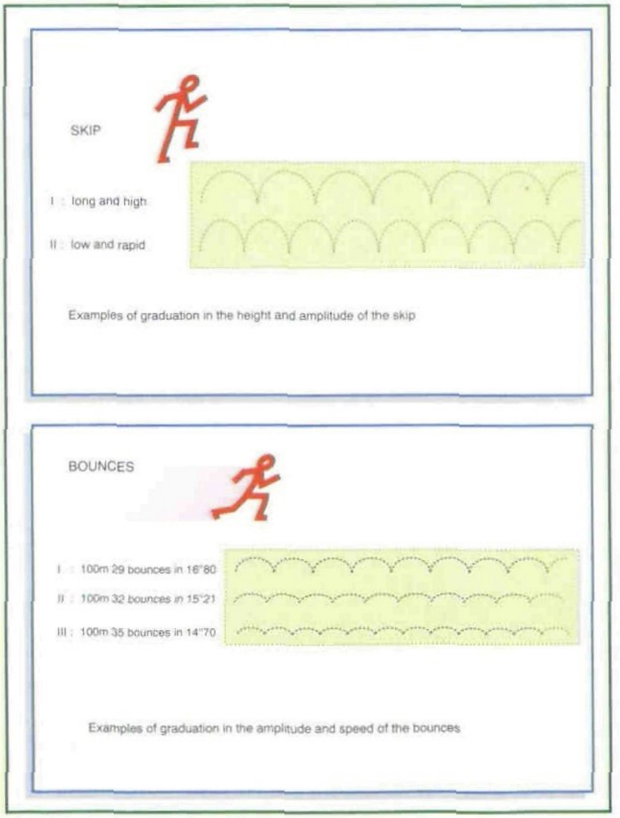


Figure 5: Examples of graduation of exercises

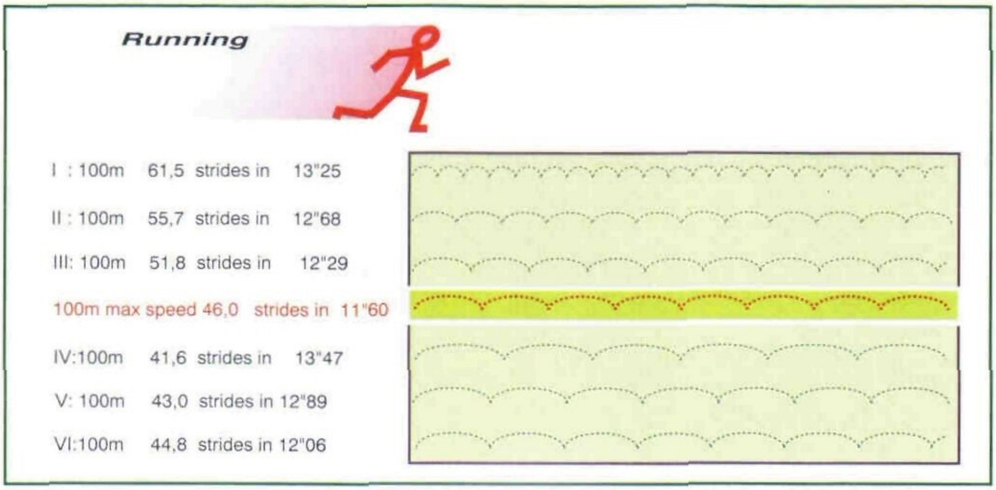


Figure 6: Examples of graduation of the running with shorter (quicker) and longer than normal strides

related. To put it simply, we may say that *stride length is determined mainly by the amount of force generated, while stride frequency depends on the CNS's capacity to emit strings of nervous stimuli in close succession, so that force is applied swiftly.*

In running at maximum speed both features are strongly involved and it is impossible to distinguish clearly the role of each parameter. In fact, most coaches make the mistake of focusing on the result of the interaction of the two: expressing running speed only in terms of strength. Such an interpretation is very restrictive in regard to training method.

New aspects of running speed become apparent when an athlete is asked to run with strides that are longer or shorter than normal.

A practical example is probably the best way to illustrate this statement. During a training session our sprinter ran 60 metres

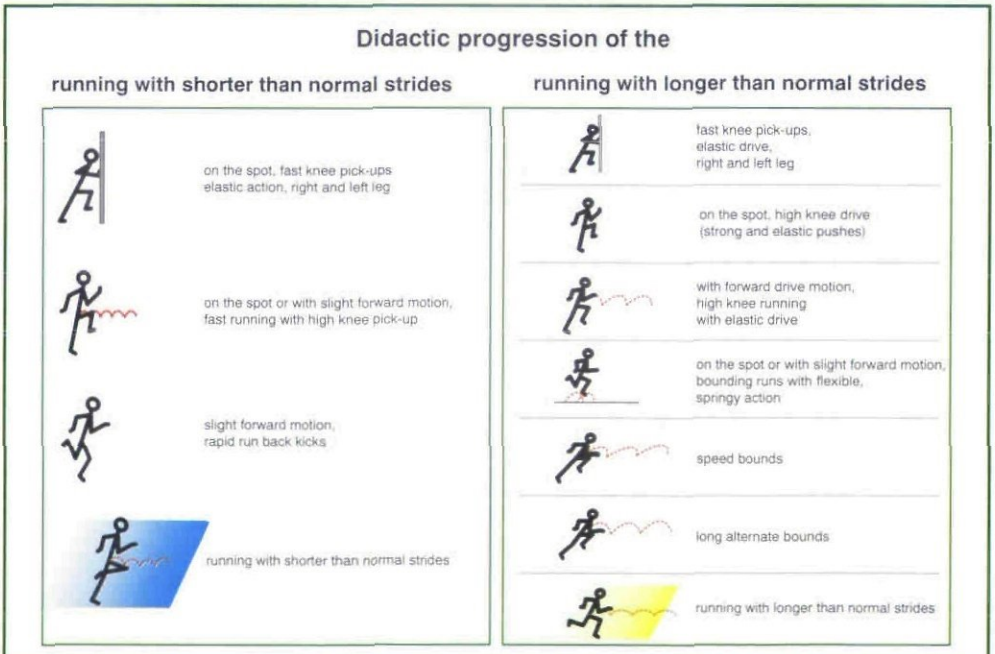


Figure 7: Didactic progression of the different forms of running

with 28.5 strides and timed 6.30sec (manual time), see *Figure 8*.

