Physical Training for Junior Orienteers

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1 Why all this physical training stuff?

So, you are reading this. This probably means that you are interested in becoming a faster orienteer. This report is a summary of my thoughts on how to tailor your physical training to accomplish this goal. I have always been interested in the subject, but only recently came to realization that the best answers are found in specialized running literature. This article is based on such literature, my studies of elite orienteers’ writings and training logs, and on personal experience.

The report contains absolutely nothing about technical training or O-racing. Both technical competence and running speed are important for one’s success in “foot” orienteering. The two go together; some say both are of equal importance, 50%–50%, and others assign different weights to the two. I would not like to try to figure out these percentages, but simply note that one’s running capability contributes a lot to her orienteering results. Because of that, it is important to understand how this running capability can be improved.

An even more interesting question is how to achieve certain gains in one’s running capability in the minimum possible time. That is, there are many ways to train. For example, an athlete’s training may mostly consist of spending a certain amount of time per week running on trails, at a certain intensity; another athlete will spend a different amount of time running on a treadmill at another intensity. If, after several weeks, both athletes report similar gains in their in-the-woods running speed, and neither gets injured, we should conclude that the one who spent less time training has had the better training program for “foot” orienteering. After all, this person had more time left to spend on other exciting stuff! The end goal of an athlete is not to spend as much time as possible training, but to get better orienteering results.

An alert reader can have noticed that in outlining the goals for this paper, I have already made some important assumptions. These assumptions are:

1. You can learn from scientific literature.
2. You can learn from the best in the sport.
3. You can, to a large degree, separate the physical part of training for orienteering from the technical part.

Assumption 3 is certainly contentious. There are whole camps of athletes and coaches that disagree with it, some quite strongly. As a matter of fact, some coaches state that no training sessions should be held without a map. Some of athletes who subscribe to this point of view have won numerous WOCs and JWOCs.

Other coaches and athletes, who have achieved equally impressive results, think that it is worth looking at the physical and technical training separately. Certainly, if one lives in an area that is far from O-maps, claiming that no good training can be done off the map dooms you to no training at all! In this situation, one can just resign to getting slower, waiting for those precious opportunities to get on a map. Or, one can take control of the situation and do some of that “boring” running training. Then, when time comes with lots of opportunities for technical training (such as a training camp), this built-up running training can be put to good use. Unfortunately for almost all of us in North America, at a certain point, our lives and careers will put us in this situation, far from the known O-universe. It is up to us to make the best out of it.

If you think you agree with the “no training off the map” camp, you probably should not read the rest of the paper. The structure of training that I am proposing demands certain types of training sessions, such as $\dot{V}O_{2\text{max}}$ intervals, which cannot be held while doing any useful kind of map reading. But I am ahead of everyone here with this $V_{O_{2\text{max}}}$ animal.

I obviously subscribe to Assumption 3; however, I am not going to say that the people who disagree are wrong. Simply put, there are different approaches to O-training. I am going to present
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one, and only the physical part of it. Many successful orienteers seem to generally follow the same structure of training. If you think that you’ll be more successful with different training, you should seek the advice of those who are experts in your chosen training framework.

Finally, who am I to offer this advice? I certainly do not qualify as a successful elite runner. My best result as a junior was 3rd place in the 1993 US Champs in M20, behind David Farquhar (NZ) and James Scarborough; ahead of Eric Bone. I placed 5th in the 1997 USOF rankings. Unfortunately, the demands of graduate education over many years never allowed me to train to fully develop my potential. However, I think that I can analyze scientific literature and patterns in elites’ training to the point of distilling out the useful information. I have always followed the basics of training schemes I am outlining in this article (although not always consciously).

This report, by itself, is absolutely incomplete as something you would use to plan your training in detail. It is meant to be a starting point. My goal is to outline the current knowledge and accepted training philosophy, and then direct you to sources that you can use for a much more thorough job. Large portions of this article are based on books listed in Section 3, and again at the end, in References. Read those books! There is too much wisdom in them to pass up.

