DEVELOPMENT OF MAXIMUM SPRINTING SPEED

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The 15th Annual Congress of the European Athletics Coaches Association (held in East Germany last January) focused on sprints and hurdles. We are fortunate to have this contribution firom EACA president and British director of coaching Frank Dick. Dick analyzes the Seoul 100m results and points out the important differences in sprint technique and training between men and women.

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THE DISCIPLINE

To the winner of the Olympic 100m goes the accolade "The world's fastest man/woman." It is a discipline where the focus of achievement in terms of improved performance and/or in terms of defeating opponents is measured in tiny time increments: increments of personal performance improvement may be as small as 1/100th second; while the difference between a gold and silver medal may require examination of photo finish detail to 1/100th second.

In preparing an athlete to challenge performance standards and opposition in pursuit of eventual Olympic success, the coach must reject the old adage that "sprinters are born not made." Instead, he should consider the needs of the athlete against the demands of the discipline; evaluate potential contribution of all relevant resources; and then prepare custom built programs designed to meet short-, medium- and long-term objectives.

THE DISCIPLINE SECTIONS

a) Reaction and Response Speed	= Reaction time and 10m time
b) Starting Acceleration	= 30m time
c) Pickup Acceleration	= Distance required to achieve maximum speed
d) Maintaining Maximum Speed	= Distance maximum speed held
e) Reducing the rate of loss of maximum speed	= Distance over which near-maximum is held after maximum speed peak is passed

10M BREAKDOWN IN SEOUL FINALS

To illustrate these, we should look at the data made available by the IAAF Biornechanical Analysis program from the Seoul Olympic 100 finals.

100m MEN'S FINAL

	JOHNSON		LEWIS		CHRISTIE	
10	1.83		1.89		1.92	
20	2.87	1.04	2.96	1.07	2.97	1.05
30	3.80	.93	3.90	.94	3.92	.95
40	4.66	.86	4.79	.89	4.81	.89
50	5.50	.84	5.65	.86	5.66	.85
60	6.33	.83	6.48	.83	6.50	.84
70	7.17	.84	7.33	.85	7.36	.86
80	8.02	.85	8.18	.85	8.22	.86
90	8.89	.87	9.04	.86	9.09	.87
100	9.79	.90	9.92	.88	9.97	.88

100m WOMEN'S FINAL

	GRIFFITH JOYNER		ASHFORD		DRECHSLER	
10	2.00		2.02		2.01	
20	3.09	1.09	3.13	1.11	3.12	1.11
30	4.09	1.00	4.15	1.02	4.14	1.02
40	5.04	.95	5.11	.96	5.11	.97
50	5.97	.93	6.07	.97	6.08	.97
60	6.89	.92	7.01	.94	7.02	.94
70	7.80	.91	7.96	.95	7.97	.95
80	8.71	.91	8.91	.95	8.92	.95
90	9.62	.91	9.87	.96	9.88	.96
100	10.54	.92	10.83	.96	10.85	.97

Brief comment on these sections is made here:

a) The 10m performances for the first three men showthat the pattern of the race for them was being laid down very early. The difference between the first three women's 10m performances was rather less significant.
b) The men's 30m times clearly separate Johnson from the field, 0.01 sec. was sufficient difference for Lewis to be aware of Johnson's lead and what this meant. It should be borne in mind that from this point onwards, the data should not be read simply as a series of sprinting speed measures, but as products of the complex process of athletes expressing their techniques aware of the challenges of the opposition.
c) The final phase of acceleration would appear from the data presented here, to bring athletes to maximum speed in the 50m and 60m section of the run—except in the case of Griffith Joyner. We shall consider this phase further here.
d) For every athlete except Griffith Joyner, maximum speed was maintained for one 10m section. If we consider as maximum speed "fastest 10m time and fastest 10m time + 0.01 sec," we have varying profiles:

JOHNSON		LEWIS		CHRISTIE	
40m-50m	0.84			40m-50m	0.85
50m-60m	0.83	50m-60m	0.83	50m-60m	0.84
60m-70m	0.84				

GRIFFITH JOYNER		ASHFORD		DRECHSLER	
50m-60m	0.92	50m-60m	0.96	50m-60m	0.94
60m-70m	0.91	60m-70m	0.95	60m-70m	0.95
70m-80m	0.91	70m-80m	0.95	70m-80m	0.95
80m-90m	0.91				
90m-100m	0.92				

It is my opinion that the capacity to maintain a speed within 0.01 seconds of maximum for 30m should be the object of the sprinters. Lewis' midrace data reflects a loss of concentration rather than a fair picture of his capacity to hold maximum speed:

40m-50m	0.86
50m-60m	0.83
60m-70m	0.85

Griffith Joyner's data suggests that her maximum speed was not achieved in this race. She in fact held a speed within 0.02 sec. of her fastest 10m time in the Seoul Olympic final for the final 60m of the race!

e) There is difficulty in drawing conclusions from the available data in reference to Johnson and Lewis. There had been so much publicity surrounding the JohnsonLewis encounter since Rome, that the two sprinters viewed themselves as the only two probable winners. They ran the race against each other rather than all 8 finalists. By 70m Johnson had reached his maximum 0.16 sec. lead over Lewis—and held this to 80m after which point Johnson ran the final 20m as if the race had already been won (arms aloft for the final 10m); and Lewis ran as if he'd lost. Thus Johnson covered the final 10m 0.07 sec. slower than his fastest 10m; and Lewis 0.05 sec. slower. As for Griffith Joyner-she was still within 0.01 sec. of her fastest 10m in the race, again raising the question whether or not she had achieved her maximum speed.

This leaves Christie, Ashford and Drechsler. The drop off from maximum speed to the finish was:

Christie	0.04 sec.
Ashford	0.02 sec.
Drechsler	0.03 sec.

From this and other data, it would appear that 0.020.04 is the normal range.

COACHING 100M

In coaching sprinters for the 100m, the coach seeks to prepare the athlete for the demands of each of these five sections-and for blending these into a whole. He must also, of course, build into the program, either through training or through competition itself, preparation for head-to-head competition.

The broad framework of preparation assumes a simple shape.

Phase 1: Develop basic conditioning
—all-round balanced strength
—sound general mobility
—running endurance
—general speed of coordination
Phase 2: Develop basic sprint technique(s)
—driving
—striding
—lifting
Phase 3: Develop specific conditioning
—specific strength
—specific endurance
—specific speed of coordination
—specific mobility
Phase 4: Develop advanced technique(s)
—driving
—striding
—lifting
—race experience/ tactics

STRIDE AND LIFT TECHNIQUES AS THE BASIS OF SPRINT DEVELOPMENT

In former times the basis of selecting sprinters was, in the first instance, results in age group sprint races. Unfortunately many high potential sprinters were lost at this point because too often age group sprinting success is determined by starting efficiency!

Although times and wins continue to be of interest to coaches, there is increasing awareness that central to all sprint development is a sound sprint *striding* technique. As a consequence, coaches now place much greater early emphasis on ensuring that the athlete is exposed to a relevant conditioning program of the sprint stride. The other two sprint techniques are built around this.

While much is made of specific conditioning and coordination drills, there is growing emphasis in ensuring that the first two phases (above) are more carefully dealt with in athlete development at all levels.

When considering maximum speed, the focus of attention on technique shifts from the *driving* technique of sections a + b through the *striding* technique of c to the *lifting* techniques of d then the *striding* techniques of e.

The *lifting* technique is normally only a feature of the experienced athlete's "armory," but it can be introduced to the developing athlete's technique training program. It is used as the athlete reaches the point of maximum speed—when coordination balances precariously on the brink of risk. The foot contact is at its briefest. As momentum catapults the body past each contact, that contact must contribute to the momentum. To keep contact for even a millisecond too long in trying to express strength will bring loss of speed. The focus is lightness of touch and coordination at speed.