MAXIMUM SPEED			
6" 30	28.5		
SHORTER STRIDES		**LONGER STRIDES**	
6"43	30.5	6"41	27.5
6"70	35.2	6"72	25.7
6"94	38.0	6"89	24.6

Figure 8: Relationship between running speed (over 60m) and stride length

After an adequate pause, he was asked to run the same distance again, at full speed, but inserting two or three extra strides. His time was 6.43sec for 30.5 strides. After another pause, he ran the same distance with an even shorter stride: his time was 6.70sec, with 35.2 strides. The fourth run was timed at 6.94sec with 38 strides.

A graphical representation of the results of these runs shows that these are not random results but correspond to a real function, representing the interdependence between stride length and stride frequency i.e. between stride length and speed (*Figure 9*).

What is more significant and more relevant for training purposes, is that the relationship between stride length and frequency is a *continuous function*. Therefore it has value for any difference, even minimum, in the length of the strides themselves, (i.e. it takes the athlete 6.70sec to run 35.2 strides, 6.72sec to run 35.4, and so on).

Consequently, if an athlete's capacity to achieve higher speed, when running with short, rapid strides, can be developed by means of specific exercises, the athlete's speed will be positively influenced also for runs with slightly longer or shorter strides (*Figure 10*).

Similarly, it is interesting to examine an athlete running with strides longer than normal.

If the athlete is in good condition the research can continue immediately after the runs with short, fast strides.

In our example, the first run with longer strides was accomplished in 6.41sec with 27.5 strides; the second in 6.72sec and 25.7 strides; the third in 6.89sec and 24.6 strides.

The first consideration is that the process observed here is the mirror image of the one observed in the case of the runs with shorter

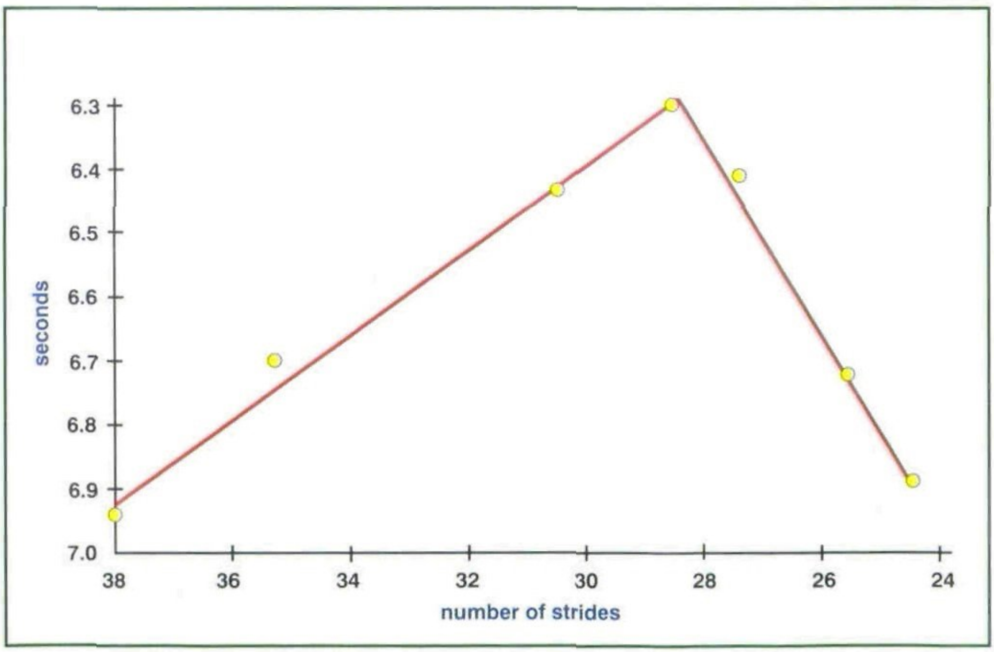


Figure 9: Relationship between running speed (over 60m) and stride length
The point of intersection of the 2 lines shows the theoretical optimal relationship

