Understanding Speed Training

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Speed development remains the foremost task from American cross-country skiers. Our skiers may achieve world-class speed but cannot sustain that speed through enough of the race distance. If the speed slows, even slightly, as it often does in mass start races, then American skiers place higher. We survive longer in the lower gear. Unfortunately, that is too often our top gear. The task at hand, therefore, is to develop another gear, or, more accurately, re-engineer our gears at every speed, so at the same efforts we cover more ground at each, from base endurance pace to threshold to race pace. Only if the entire speed platform rises will a faster race pace result. For we know the Europeans not only race faster, they train faster while not exceeding the average heart rate levels we follow.

Part of the challenge is metabolic, energy systems. That is a matter of yearly hours and recipe and timing of training modes.

But for Americans, I think, the bigger challenge of developing speed lies primarily in neuromuscular coordination work. We have to learn to generate greater and faster energy output per stroke/stride, and that can only be accomplished through greater speed of contraction of the muscles. The close interconnection between power is obvious, but we should be careful to understand that the power comes from the speed of contraction, not the other way around. That confusion of cause and effect has long been a pitfall for us and lead us to do a lot of general strength work which has not brought the performance improvements we expected. Many sport scientists and coaches now agree it is the other way around: "The indispensable requisite for development of maximum power is the highest possible level of speed." (Rene Lacour of France in *NSA*, 2-3, 1996, p.60)

Speed development among US skiers cannot remain a secondary task, therefore, to be simply "peppered" into other endurance or power-endurance workouts. It must remain there, to be sure, but it must also be executed alone or near the beginning of other sessions, at least until the necessary higher goals speeds are securely integrated at all levels of training. This can only happen gradually over several years of carefully monitored speed work.

Jan Helgerud makes some useful distinctions in his double-pole article, "Maximal strength training improves work economy in trained female cross-country skiers," *MSSE* 31:6, 1999. Although he is talking about maximal strength training, his emphasis is on speed of contraction and the gains in overall efficiency it brings with it. It is what Helgerud calls a "nuanced view upon the strength capacity of cross-country skiers." (p. 871) The decisive point is that "during strength training it is the speed of contraction that is fast, not the movement speed....Improvement in double-poling economy was not associated with changes in peak poling force or poling frequency. It appears that one of the major changes was a decrease in the time to peak force during double-poling. Decreasing time to peak force... without changing the poling frequency at a standard work load results in longer rest period between strokes and may enhance blood perfusion in muscle resulting in better mechanical efficiency during exercise." (875) (Cf. Same conclusion in "Power Diagnosis in Endurance Sport") The resisting load is thus a means to achieving greater speed of contraction, not primarily to gain either muscle mass or develop higher strength numbers. And the greater speed of contraction/neuromuscular coordination becomes a key to overall mechanical efficiency/enhanced metabolic capacity. This is the meaning of "higher overall speed platform," re-engineering the skier's gears. The change of gears is not just a simple gain in mechanical advantage; it parcels out the "engine's" inherent power and fuel supply more effectively. Speed not only gets you there faster by itself, it brings with it that "better mechanical efficiency" which will then apply at every level of intensity in training. Without this re-gearing, which

takes unusual patience, discipline and attention to details, all the training in the world will not help us race faster.

In its purest form the development of speed is going to come from rapid, short contractions over very short distances, with total recovery between sets. It is neuromuscular coordination training. That is perhaps the most difficult psychological aspect for endurance athletes. There doesn't seem to be enough real continuous work in it. Others, finding reason for their preference for endurance work, sometimes say "I just don't have natural speed; I have to work harder." Or "that's just the way I run."

They need to hear Yuri Verkhoshansky* make another fundamental distinction which allows them real hope for improved speed: **quickness is one thing, speed another**. "The quickness characteristics of an individual are genetically predetermined, and, therefore, there is little space for improvement. Movement velocity (locomotion) is a specific human motor skill which can be improved by means of special training." (*NSA*, p.37) Quickness is involved in catching a fly, or dodging a snowball, where there is no real expenditure of energy. Speed concerns movements requiring energy and muscular effort in a context of external resistance of some sort. (*NSA*, p.29f.)