It requires a foundation of specific strength, mobility and endurance-and mastery of the *stride* technique. Above all, it requires control. Without doubt, like all techniques, it must be practiced. However, the difficulty is that 9 athletes must endure the exhausting experience of maximal accelerations in order to reach maximum speed-the number of repetitions of runs at maximum speed to rehearse *lifting* and/or striding at this pace or at near to this pace, will be seriously restricted.

Because sound technique—both *striding* and *lifting*—are critical to development of maximum speed, their key features are worth review.

STRIDING

Posture: The athlete has the appearance of "running tall",
shoulders are down not hunched.
There should be no signs of straining or tension on face and neck.
The whole movement should be smooth a continuous—not jerky and broken.

Arms: MEN
Elbow angle of approximately 90° is held.
A full range of action is pursued—with the elbow pulled back and high with a strong "squeeze."
The hand reaches shoulder height on the forward beat—and the hip on the backward beat.
WOMEN
a) High stride frequency—coordination emphasis. Elbow angle of approximately 90° is held.
A short, fast "drumbeating" action—mostly in front of the body.
b) "New generation" high hip /leg complex strength emphasis.
Arm action as for men.

Legs: The athlete strikes the ground with a claw like action from a high knee lift. Women a) technique athletes do not have as high a knee lift as men b). A full range of action is pursued.

LIFTING

Posture: As for striding.
There should be an overall impression of lightness and speed of knee lift.

Arms: The arm action is similar to that of the stride technique. The main difference is slight in crease in the speed of action.
The range is virtually the same, but for a more emphatic pumping/beating in front of the body.
The women a) is, in effect, a more exaggerated version of the "stride technique" arms.

Logs: The leg action is characterized by a higher, faster knee lift or "prancing." It is a light, fast movement associated with a quicker, more active, and lighter striking/ clawing motion of the foot. It is as if it is the track which is speeding under the athlete—and the foot has only the briefest of moments to match this speed and touch it at that speed. The women a) technique athletes find problems with the concept of a higher knee lift and resolve the problem simply by main taining a very high frequency of striding.

DEVELOPMENT OF MAXIMUM SPEED

Athletes working to develop the maximum speed sections of 100m must include certain specific training units throughout the annual cycle. While there clearly are several ways of designing relevant programs-all pursue similar principles.

(i) Specific strength units are included through out the annual cycle but are reduced or removed during competition phases.
(ii) Strength units for women are continued later than for men—well into the competition phase.
(iii) Submaximum to maximum technique work is incorporated within each microcycle through out the annual cycle as a means of relating conditioning work to technique development.
(iv) Specific maximum speed work to super maximum speed work is mainly restricted to pre-competition and competition phases, but can be located in specific preparation blocks of work where altitude, elastic catapult, down hill/sprints or supermaximal speed tread mills, etc., are used.
(v) All systems use a double periodized year. Moreover, the various training units or systems enjoy certain common characteristics.
(i) Specific strength work uses interplay between relevant muscle dynamics and joint actions.
(ii) Where high-intensity strength loadings are a feature of the program (90%-100%) units can be continued through even to the days of competition.
(iii) Initially there is progression from submaximum to maximum speed intra unit and inter unit, to ensure the integrity of techniques.

