<u>CompassSport Series - Fitness for Orienteering</u>

<u>Part 4 – Endurance Training</u>

This series of articles over the next year is aimed at helping the orienteer, irrespective of their age, ability or ambition, to develop their understanding of the fitness aspects of the sport and to help increase their enjoyment of orienteering through a logical approach to fitness development.

The previous article in the series addressed the weekly training 'microcycle' for the orienteer and examined how this would change throughout the periodised year. The essence of the ovearching plan is now in place and we now need to focus on specific suggestions for what each individual training session should comprise, with an eye on how this would fit within the various phases of the yearly programme. This article will focus on the development of stamina for orienteering.

Endurance Training

As outlined in the first article of the series, a strong aerobic foundation is required for the sport of orienteering, with the majority of events requiring competitors to continuously perform at a specific power output or velocity for a long time, ie. typically between thirty minutes to two hours. The development of a solid endurance base is thus the foundation stone for all other aspects of fitness development and should be the number one priority for orienteers, regardless of their level of performance.

Effects of a low aerobic capacity or a poor foundation of endurance training can easily be highlighted by analysis of a typical event's splitsbrowser trace (Figure 1 below). Competitor 1 has managed to maintain an even pace throughout the race, with only a minor reduction in split times, resulting in a strong overall performance on their course. Competitor 2 has seen a gradual linear decline, indicating that the endurance component is reasonably sound, but there may be elements of their top end, anaerobic fitness that require work in order to narrow the gap between themselves and the top orienteers. Finally, competitor 3 sees a curvilinear decline, which indicates that their second half performance on the course is witnessing a significant reduction in pace. Here the stamina side of their fitness is clearly deficient, as they are unable to maintain their early speed, and the focus of their programme would need to be an establishment of an endurance base capable of coping with the demands of such an event. Development of this orienteer's aerobic capacity would greatly improve their performance (and probably their enjoyment of the event!).

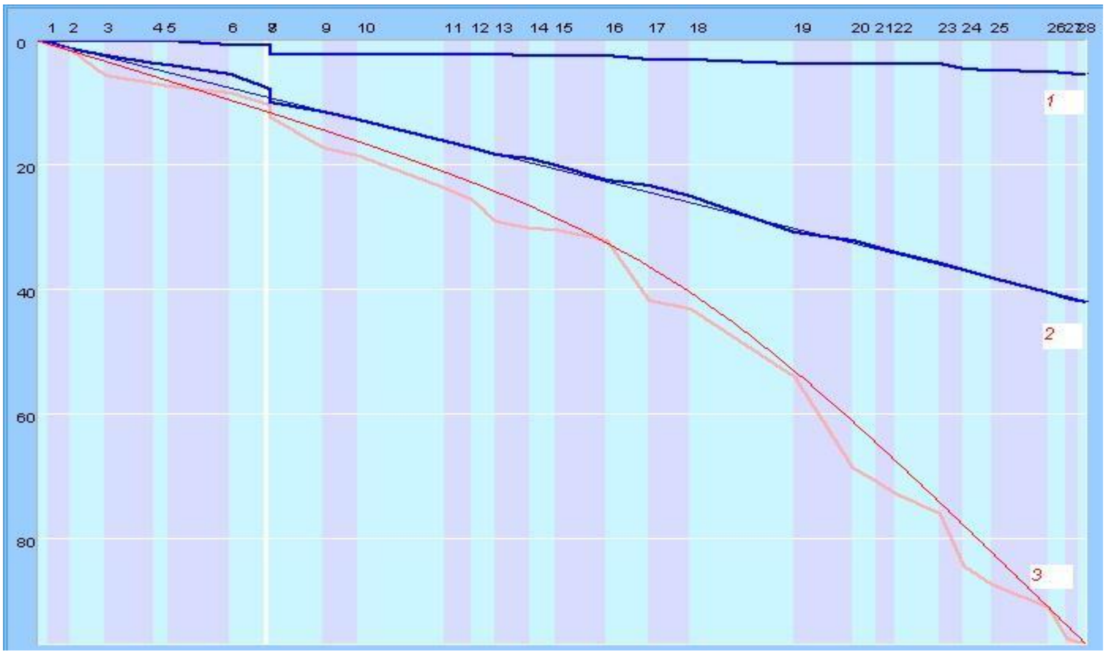

Figure 1. Splitsbrowser sample trace from the JK festival, 2010.