So not having "natural speed" in the sense of quickness does not preclude your learning to go very fast. Put another way, you don't learn to go fast simply by going as fast as you can now, with the speed you inherited.

Speaking particularly of young athletes, Brian Grasso puts it more drastically: "It is a very common misnomer that exists within the youth sporting world – to train speed, one must simply run fast; that is exactly the wrong thing to do." Verkhoshansky explains why. He describes two variants in approaching the task: A. Increase the speed of execution of the competition-specific exercise; and B. increase the potential for the application of force. (*NSA*, p.155) "Coaches tend to chose variant A, and this is a mistake. The intensification of training in the preparation phase, in particular by performing the competition-specific exercise at high velocity, or with a considerable strength effort, increases an athlete's functional capacity in the short term, but does not favour the transformations or morphological re-structuring necessary for further improvement of the specific work capacities and skills. Furthermore, a premature velocity increase negatively influences the development of the degree of training. Thus, in sports disciplines requiring speed-strength, this method causes excessive muscle factigue (in some cases even injuries) and an alteration of the bio-dynamic structure and rhythm of movements. As a consequence, the morphological and functional specialization process is slowed down, while a motor-coordination is created that does not correspond to competition conditions. A gradual increase in the intensity of the load, spread over a longer period, produces a greater and more stable development of the functional capabilities." (*NSA*, p. 156)

Two elements must therefore precede speed work. The skier must already be fit enough to tolerate gradual bu significant speed increases in specific training sessions. That means at least six weeks of patient preparation training. Secondly, the athlete must have mastered the proper technique before adding speed and never adds more speed that can sustain proper technique. The more a skier grasps the biomechanics of all the various modes of training, particularly running/skiwalking/bounding and skiing/rollerskiing, the more effective those training sessions will be for his skiing. Another article discusses in greater detail the speed-specific aspects of technique.

Verkhoshansky list four main methods of training speed (*NSA*. p. 39ff.):

1. **Long accelerations**. "The aim is to progress gradually to maximum speed and then maintain

the level achieved. During the accelerations the intensity of the muscle work decreases gradually, but the rhythm and movement technique must be maintained and controlled right up to the end [where you stop].... Rest intervals must be sufficient to ensure complete recovery."

2. **Fartlek**. Long accelerations (8-12 seconds) are interspersed during moderate intensity work not exceeding anaerobic threshold. The speed, distance, and number of accelerations are gradually increased, while the intervals between accelerations are maintained and their duration is dictated by the athlete's condition.....Experiments have proved the efficiency of short (up to 8 seconds) maximal accelerations performed during long distance swimming at anaerobic threshold." (*NSA*, p. 39)

3. **Competition-specific exercises, performed at increasingly higher speeds**. One variant focuses on even pacing, with no increase in the rate of movement or intensity of effort. The second variant allows the athlete any pace as long as he achieves the programmed result. (*NSA*, p.40)

4. **Progressively longer distances performed at the aimed at speed.** "The exercise distance is that attained up to the point at which speed decreases, and the aim of the exercise is gradually to increase the distance." (NSA, p.41)

Numbers 1,3 and 4 may be most familiar to us. They are essentially pace work, but not just any pace we can presently handle. The focus is always on a certain speed development goal, in which the measured speed desired is achieved and sustained until the technique breaks down. That point is the true functional meaning of "threshold."(Manshasov, *Lyshnya Trenerovka,* p. 53) Other "long" accelerations (2. fartlek) aim at the same coordination threshold but are much shorter, under 15 seconds, because of the maximum speed developed. Monitoring speed is more important here than monitoring heart rate. That is a difficult task for skiers especially because of the varied terrain we train in. But until we undertake to do that constant timing (best done on a track) and knowing where we are, we will not succeed in building the speed we want.