TABLE 1: CONTROLS FOR 10OM/200M ATHLETES

Time Trials-hand timed						Competition Performance (electric timing)	
30m from Blocks	30m Flying	60m from Blocks	150m from Standing*	250m from Standing*	60m	1 00M200m	
3.58-3.61	2.48-2.51	6.22-6.27	14.87-14.97	25.47-25.72	6.49-6.53	10.0910.16	20.17-20.32
3.62-3.65	2.52-2.55	6.28-6.33	14.98-15.08	25.73-25.98	6.54-6.58	10.1710.24	20.33-20.48
3.66-3.69	2.56-2.59	6.34-6.39	15.09-15.19	25.99-26.24	6.59-6.63	10.2510.32	20.49-20.64
3.70-3.73	2.60-2.63	6.40-6.45	15.20-15.30	26.25-26.50	6.65-6.68	10.3310.40	20.65-20.80
3.74-3.77	2.64-2.67	6.46-6.51	15.31-15.42	26.51-26.76	6.69-6.73	10.4110.48	20.81-20.96
3.78-3.81	2.68-2.71	6.52-6.57	15.43-15.54	26.77-27.02	6.74-6.78	10.4910.56	20.97-21.12
3.82-3.85	2.72-2.75	6.58-6.63	15.55-15.66	27.03-27.28	6.79-6.83	10.5710.64	21.13-21.28
3.86-3.89	2.76-2.79	6.64-6.68	15.67-15.79	27.29-27.54	6.84-6.88	10.6510.72	21.29-21.44
3.90-3.93	2.80-2.83	6.70-6.75	15.80-15.92	27.55-27.80	6.89-6.93	10.7310.80	21.45-21.61
3.94-3.98	2.84-2.88	6.76-6.81	15.93-16.06	27.81-28.06	6.94-7.00	10.8110.90	21.62-21.88
3.99-4.03	2.89-2.93	6.82-6.87	16.07-16.20	28.07-28.31	7.01-7.06	10.9111.00	21.89-22.09
4.04-4.08	2.94-2.98	6.88-6.93	16.21-16.35	28.32-28.55	7.07-7.12	11.0111.09	22.10-22.30
4.09-4.13	2.99-3.03	6.94-6.99	16.36-16.51	28.56-28.80	7.13-7.18	11.1011.19	22.31-22.50
4.14-4.18	3.04-3.08	7.00-7.05	16.52-16.68	28.81-29.06	7.19-7.25	11.2011.29	22.51-22.72
4.19-4.24	3.09-3.14	7.06-7.12	16.69-16.86	29.07-29.34	7.26-7.32	11.3011.40	22.73-22.95
4.25-4.30	3.15-3.20	7.13-7.19	16.87-17.05	29.35-29.63	7.33-7.39	11.4111.51	22.96-23.19
4.31-4.36	3.21-3.26	7.20-7.26	17.06-17.25	29.64-29.91	7.40-7.46	11.5211.62	23.20-23.43
4.37-4.42	3.27-3.32	7.27-7.33	17.26-17.46	29.92-30.19	7.47-7.53	11.6311.73	23.44-23.69
4.43-4.48	3.33-3.38	7.34-7.40	17.47-17.67	30.20-30.50	7.54-7.61	11.7411.85	23.70-23.95
4.49-4.54	3.39-3.44	7.41-7.50	17.68-17.88	30.51-30.91	7.62-7.71	11.8612.01	23.96-24.27
4.55-4.60	3.45-3.50	7.51-7.60	17.89-18.09	30.92-31.32	7.72-7.81	12.0212.17	24.28-24.64
4.61-4.70	3.51-3.60	7.61-7.70	18.10-18.30	31.33-31.74	7.82-7.91	12.1812.33	24.65-24.98
4.71-4.80	3.61-3.70	7.71-7.80	18.31-18.55	31.75-32.15	7.92-8.02	12.3412.49	24.99-25.30
4.81-4.90	3.71-3.80	7.81-7.90	18.56-18.81	32.16-32.56	8.03-8.12	12.5012.65	25.31-25.65
4.91-5.00	3.81-3.90	7.91-8.00	18.82-19.12	32.57-33.06	8.13-8.25	12.6612.85	25.65-25.99
5.0-5.1	3.9-4.0	8.0-8.1	19.2-19.6	33.1-33.7	8.3-8.4	12.9-13.1	26.0-26.5
5.1-5.2	40.4.1	8.1-8.2	19.6-20.0	33.7-34.3	8.4-8.5	13.1-13.3	26.5-27.0
5.2-5.3	4.1-4.2	8.2-8.3	20.0-20.4	34.3-35.0	8.5-8.7	13.3-13.6	27.0-27.5
5.3-5.5	4.2-4.4	8.3-8.5	20.4-20.8	35.0-35.6	8.7-8.9	13.6-13.9	27.5-28.0

*Timed from first foot contact over start line.
tPosssible inconsistency where there are specialist 60m indoor athletes.