Factors Related to Aerobic Endurance Performance

As the duration of the orienteering event increases, from sprint to middle to 'classic', the proportion of energy demand met via aerobic mechanisms increases, as formerly outlined in the first article of this series. Therefore, high maximal aerobic power ($\dot{V}O_2max$) is a prerequisite for successful performance in the sport and, as stated previously, international level female orienteers have $\dot{V}O_2max$ values in the region of 60-70ml/kg/min, with international males reported to be in the 70-80ml/kg/min range (Gjerset et al., 1997; Jensen et al., 1999). Also, most races orienteers are running at around 80-86% of their maximum oxygen uptake levels throughout the event (Smekal et al., 2003).

Whilst up to 50% of the orienteer's $\dot{V}O_2max$ potential is predetermined by genetics (Bouchard, 1992), much can be done to maximise use of this capability, particularly within orienteers that are not previously well trained. The ability to achieve a high aerobic capacity is dependent on the increased development of all the complex factors arrayed in figure 2, and is essentially down to maximising the functioning of the pulmonary, cardiovascular and muscular systems. Good quality training programmes will be designed in such a way as to improve all of these components, in order to exploit fully the orienteer's $\dot{V}O_2max$ potential, but although a high aerobic capacity underpins successful performance, other factors may be equally or even more important, particularly once this component's ceiling has been reached. With elite orienteers, for instance, the differential between $\dot{V}O_2max$ values is often very small and, in these cases, it then becomes a matter of who can work at a higher percentage of their maximal capacity without accumulating large amounts of lactic acid in the muscle and blood (Baechle & Earle, 2008). Thus factors such as anaerobic threshold (the point at which the body cannot meet its energy demand through aerobic metabolism alone), running economy (the oxygen uptake required to perform exercise at a given intensity), effective fuel utilisation and muscular endurance also have a major role to play here.