In am particularly concerned in this discussion with the pure speed implications of Verkhoshansky's explanation of fartlek, in particular the very short time of stimulation. We remember Helgerud's protocol of 3 times 6 repetitions. A competition frequency for classical skiing (47-50 strokes/strides/min) 6 repetitions come to +/- 8 seconds. There is Verkhoshansky's fartlek. Helgerud also uses 85% 1RM as the desired resistance, reasoning "Sometimes it might be advantageous to overcome resistance with the greatest possible speed at the beginning of the movement, when the external load is low and the duration of the movement short. In such cases, the influence of maximal strength is diminished and the importance of rate of force development increases. Poling at high speeds on flat terrain is an example of such a situation, and this property seems more important in cross-country skiing after the introduction of skating techniques with high racing speeds." (*MSSE*, p. 875)

The response to high (but not maximal!) resistance is increasing power output per individual movement cycle, i.e. per stroke or stride, and that results in the capacity to reach peak force sooner. "The optimizing of intramuscular coordination (within the muscle) means that more motor units contract simultaneously. 'Motor unit' defines the number of muscle fibers which are stimulated/excited by a motor nerve cell. Whereas in an untrained person only about 65% of is fibers contract simultaneously, despite great effort, up to 95% of the fibers in a power-trained athlete activate, because the synchronous activation of the available motor units functions much better." (*Das grosse Buch vom Skilanglauf*, p. 331) The optimization of intramuscular coordination requires great volitional focus, particularly on achieving the stretch-shortening cycle, at the initiation of the movement. Greater speed of individual contraction gains are followed by greater duration of the speed you have developed.

Speed thus becomes a habit. Thus high (but not maximal) resistance is necessary to enervate the fast-twitch oxidative muscle fibers first, and second sustain their extended activity levels. Power first, then power-endurance has its analog in speed first, then speed-endurance (or more accurately, endurance at the new speed level). (Cf. Jim Galanes' article, "Speed vs. Intensity in Training.")

The distinction between speed of contraction and either speed or frequency of movement is also the basis for earlier German research into developing power. The only way to train for increased output per individual cycle was seem in keeping the frequency very close to race frequency and not more. That study also validated the notion of very low repetitions in developing speed/power. (S. whole article "Power Diagnosis in Endurance Sport," also mentioned below.)

That study was done by Maren Witt and Jürgen Küchler in *Information/Dokumentation Sport*, IAT (Institute for applied training science) Leipzig. In "Power Diagnosis/Assessment in Endurance Sport" the possibilities for enlarging the energy amount in an individual cycle in cyclical movements are shown. The aim of such training is to emphasize the single cycle, as in pure speed work, and thus "alter the relationship of action- and pause time, raising inner-cyclical speed fluctuations," as with Helgerud, thus shortening the time to peak force and lengthening the recovery time (swing phase) in the cycle. (*Info/Dok Sport*, p. 37)

Echoes of Helgerud's results are clear, as is the critical role of elevated resistance. That is accomplished through braking devices (resisted wheels), weight vests, towed resistance, or special ergometers. We might think of hills as well, but there we would make a mistake: hills provide resistance, but they also slow the speed qualities of the movement. It is also done by using speed itself as the resistance, overspeed work as in shallow downhills or towing, or simply by higher rates with lower than usual resistance, but this must be done with great care and very small increases. Too great a gratuitous momentum can cause and athlete's coordination and balance to break down and even lead to injury. Verkhoshansky gives an example of facilitated speed work: using smaller paddles in canoeing. "It has been established that with the use of smaller-surfaced paddles (reduction 25, 50, and 75%) the strength index decreases but so does the time index of the work phase of each movement cycle and so the rhythm improves and the movement rate increases. When compared to the movement of the normal paddle, blood flow to the upper limbs increases and that to the lower limbs decreases. This points to a greater work load on the shoulder girdle and to the possibility of inducing an adaptive reaction of the cardiovascular system in response to the higher work rate." (*NSA*, p. 43)