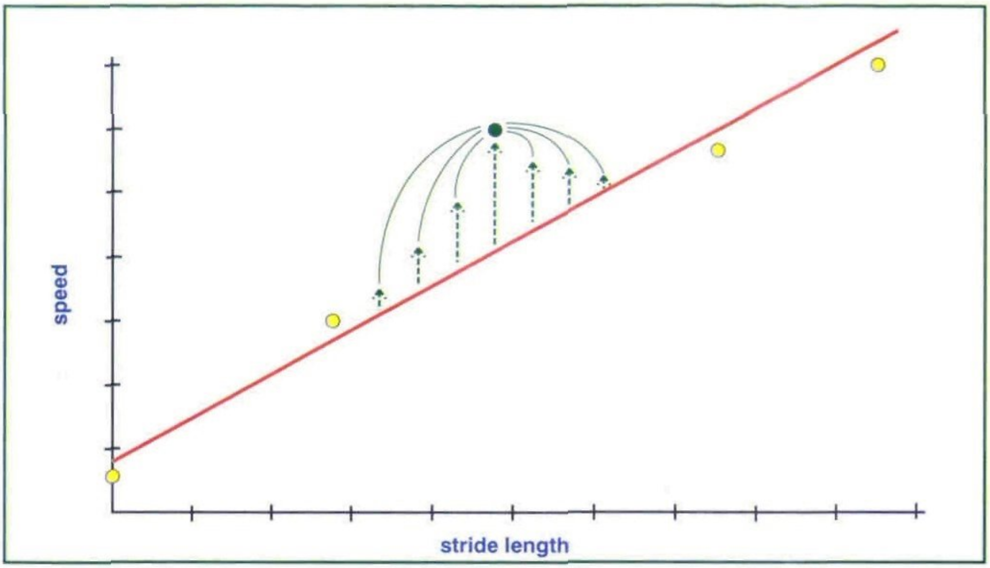


Figure 10: Schematization of the improvement resonance

strides: *a greater exertion of strength produces a more than proportionate limitation of stride frequency.*

The second consideration is that these results also point to the existence of a real function connecting the 3 runs with longer strides and the initial run with normal strides (*Figure 9*).

The athlete's maximum speed, then, is represented on both lines; consequently, the point of intersection of these two lines (showing the number of strides and speed) indicates the athlete's maximum speed capacity at that specific moment.

Indeed, in our example the maximum speed achieved in a 60m run (6.30sec in 28.5 strides), almost coincides with the point of intersection of the two lines (*Figure 9*).

An accurate analysis of these results reveals the following very interesting points (*Figure 11*):

- in the second run the athlete's stride was shorter by 6.5% while the speed was only 2% lower, thanks to a 5% increase in stride frequency;
- in the third run stride length decreased by 19%, speed decreased only by 6%, because stride frequency increased by 16%;
- in the fourth run stride length decreased by 33%, speed decreased only by 10%, because stride frequency increased by 21%.

This means that less use of strength produces a considerable increase in stride frequency and the decrease in speed is much less than the decrease in stride length.

Here again, a close analysis of the results shows that:

- in the fifth run, with strides longer than normal, stride length increased by 3.6%; speed decreased by 1.7% on account of a very significant 5.1%, decrease in stride frequency;
- in the sixth run, stride length increased by 10.7%, speed decreased by 6.2%; stride frequency decreased by 15.5%;
- in the seventh run, stride length increased by 15.9%; speed decreased by 8.9%; stride frequency decreased by as much as 21%.

The analysis of the relation between stride length and stride frequency provides a better understanding of sprint performance, in that it allows us to measure, in detail and separately, its two essential parameters (*Fig. 12*).

It also provides two distinct goals for speed training: the development of stride frequency and the development of stride length. This significantly enriches training methodology for a number of reasons.

Firstly, it allows training with a high intensity all the year round. At present, sprinters, 400m runners and middle-distance runners can train at maximum speed only for very short periods and for a limited number of training sessions, because of the extremely high energy consumption entailed, while training that is *focused mainly* on either

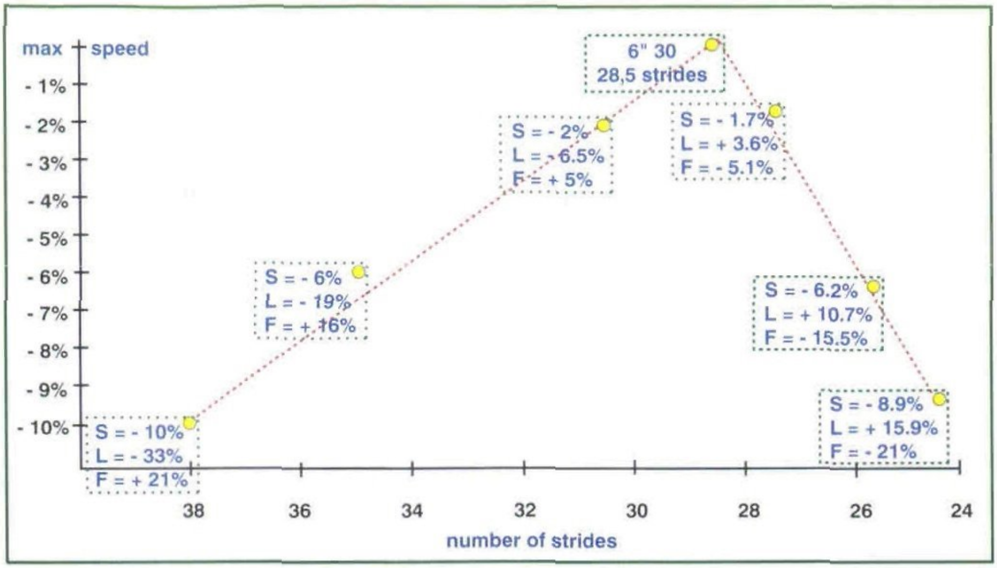


Figure 11: Performance variations of running speed and stride frequency in relation to stride length (running distance 60m)

stride frequency or stride length certainly uses up much less energy.

Secondly, it is a means by which training can be aimed alternatively at either of the two parameters, depending on the individual athlete's characteristics and requirements: in this way training becomes more personalized.

Lastly, it is perfectly consistent with the periodization of training, in which, week after week, training becomes increasingly more specific. Such an increase of specificity may be achieved through a progressive passage from training sessions using strides shorter or longer than normal to training sessions using close to the normal stride pattern.