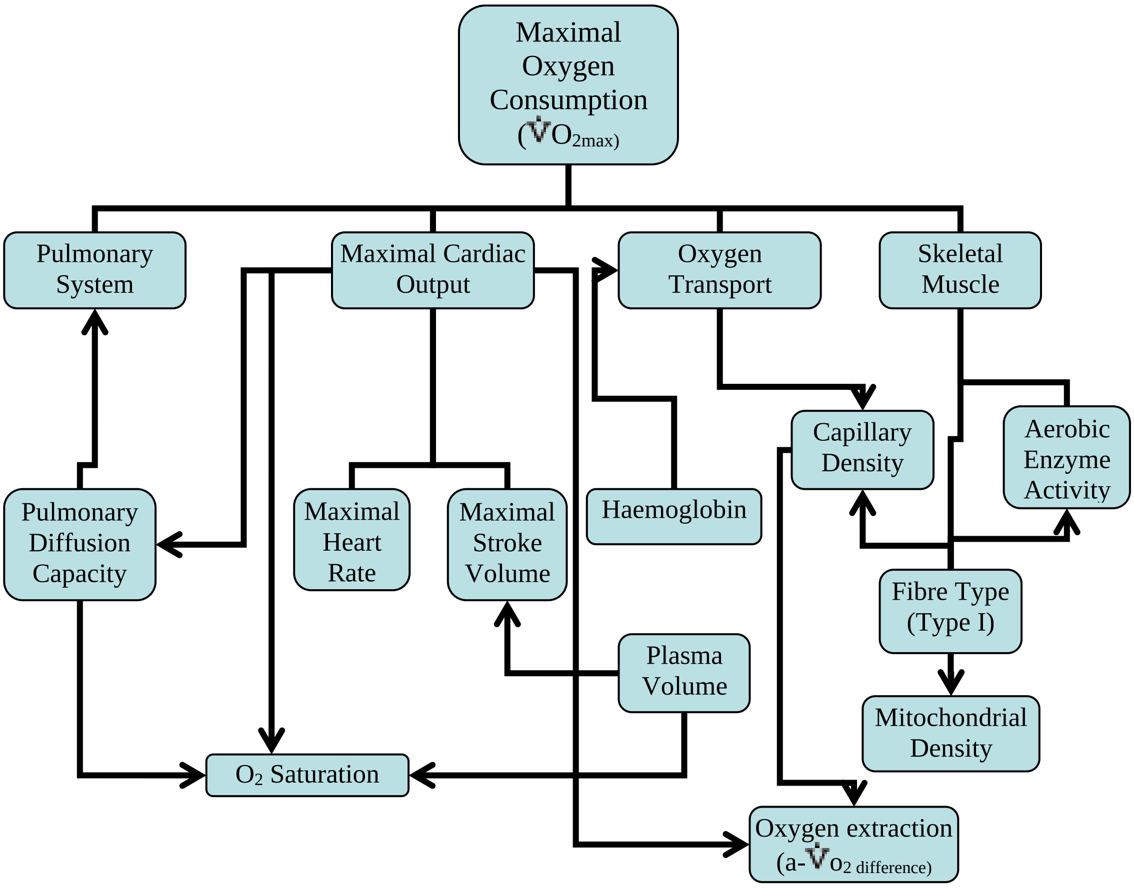

Figure 2. Factors affecting maximal oxygen consumption (Adapted from Bompa, 2009)

Methods for Developing Endurance

There are a number of types of training methods that can enhance aerobic endurance capability, from traditional continuous training, performed at low intensity, through to high-intensity interval work, all of which have their place in the development of the orienteer's fitness levels. Table 1 summarises the key methods, with the main design variables shown for each type of training session. Whilst the frequency and duration of the various sessions are easy to monitor, the intensity is much harder to gauge and is the key to making sure the programme is successful and that the benefits of each type of training are maximised. The calculation of the correct intensity for each training type is thus the focus of the next section.

	Recommended frequency (times per week)	**Duration of training portion**	**Intensity (%HRR/$\dot{V}O_2$max)**
Training method			
Recovery/active rest	1-2	30-45 min	~60%
Long, slow distance	1-2	>30min (race distance or longer)	60-80%

Pace or tempo training	1-2	20-30 min	80-90%
Aerobic Interval training	1-2	30-40 min total time	85-95%
Anaerobic Interval / Repetition training	1	30-40 min total time	Supermaximal
Fartlek	1	20-60 min	Varies between 60-90%

Table 1. Types of Aerobic Endurance Training. (HRR = Heart rate reserve)

Calculation of Training Intensity

A variety of methods exist to calculate the appropriate exercise intensity for aerobic training sessions, varying from simple, imprecise techniques, such as gauging exertion through breathing rate, to complex, expensive methods, such as calculating exact individual levels via laboratory testing. One of the best methods that is relatively inexpensive, yet still fundamentally sound, is via heart rate measurement and the calculation of heart rate zones. The use of heart rate monitors by athletes in a wide range of sports has increased enormously in the past fifteen years and cheap models can be acquired for relatively low cost.

Heart rate training zones are calculated by taking into consideration an individual's maximum and resting heart rates (MHR and RHR, respectively). To determine RHR take three measurements on separate days, ideally not following a demanding day's racing/training. On waking, and before getting out of bed in the morning, take a fifteen second count (and multiply by 4) to determine resting pulse rate (beats/min). Use the lowest value recorded over the three separate days as the RHR.

To determine maximal heart rate use one of the three methods below:

1) Wear a heart rate monitor (HRM) during a maximal test (such as a bleep test) and record the highest value achieved in the last two minutes.
2) Following a good warm-up, which gradually increases in pace, conduct a repeated (2-3 times) maximal three minute all-out effort. Ideally wear a HRM during this test and record the highest heart rate seen during the repeated bouts of exercise.
3) Finally, sprint and short hill races, where it is likely that the running will be at or around maximal intensity, can be used. Also a 3km time trial often results in the athlete reaching maximal HR levels during the final stages. Take the highest recorded HR value during the race.