If there is a heightened resistance, they all also caution, it should "only be so large that the musculature can be evaluated [work] in a functional relationship to competition." (*Info/Dok Sport,* p.37) Helgerud's protocol has the final repetitions verge on failure, but on a double-pole machine (Concept2 with a TaylorBar) I was unable to produce the watts output with maximal resistance that I could a little lower, at his 85% namely. That seemed to me to follow Verkhoshonsky's advice that "velocity should be high enough to stimulate adequate adaptive changes, but not so high as to produce a deterioration of technique." (*NSA*, p..39) Similarly, the frequency of movement "should in no case be higher than that in competitions." (Witt, Küchler) That allows concentration to fix solely on speed of each contraction without any added tension from rushing.

Finally, the point that in approaching power and efficiency through speed development we are primarily working with neuromuscular characteristics rather than cardiovascular is central to understanding the proper context of a pure speed training session: few repetitions, high resistance, complete recovery .between bursts. **Goal speeds are set; timing is routine and comprehensive.** Speed is subtle, sliced thin. Going even slightly slower, just to finish a session, is counterproductive.

Witt and Küchler compare two protocols which clearly elucidate the endurance approach versus the neuromuscular speed approach. The first was on a power training device, doing 4 x 1 minute of maximal pulls with 2-3 minutes rest between each minute. The second was done swimming, doing 6x10 repetitions, 4x20, then 1x40, with 3 minutes recovery between the series, and between the sets of repetitions just letting the pulse drop back to a good recovery rate. In the former protocol the per cycle outputs were relatively low, with high cumulative lactate values. In the latter by comparison, with fewer repetitions, lactate concentrations were quite low and outputs per cycle significantly higher. I have done both protocols on a double-pole machine and validated these comparative results, with the rate of improvement with the second well-documented, both in output measures in watts achieved and the peasant sensations of dramatically heightened double-poling effectiveness on rollerskis.

I have used this study to again emphasize the few repetitions and short distances of pure speed work (neuromuscular, intramuscular coordination). At the same time I recognize it as indeed a power-endurance protocol ultimately and falls into Verkhoshansky's catergory of "progressively longer distances performed at the aimed at speed." Even so, 10 repetitions at 70 strokes/min come to 8.6 seconds, 20 strokes/min to 17, and 40 to 34. Only the final 40 are truly outside the realm of pure speed work. And 40 repetitions at maximal speed reaches reaches the metabolic failure which Helgerud's study aimed at. Frequency/speed of movement can be maintained, but output drops by 15% or more. That in itself suggests why a diet of 30 second sprints or pickups in the midst of other training can only serve as pace maintenance work but not real speed development training. It will keep what speed you have but will not make you faster.

The following are some examples of speed development session for runners. Because acceleration is a bit slower in other modes of training – rollerskis, kayak, rowing, double-pole (both machine and on rollerskis, biking (in a fairlu big gear) – I allow 3-4 repetitions to get speed up before executing the actual speed repetitions themselves. The sessions respond to the principle: "The higher an individual's maximal sustainable pace for even relatively short distances, the higher will be his or her sustainable submaximal longer paces. This is primarily because of improved neurological recruitment abilities." (*Better Training for Distance Runners*) Simply put: **How fast you are is how fast you'll go.**

Execution

During 3-5 weeks of preparation for technique and strength work begin with fewer, shorter, easy "familiarization" runs, fast but at "comfort speed." Sometimes these are called "swing speeds." It also takes some time to become psychologically accepting of how short and apparently easy they feel. Also always think of two limbs working in concert, not one leg pushing off, the other swinging forward. The movement should be perceived at a sort of scissoring of the limbs. The speed remains thus perceptually centered.

The same principles apply to upper body and lower body work, the double-pole machine, roller skiing, with poles or without. Resistance can be added with a weight vest, 5 lbs of tired chains attached by a 10' rope around the waist, or an elastic cord (12' of 1/2" surgical tubing with hooks on both ends).