4 Method

In the past thirteen years, data concerning about 200 male and female runners, has been systematically collected. These runners were

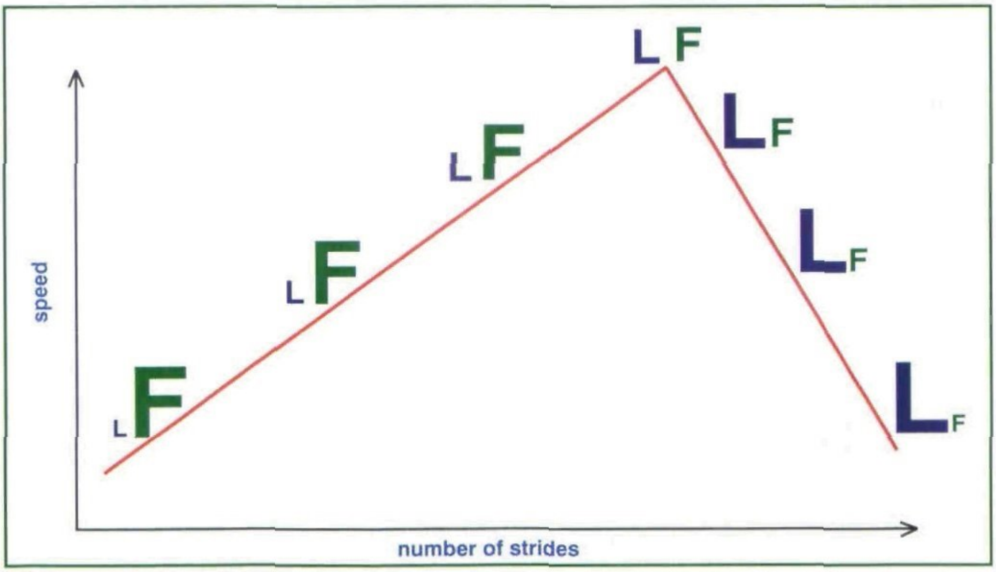


Figure 12: Relationship between stride length (strength) and stride frequency (frequency of nervous stimuli) – Each point of the 2 lines corresponds to a specific period of training

in different age groups, had different levels of performance and specialized in different distances. By this means it was possible to sketch an outline of a training methodology and a test that could validate it.

A more specific study was carried out on 42 Italian high level athletes, 25 male and 17 female, 25 specializing in sprint and sprint hurdle events and 17 in middle distance running.

Each of these athletes performed, at various times in the course of the year, several runs with short, rapid strides and several with longer than normal strides.

During each training session the runs were performed in the following succession (*Figure 13*).

a) At the beginning of the session runs were made with strides *shorter* than normal: the first run with very short strides and then with the strides becoming progressively longer, but, obviously, always shorter than the normal stride. Consequently running speed gradually increased;

b) immediately after this, runs were made with *longer* than normal strides, firstly with very long strides and then with progressively shorter, but always longer than normal strides. Here again, speed increased.

Each run was followed by an adequate rest and the distances varied between 60 and 100 metres, depending upon the individual athlete's characteristics and upon the specific requirements of each training period.

The following is an example of a high level athlete, during different periods of training, following these methods.

Pier Francesco Pavoni, sprinter:

March 1987: Pavoni was silver medallist at the Lievin European Indoor Championships, with a time of 6.58sec (28.1 strides).

Figure 13 shows the results obtained in a training session ten days before the chanmpionships.

When the times and the number of strides of each run are plotted on a graph and the first four 60m runs, where the strides were shorter than normal, are interpolated by a line, the correlation coefficient is very high, r = 0.9931. The second group of four runs, where the strides were longer than normal, is interpolated by another line and the correlation coefficient is also very high: r = 0.9856.

In the World Championship in Rome, July–August 1987, Pavoni qualified for the 100m final with a time of 10.22sec and for the 200m final with a time of 20.38sec.

The results he had obtained few days before, during a training session, are illustrated in *Figure 14*.

5 Results

The effectiveness of this training method, based on the breakdown of sprint performance into two parameters, depends greatly upon the coach's ability to evaluate and correct the athlete's technique and his choice of constant conditions for the exercises to take place.

PIER FRANCESCO PAVONI
Sprinter
(silver medal 60m in European Indoor Championships, finalist 100m and 200m in World Championships)

TEST 1 – 60m, March 1987

SHORTER STRIDES		LONGER STRIDES	
46.2	7"78	23.5	7"36
43.0	7"44	24.2	7"01
41.5	7"30	25.5	6"73
36.0	6"91	26.0	6"51

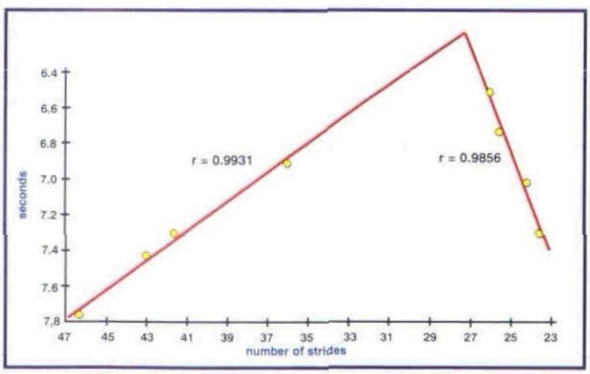


Figure 13: Performances during training obtained by Pier F. Pavoni in March 1987 (running distance 60m)