The calculation of an appropriate zone value shown in table 1 is performed in the following way:

- Take MHR using one of the methods above and record RHR
- Subtract your RHR from your MHR giving you your working heart rate (WHR), also known as heart rate reserve (HRR)
- Calculate 10% of the WHR giving us "x" (rounding up or down to a whole number)
- Deduct "x" from your MHR to give 90%

- Continue deducting “x” to give the 80, 70 and 60% values

Example: The orienteer's MHR is 200 and their RHR is 60. They wish to calculate their pace or tempo training zone (80-90%). Thus:

- MHR - RHR = 200 - 60 = WHR of 140bpm
- 10% of 140 = 14bpm
- MHR-10% = 200 - 14 = 186 bpm (90% zone)
- MHR-20% = 200 - 28 = 172 bpm (80% zone)

Therefore our orienteer now has a zone calculated of between 172-186bpm for their tempo sessions and using this should give them a workout that will be both effective and scientific. They can easily calculate the other zones for their various training sessions using this method. Let us now examine the individual types of endurance workouts and place these into context for the weekly plan.

Recovery/Active Rest

These sessions are useful in helping the orienteer overcome the demands of heavy training sessions or races and must be performed at a low intensity to gain maximum benefits. The aim of these workouts is to encourage the removal of waste products and debris from the muscles, reduce inflammation and enhance the rebuilding and strengthening of the damaged soft tissue. Often running sports can utilise non-weight bearing workouts or cross-training, particularly cycling and swimming based exercise, to help the musculo-skeletal system recover quickly from the demands of high-intensity work, but without imposing on the body the impact forces normally associated with running. Within the micro-cycle, these sessions are usually placed the day after a race or a high-intensity session. They can also be used in the transition or recovery phase of the training year to help the athlete recuperate after a demanding season of races.

The important factor here is that the intensity of recovery sessions should be low (<60% HRR/$\dot{V}O_2max$) and the problem is that often the recreational orienteer will run these sessions at too high an intensity. For instance, Foster et al. (2001) found that athletes tend to run too hard on easy days and when this fault was corrected in a later study (Esteve-Lanao, 2007), through heart rate monitoring, the subject group improved their 10-km performance significantly.

Long, slow distance

These running sessions are the fulcrum around which everything else is built and are most important during the preparatory/base period of the yearly programme. Physiologically, these sessions are important in order to enhance thermoregulatory and cardiovascular function, improve mitochondrial energy production and oxidative capacity of the skeletal muscle and increase the utilization of fat as a fuel (Baechle & Earle, 2008). The other important benefit is the increased resistance of the orienteer’s muscles to the usual micro-trauma that ensues from the repeated impact forces associated with running, particularly of a downhill nature.

A typical microcycle during this period, where the orienteer is attempting to increase their aerobic foundation, will contain a mix of long, slow distance, active recovery, passive rest and aerobic interval/tempo sessions. Diagrammatically, a typical week during this phase is shown in table 2 (below).

Day	**Mon**	**Tue**	**Wed**	**Thur**	**Fri**	**Sat**	**Sun**
Workout	Rest day						
Endurance training		LSD	Recovery	Aerobic Intervals	Recovery	LSD	Tempo
Resistance training			Weights / Circuits		Weights / Circuits		
Total Duration		60	45	45	40	90	40
Interval Duration		60	45	5	40	90	25
Recovery (min)		0	0	1	0	0	0
Work/rest ratio		1:0	1:0	5:1	1:0	1:0	1:0
Intensity (%HRR / $\dot{V}O_2max$		65-75%	50-60%	85-95%	50-60%	60-70%	80-90%

Table 2. General preparation microcycle emphasising long slow distance (Adapted from Bompa, 2009)

As well as setting the intensity of these sessions at around 70% HRR/$\dot{V}O_2max$, these workouts should be viewed as ‘conversational’ exercise, where the orienteer can talk without undue respiratory distress. Typically, the orienteer will run for around 30-90 minutes and it is important to hold some of these workouts in terrain, particularly towards the end of the preparatory phase. This will have the sport specific, concomitant benefits for the orienteer of improved muscular endurance, core strength, balance and co-ordination.