Examples

1. 3-4 runs over 30-50m: 4x30m@85%/2 min recovery
(5-8 strides/strokes) 4x30m@90%/2
4x30m@95%/2
4x30m@100%

2. 5-8 x 20-80m(thus: 5x8secs/1 min recovery
5 min between each of the 5-8 sets

3. 50m strides(800 pace) or accelerations (1st 25m 800 pace, 2cnd 25m faster by halving the time on support leg)

4. 1/2" surgical tubing 12' long attached between two runners. The lead runner accelerates away from the following runner, until the cord is well-stretched (resisted speed). When the rear runner decides it is stretched enough, he lets it sling him past the leader, picking up the cord in his hand as he goes by to keep it out of his way (facilitated speed). The acceleration lasts 4-6 seconds. Each runner may do only 3 or 4 before a full recovery is taken (3-5 min) and the next set taken.

5. I like the following speed preparation series by Tim Hiserman the best because it is systematic, gradual and fits nicely into other training. It does take time to organize, measuring everything, and it is not as easy as it might appear at first glance. It is ideal for getting fit for speed work and gets good result by itself. Most importantly, it exemplifies the principle that you must learn to run faster at all speeds, without increases of effort. I include it on a separate page, so it is more easily copied.

References, Authors

1.In *NSA*, New Studies in Athletics, a quarterly magazine of the International Amateur Athletic Federation, 2-3, Sept, 1996. The entire double issue is devoted to speed.

2.*Yuri Verkhoshansky, PhD is a Vive President of the Dept. of the International Academy of Information and the head of the Centre of Methodological and Theoretical Problems of Sports Theory of the Russian Research Institute of Sport, Moscow. He is also the President of the International Association of the Theory and Methodology of Training in Elite Sports.

3. *Rene Lacour is director of the Laboratory of Physiology at the University of Lyon, France.

4. *Das grosse Buch vom Skilanglauf*, Hottenrott, Urban, Neumann, Ostrowski, 2004. My translations.

5. *Development Trends in the Training and Competition Systems in the Endurance Sports with Implications for the Olympic Cycle 1996-2000, Information/Dokumentation Sport.* Institute for Applied Training Science, Leipzig. My translations. In the same volume Witt and Küchler, "Power Diagnosis/Evaluation in Endurance Sports."

6. *American Track and Field Resource Guide 2003*, Brian Grasso, "Speed Training for Young Athletes."

7. *Medicine & Science in Sports and Exercise (MSSE*), 31:6, 1999. Hoff, J., Helgerud, J., Wisloff, U., "Maximal strength training improves work economy in trained female cross-country skiers." This research was repeated with male skiers with similar results.

8. *Better Training for Distance Runners*, David Martin, PhD and Peter Coe. Peter Coe was father to Sebastian Coe, winner of two Olympic gold medals in 1500m anf two silver medals in 800m. He held a total of twelve world records.

Speed Conditioning Series

10meters = 3 strides/strokes
(allows conversion to other training modes)

swing=easy, loose, balanced
fap= fast as possible
ant= anaerobic threshold, full but without strain

week 1 swing: 10x100m, 10x100m
fap: [3x30][2x30, 1x40][1x20, 30,40]
ant: 8x100
total 3088m

week 2 swing: 10x200, 6x100
fap: [4x30][1x20, 2x40][4x20]
ant: 3x200, 6x100
total 4100m

week 3 swing: 6x300, 6x200
fap: [5x30][1x30, 2x40][1x20, 2x30]
ant: 3x300, 5x100
total 4450m

week 4 swing: 10x250, 8x100
fap: [3x20][3x40][1x20,30,40]
ant: 8x100, 8x100
total 4920m

week 5 swing: 6x300, 8x150, 8x100
fap: [5x20][2x40, 1x50][1x30,2x40]
ant: 4x250, 4x200
total 5120m

week 6 swing: 8x250, 8x150,8x100
fap: [5x20][2x40, 1x50][1x30, 2x40]
ant: 3x300,5x200
total 5440m

week 7 swing: 10x200,8x150, 10x100
fap: [3x40][1x30, 2x50][1x40,30,20]
ant: 2x500,5x200
total 6340m