TEST 2 – 100m, August 1987

SHORTER STRIDES		LONGER STRIDES	
56.0	10"88	39.8	10"21
53.9	10"69	40.7	10"10
49.8	10"15	41.8	9"96

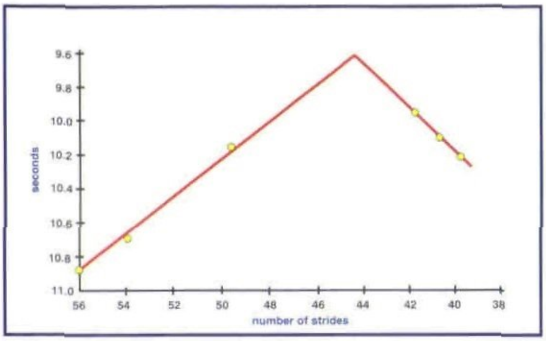


Figure 14: Performances during training obtained by Pier F. Pavoni in July–August 1987
(running distance 100m)

It is essential that

- adequate rest periods are given, since fatigue would render the data obtained useless for comparison;
- weather conditions (especially wind and temperature) are as constant as possible;
- the type of track, clothing and shoes are the same for all the runs (performances obtained with spiked shoes cannot be compared to those obtained with rubber soled shoes);
- the runner's technique should be stable because any variation would influence the results;
- the number of strides and the times are recorded very accurately.

The above examples lead to several significant observations;

a) the slope of the line representing runs with short rapid, strides is *usually less accentuated than that* of the line representing the runs with longer strides;

b) the point of intersection of the two lines indicates the time and the number of strides that the athlete should, in theory, be able to achieve in that specific period, in a maximum speed run;

c) in order to forecast an athlete's performance, it should be noted that, near the point of intersection, the two lines tend to curve and form a parabola (*Figure 15*).

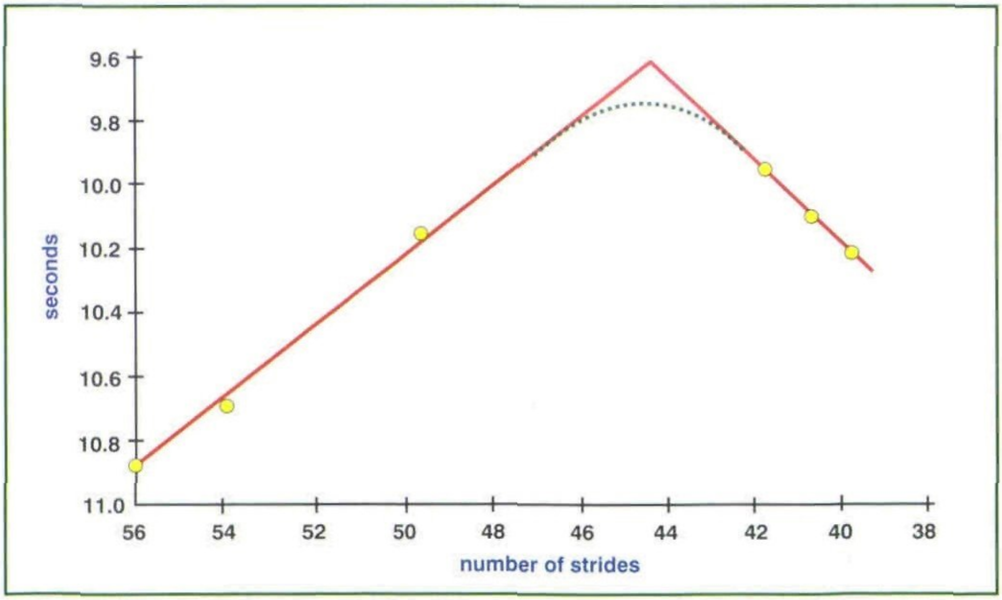


Figure 15: Near the point of intersection the 2 lines tend to curve and form a parabola
(Pier F. Pavoni, July–August 1987, 100m)

A computer programme, called "Sprint Test", has been produced, to help the coach to process recorded data and highlight possible errors and thus improve his evaluation of the athletes' training condition and of their potential performance.

Sprint Test will:

- *calculate the performance the athlete should be able to achieve in competition* (time in seconds and hundredths of seconds, number of strides) – an equation calculates the point and the angle of intersection of the two lines;
- *monitor* possible *errors* in the collection or input of the data; the programme automatically checks variations of the correlation coefficient and variations of the curve's inclination and requests the operator to double check the doubtful data or eliminate the definitely wrong data;
- *file* recorded *data,* with the name of the athlete and the date of the training session;
- *compare* the results of different training sessions of the same athlete or the results of different athletes.
- *group* the results of one or more training sessions of the same athlete, referring to a specific period;
- *process and represent graphically* all the data concerning the runs with strides shorter or longer than normal, at distances of from 150m to 800m.

The Sprint Test forecast for Pier Francesco Pavoni, in March and in August 1987, turned out to be very close to the result obtained in competition (*Figure 16*).

We may add that, during a training session in that same period, Pavoni ran the 100m in 9.75sec with 43.5 strides (10.17sec, with electric timing, in 44.1 strides).

Sprint Test has been extensively tested also for the women's 100m and the men's 110m hurdles.

In the case of hurdlers, the breakdown into frequency and length refers to the three strides between hurdles. It is possible, and effective, to enhance either of these two parameters in training.

Here, the "normal stride" is the one established by the rules and not the athlete's natural stride, which would, as in the case of sprinters, lead to the achievement of that athlete's best performance.

Pier Francesco PAVONI

PERIODS	SPRINT TEST	COMPETITION
January '87	6"68 (28.9)	6"70 (28.7)
March '87	6"59 (27.8)	6"58 (28.1)
August '87	10"14 (44.7)	10"19 (44.9)

Figure 16: Comparison between Sprint Test's forecast and results in competition

The use of Sprint Test allows a comparison between the "required" stride and the individual's "ideal" stride, so that the coach may adjust the athlete's characteristics to the requirements of the event.