(iv) When working at maximum or supermaximum speeds there are full recoveries with stimulus duration of 2.0 sec-3.0 sec.—in sets of 2-4 and repetitions of 2-4. Athletes build gradually to maximum speed—rapid accelerations are avoided. Units for maximum speed development are normally separated by 48 hours. Two units per weekly microcycle are sufficient where other units include starts, acceleration and pickup work.

(v) Maximum speed work, accelerations, starting or pickup—all are performed with squads—and not by an athlete on his/her own.

(vi) The high intensity nature of training demands that regeneration units are liberally distributed through the competition and competition microcycle. It is also essential that athletes have access to a comprehensive program of medical management.

(vii) Coaches use personally devised tables for contrasts of strength, speed and speed endurance. For example: I use the following (Tables 1 and 2).

AN INTERPRETATION OF PREPARATION PROGRAM DETAIL FOR MAXIMUM SPEED DEVELOPMENT

In practical terms—one interpretation of these common principles and characteristics are as follows:

1) Core Preparation Phase
   = 6 weeks: November to Mid-December
   = 6-8 weeks: March to Mid-/Late April

Specific Strength (3 units per weekly microcycle)

OBJECTIVE	**EXERCISE**
Sprint Drive	Heavy harness sprints from crouch over 30m-40m x 3-4
	Left leg lead 10 bounds plus run out to 50m x 2-3
	Right leg lead to bounds plus run out to 50m x 2-3
Sprint Stride	Power running over 100m x 3-4
	Light harness from rolling start—fast over 30m x 3-4
	Alternate leg split tuck jumps—sets of 12 repetitions x 3-6
	High knee prancing over 40m-60m x 4-6
	Loaded thigh-high/fast knee lift/max possible speed of limb movement over 20-30m x 3-5

TRACK UNITS (3 units per 2-week microcycle)

OBJECTIVE	**EXERCISE**
Technique Differentiation	3 x 2 x 150m 30m drive 30m stride 30m lift 30m stride 30m lift.
	3 x 3 x 90m 30m drive 30m stride 30m lift.
	3 x 3 x 90m (from roll) 30m stride 30m ease 30m stride.
	3 x 4 x 60m-3/4—full speed—varying pace in mock race situations.

The balance of training units are general strength units mixing body weight exercises with weight train-

TABLE 2: BOUNDING CONTROLS

Target Time	Standing Jump Long (m)Reach(cm)	3 Bounds* (m)	5 Bounds* (m)	10 Bounds* (m)
10.20-10.65	2.90-3.2076-85	9.20-10.00	15.90-17.10	29.50-39.50
10.70-11.10	2.7G-3.0068-77	8.50-9.10	14.60-15.60	27.00-37.00
11.20-11.70	2.60-2.9060-69	7.90-8.50	14.00-15.00	25.00-35.00
11.80-12.20	2.50-2.8053-61	7.50-8.10	13.40-14.40	23.00-33.00
12.30-12.70	2.40-2.7046-54	7.20-7.80	12.80-13.80	21.00-31.00
12.80-13.20	2.30-2.6039-47	6.80-7.40	12.20-13.20	19.00-29.00

*From standing

Broad ranges reflect leg length variations as much as strength differences within groups. Coaches will establish tighter anges for individual athletes and “height groups.” Note: The data here represents a loose guide linking control and competition performance. Athletes may produce a given performance in competition without meeting all control criteria! Tables must be adapted and interpreted by coach and athlete accordingly.