Pace/tempo training and aerobic intervals

Often these sessions mirror the pace and demands of an orienteering race, where the runner is working at or slightly above their lactate threshold. The workouts can be conducted either continuously (tempo training, usually at a constant pace for around 20-30 minutes) or intermittently (aerobic intervals, for instance as 3x10minutes with 5 minutes recovery jogging between each interval). Examples of aerobic intervals sessions are: 3 x 1M or 6 mins at 80-85% HRR/$\dot{V}O_2max$, with 800m or 3-4 min recoveries (down to ~60% HRR/$\dot{V}O_2max$); 6 x 600m or 2mins at 85-90% HRR/$\dot{V}O_2max$, with 400m or 2-min recoveries; 8 x 400m or 75 secs at 90-95% HRR/$\dot{V}O_2max$, with 2-300m or 90 secs recoveries. Pyramid interval sessions, such as 1K, 2K, 3K reps at around 80% HRR/$\dot{V}O_2max$, with half-length recoveries in between each repetition, are also popular workouts for quality aerobic development.

These sessions, usually performed in the later stages of the preparatory phase, are demanding, with the repetition work intensity around 80-90% HRR/$\dot{V}O_2max$, but they are crucial for developing the endurance required to sustain ‘race pace’ in an orienteering event. Research has shown that performing aerobic intervals and tempo training twice a week for up to 4 weeks can stimulate significant performance gains (Laursen & Jenkins, 2002; Laursen et al., 2002). Improvements will be based physiologically around an increased lactate threshold, enhancement of running economy and the development of both aerobic and anaerobic metabolism. Care must be taken by the orienteer that there is sufficient rest during the microcycle to allow for adequate recovery from these sessions to take place, as too much of this type of training can easily lead to overtraining, resulting in staleness, injury and illness.

Anaerobic Intervals/Repetition Training
Similar in concept to aerobic intervals, but here the work intervals are very short (<2min) and the intensity is supramaximal (>100%$\dot{V}O_2$max). As the repetitions are so brief, the use of heart rate monitoring to gauge intensity becomes impractical, and intensity must be calculated via other means, such as related to time trial performance, and a number of online calculators exist to help devise the appropriate paces for the repetitions.

As the dependence is on anaerobic metabolism, the rest intervals are usually long, with the ratio of work:rest being around 1:3 to 1:5, so that a 30sec repetition would normally be followed by a 90-150sec recovery. Physiologically, this work results in improvements to $\dot{V}O_2$max, running economy and speed and increased ability to tolerate and remove lactic acid from the working muscles (Laursen & Jenkins, 2002). For orienteers, the benefits will include increases in top end speed and power through terrain, up hills and towards the end of a race.

Fartlek
A more informal type of training, these sessions typically comprise a mixture of running speeds, varying in intensity between easy running at around 60-70% HRR/$\dot{V}O_2$max and short, fast bursts of speed or hill work (~85-90% HRR/$\dot{V}O_2$max), and are conducted in a random, ad hoc fashion, often in terrain. This type of training helps to provide variety in a training programme and breaks up the monotony often associated with endurance training. Physiologically, the benefits include increases in $\dot{V}O_2$max, lactate threshold, muscular endurance and improvements in fuel utilisation and running economy (Baechle & Earle, 2008).

A typical microcycle towards the end of the preparatory period, just prior to the competitive phase, where top end, anaerobic endurance is the focus, is shown in table 3 (below).

Day	**Mon**	**Tue**	**Wed**	**Thur**	**Fri**	**Sat**	**Sun**
Workout	Rest day						
Endurance training		Aerobic Intervals	Recovery	LSD	Anaerobic Intervals	LSD	Fartlek
Resistance training			Weights / Circuits				
Total Duration		40	45	45	30-40	90	45-60

Interval Duration		3	45	45	45s	90	-
Recovery (min)		1	0	0	130s	0	-
Work/rest ratio		3:1	1:0	1:0	1:3	1:0	-
Intensity (%HRR / $\dot{V}O_2$max		90-100%	50-60%	65-75%	100%+	60-70%	60-90%

Table 3. Specific preparation microcycle emphasising anaerobic endurance development (Adapted from Bompa, 2009)

Conclusion

Using this information above, the orienteer can now begin to build their aerobic endurance base, with a varied programme of training activities that is focussed around a periodised year. It is important to consider your goals for the season and ensure that you devise your programme with these in mind and that any training programme set is progressive and gradual. The frequency and duration of your training sessions will need to be based upon your current fitness status – don't try to do too much, too soon and listen to your body! Always ensure that you get a good balance between work and rest. The next article will focus on strength development and look at ways in which conditioning work in this area fits in with the periodised plan.

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