Carla Tuzzi, 100m hurdler:

In *February 1994* Carla Tuzzi improved the Italian indoor record seven times and was fifth at the European Indoor Championships.

Figure 17 shows the results obtained at the 60m hurdles, during training sessions ten days before the championships.

CARLA TUZZI
Hurdler
(finalist 60m H in European Indoor Championships)

TEST 1 – 60m, February 1994

SHORTER STRIDES		LONGER STRIDES	
46.7	10"60	28.3	8"18
40.6	9"42	29.0	8"07
36.3	8"47	29.8	7"93
33.8	8"13		

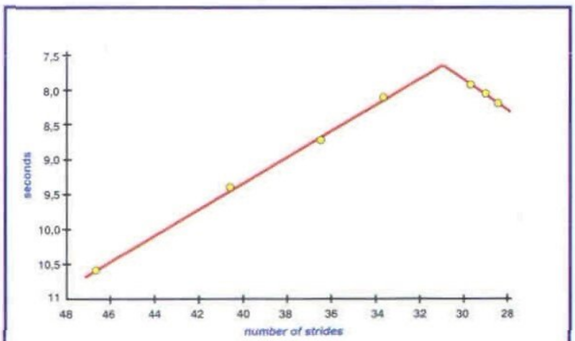


Figure 17: Performances during training obtained by Carla Tuzzi in February 1994 (running distance 60m)

June-July 1994: Tuzzi improved the Italian record several times for the 100m hurdles and finally set it at 12.97sec.

The results of training runs over the 100m hurdles, towards the end of June and at the beginning of July, are shown in *Figure 18*.

The Sprint Test forecasts for Carla Tuzzi were 8.05sec for the 60m event in February and 12.97sec for the 100m hurdles in July. The results in competition were, respectively, 7.97sec and 12.97sec (*Figure 19*).

6 The application of these exercises to the endurance events

The exercises for developing stride length and frequency were, first of all, created as a solution to the problem of lack of speed in middle distance running. However, It is evident that speed is only one of the components affecting performance in middle distance running; both 800m and 1500m runners need to develop speed endurance as well and long distance runners need it for the finishing burst.

Naturally, speed endurance can also be divided into the two basic components of:

1) Frequency endurance (of the rate of striding) and
2) Strength endurance (stride length).

TEST 2 – 100m, July 1994

SHORTER STRIDES		LONGER STRIDES	
78.2	19"43	45.2	13"60
59.6	14"96	46.4	12"31
54.7	13"74	47.7	13"02

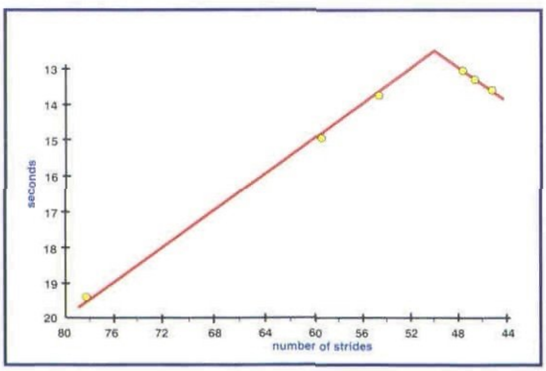


Figure 18: Performances during training obtained by Carla Tuzzi in July 1994 (running distance 100m)

Carla TUZZI

PERIODS	SPRINT TEST	COMPETITION
February '94	8"05 (32.2)	7"97 (31.0)
July '94	12"97 (50.3)	12"97 (50.0)

Figure 19: Comparison between Sprint Test's forecast and results in competition

Training sessions, using strides longer or shorter than normal, carried out at distances longer than 100m, enable us to develop these two components.

For 400m runners, it is recommended to use distances of 150m to 400m (*Figure 20*). For middle and long-distance runners, it is better to use distances of 200m to 800m..

For stride frequency and length endurance training, the two basic exercises of running with a high knee lift and running with a high back kick are especially recommended.

To improve frequency, 40 strides should be used for each exercise, while, for endurance training, 80-160-320 strides will be needed (*Figure 21*).

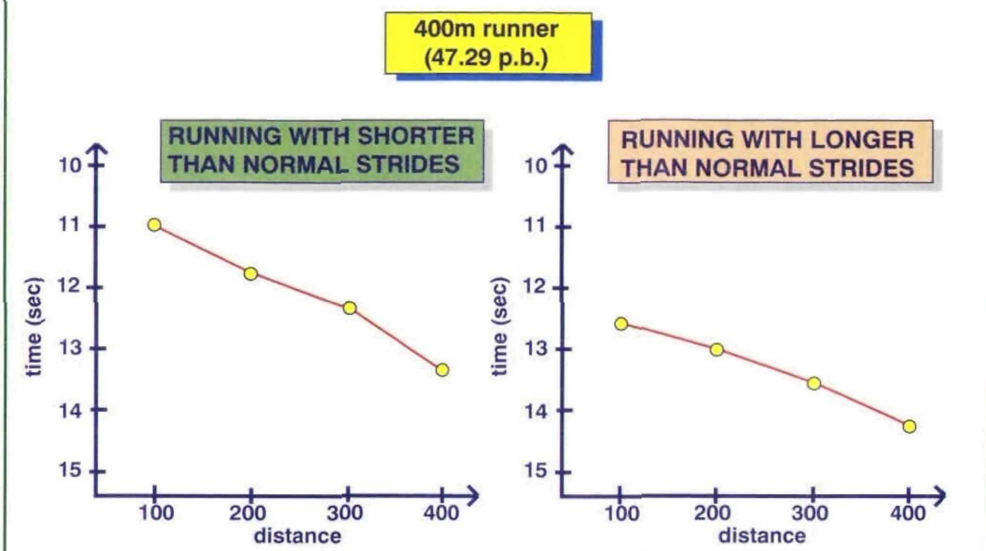
By practising all the four exercises it will be possible to transfer the improvement gained in stride frequency and stride length into an improvement in endurance.