The controls listed are by no means exhaustive. They should be adapted, added to, or rejected in light of establishing a relevant personal test battery.

Finally, statistics at the bottom end of Table 1—below the lineare presented as a guide for coaches working with athletes who are “fringing” the sprints group.

ing; and track units such as 3 x 3 x 1500m; 3 x 2 x 200m; 2 x 2 x 250m; or 2 x 2 x 300m to develop basic sprint stride, technique endurance.

2) Specific Preparation Phase
= 4 weeks: Mid-December to Mid-January
= 6-8 weeks: Mid-/Late April to Mid-June

Specific Strength (3 units per weekly microcycle)
As for the Core Preparation Phase

OBJECTIVE	**EXERCISE**
Technique Differentiation	3 x 2 x 30 drive 30m stride 30m lift
Technique at progressive speed	3 x 3 x 60m 3/4-fuII speed 8 x 100m buildups 3 x 3 x rolling 20m-30m

The balance of training units are high-quality track units over 4 x 150m; 3 x 250m; 2 x 300m; buildups over 6 x 200m; technique block work at 1/2-3/4 speed-3 x 4 x 40m and one general strength unit per weekly microcycle. Regeneration units are now introduced.

3) Precompetition Phase
—3 weeks mid-January to early February

(Special Camps-preferably warm at altitude)—3-4 weeks mid-June to early/mid-July.

Specific Strength (1-2 units per weekly microcycle)
As for the core preparation phase.

TRACK UNITS	**EXERCISE**
Progression of maximum speed	3 x 3 x rolling 20m-30m 3 x 60m time trials 3 x 2 rolling 50m Training intensity competitions & relays

The balance of training units are time trials over 100m, 150m, 200m, 250m, 5 x 30m.

Training competitions from blocks, 6 x 100m, buildups, 3 x 3 x 60m, 3/4 speed, and regeneration units.

4) Competition Phase
= 4 weeks: Early February to Early March
= 8 weeks: Early/Mid-July to Early September

Weekly Microcycle
1. 2 x 3 x 100m quality speed relay
2. 3 x 2 x rolling maximum speed 30m
3. 3 x 60m competition runs in training
4. 3- 6 x buildup 100m
5. 5 x 30m competition runs in training
6. Rest or high quality specific strength; or fast light weights.
7. Competition.

IT IS A CONTEST, NOT A TIME TRIAL

Of course, the foregoing must be viewed against a background of a progression of balanced overall strength; technique drills; and sound medical and lifestyle management; all woven into a program over a period from 1-4 years in length.

In addition to a systematic approach to the physical preparation of the athlete for maximum speed—there must be meticulous preparation of the athlete for a variety of competition situations. While the word "concentration" is readily understood when it comes to expressing the lifting technique at maximum speed the focus of concentration may not be such when race situation variables are introduced. The thought processes in chasing and catching an opponent are not the same as those when running at an opponent; nor when chasing and but failing to catch an opponent.

The coach must ensure that the athlete has opportunity to learn appropriate thought processes through the experience of the full range of race situations.

More than this there must be regular return to such learning situations under increasing pressure so the athlete's performance capacity improves.

CONCLUSION

The sprinter's development of maximum speedboth in terms of time for 100m and speed achieved within the run—rests squarely on establishing a sound technical model, improving relevant physical ability, then building towards expressing the technical model at progressive speed through those stimuli which facilitate speed both in training and competition. The key technique is the sprint stride-with the sprint lift (maximum speed) and sprint drive (start and acceleration) built onto this technique. While stride, lift and drive are each practiced separately they are constantly referred to the continuous whole of the linked sections of the discipline. In the final analysis, the discipline is, however, a contest and athletes must learn through competition and experience to master the range of situations which head-to-head 100m competition implies.