7 Conclusion

The breakdown of sprint performance into two fundamental parameters allows the coach to accentuate either stride length or stride frequency, thus making training for the sprints, hurdles and middle distances more flexible and adjustable to individual requirements.

First of all, this method allows the coach to construct two distinct groups of exercises, one aimed at the *development of speed and speed endurance* and the other at the *development of strength and strength endurance*. It should be noted, however, that each group of exercises forms both the training means and the monitoring system (*Figure 22*).

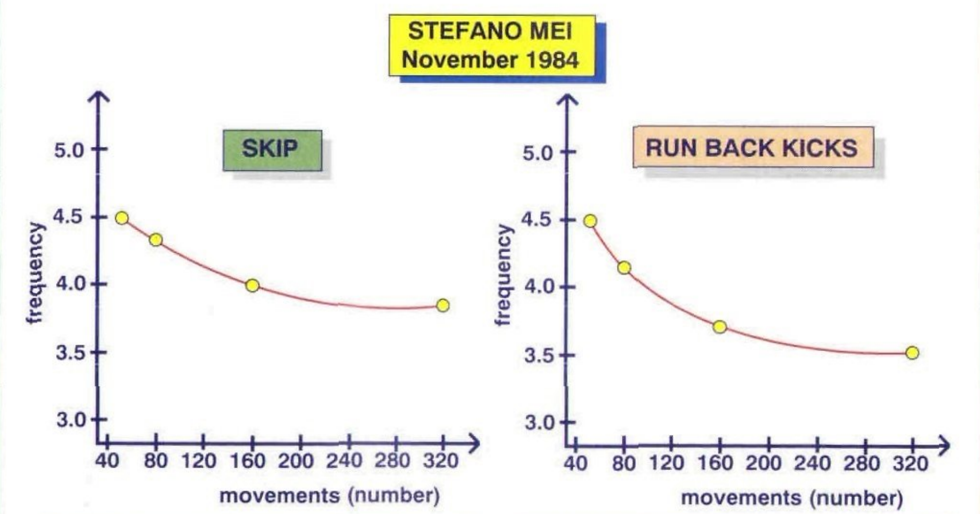
Secondly, this method allows the coach to evaluate whether the athlete is oriented towards stride length or towards stride frequency and to monitor performance, both



100m	56.0	strides	in	10" 98
200m	107.2	strides	in	23" 58
300m	161.3	strides	in	37" 05
400m	218.0	strides	in	53" 61

100m	40.2	strides	in	12" 63
200m	80.8	strides	in	26" 04
300m	125.8	strides	in	40" 88
400m	178.5	strides	in	57" 27

Figure 20: Training sample for a 400m runner



40 movements	8"72
80 movements	18"50 (9"25 x 2)
160 movements	39"80 (9"95 x 4)
320 movements	1'23"40 (10"42 x 8)

40 movements	8"88
80 movements	19"70 (9"85 x 2)
160 movements	42"94 (10"73 x 4)
320 movements	1'30"20 (11"30 x 8)

Figure 21: Training samples for the basic exercises of running with a high knee lift and running with a high back kick

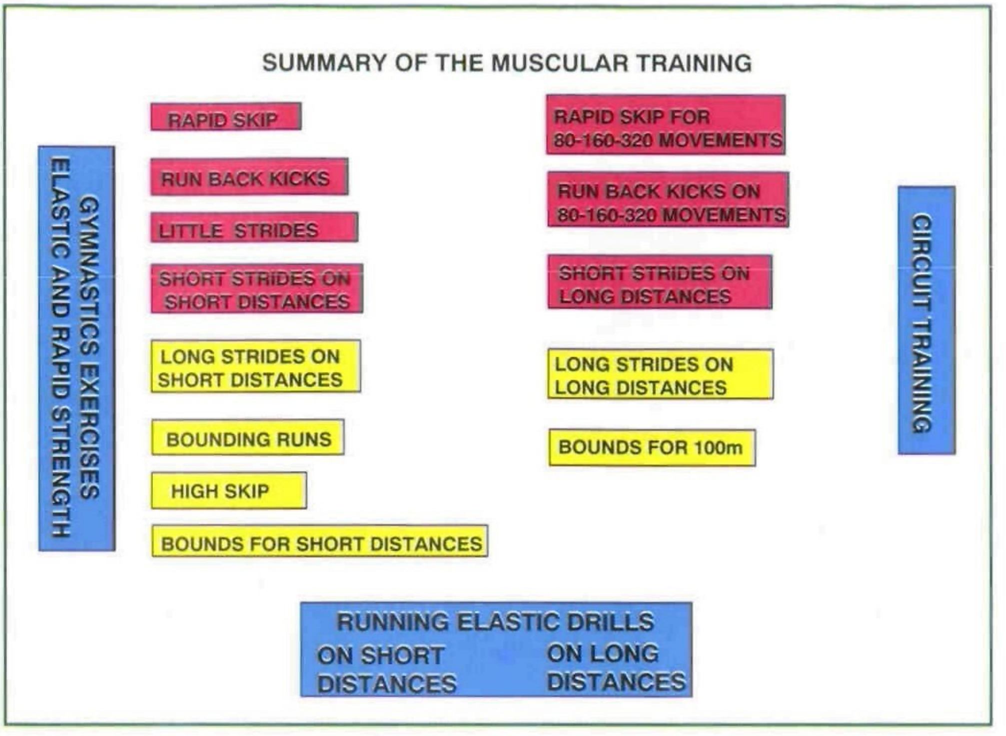


Figure 22: Training scheme muscular training

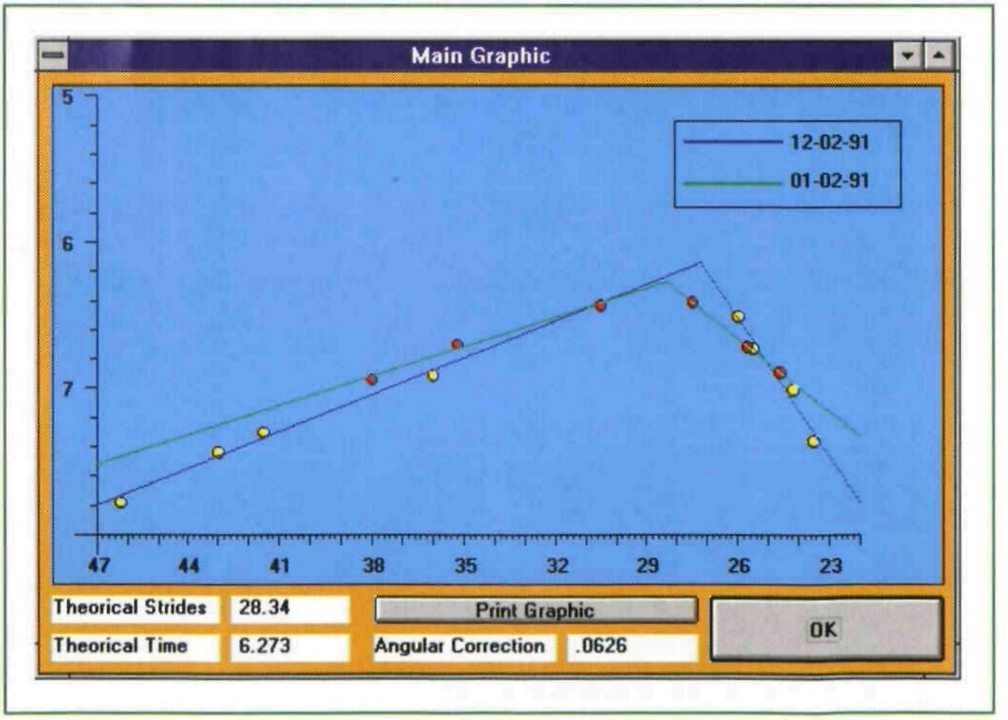


Figure 23: Sprint Test screen print of performance enhancement

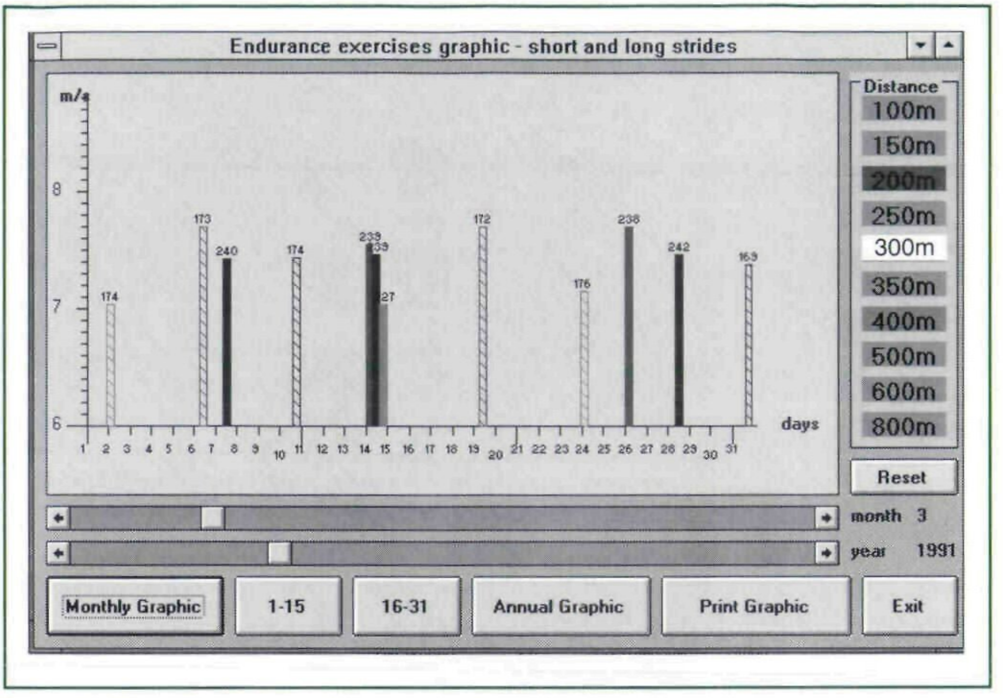


Figure 24: Sprint Test screen print – sample of monthly distribution of endurance training

in the acceleration phase and during full speed running.

Lastly, this method provides a framework for the construction of the complete training cycle, from the basic to the specific period, and allows the coach to adjust it according to the individual athlete's characteristics.

The Sprint Test computer programme allows the coach to store, process and interpret the data obtained from all the exercises. Sprint Test is a valid control system for training for speed, speed endurance and lactacid endurance. In speed training it reveals improvements in performance (*Figure 23*).

In endurance training it provides a complete recapitulation (*Figure 24*).