2 So, I guess I need to put in some running to get faster, right?

That’s right. Question is, exactly what type of running gets you faster the fastest, while not leading to injuries. The answer is not simple, and depends on the amount of time you can devote to your training.

You probably know by now that one or two days of local O-events or “A” meets per week aren’t enough in the physical training department. Some people are talented enough that they seem to manage to not get much slower on just one or two weekly O-days. However, that’s the best outcome of this type of “training”; you’ll be able to maintain your current fitness level. Personally, I have never been able to do that, and this regimen for me only led to gaining pounds and getting more sluggish. But the weekend orienteering is certainly good, productive physical training for any orienteer. It is specific (see Section 5), and if done at the right intensity, stresses the systems (Section 4) that are going to improve to make you faster. In all of the following discussion, I will assume that you plan to average one day of orienteering per week, either a race or a training session.

Well, I could go out for a run a few times a week, right? That’s a starter. Question is, how fast do you want those runs to be?

Since I am training to run O-races, I should do my training runs at the same intensity I race. Well, this is not a good plan. Why? Have you finished a multi-day like the Rocky Mountain 1000-day or the O-Ringen? Remember how tired you felt at the end? The outcome of doing too many hard training days is to get tired and injured. Even if you don’t do “too many”, but simply “many” hard days per week, there still is a danger. It turns out (Section 10) that in order to do some of the most productive types of training, you need to be well rested. Doing hard-ish training on other days will not allow you to go out really, really hard for the training discussed in Section 10 (that’s quite a bit harder than you run O-races).

OK, then, take 2: I’ll do something easy on the weekdays. This is a much better approach. As a matter of fact, easy runs on 2 or 3 days of the week, plus one or two O-sessions on the weekend, are the best recommendation for someone who is time-constrained and/or under a lot of stress at work/school. For me personally, this regime almost got me all the way to my best “pure” running results in the early 1990s.

But how easy should “easy” be? Hiking pace, or just a hair slower than your O-pace? The answer, in Section 6.

Sure there is a better way to get faster than simply a few easy runs on weekdays? Say, if I have more time?
We do hill workouts and sprints in cross country. I’ve heard about doing speedwork on weekdays. Aha, here we come to “speedwork”. What is it, and how much of it does one need? It turns out that there is no single type of “speedwork”; rather, there are several distinct types of training just below, or above your O-race intensity, that are guaranteed to get you faster if done properly. Some of them inherently carry an increased risk of overtraining and injury, so it is very important to do them as prescribed in the literature. I outline these types of training in Sections 8 through 11.

To understand which types of training to do (and not), we need to understand what it is that makes you fast (or not). Various components of your body need to function together when you race; these various components are usually called “systems”, such as the cardiovascular system, the metabolic system, etc. The good news are, most of those systems can be trained to make you faster! Another piece of news goes along with my basic assumptions from Page 2 of this report:

4. Various parts (systems) of your organism can be trained separately to produce the optimal result.

In other words, there is no “magic bullet” type of training that you can repeat over and over, and that would get you fast the fastest. “Multipace” training is better than uniform-pace training. This statement has since about the last quarter of the 20th century been well accepted among runners (Martin and Coe, pp. 207–209), but more contented among orienteering coaches and some athletes. Some elite orienteers would go as far as to recommend a certain type of training (usually at, or near, O-race intensity) to everyone, repeated over many days of the week. You won’t find such recommendations in recent running literature.

What about mileage? I have recommendations for the total weekly mileage in Sections 5 and 16. Two things are important: mileage must be increased gradually week-to-week (if it is increased at all), and it is more important to execute the planned number and duration of training sessions per week than strive for a certain mileage.

I subscribe to the point of view that mileage is more important than hours, along with my favorite book, Daniels p. 82. But I’m ahead of the game, again; the books I use as my guidelines are listed in Section 3.

What about cross-training? I heard it is important. Ah, cross-training. There’s a whole Section 12 with my views on it.

My coach tells me that I should not run any faster than I can navigate, therefore, I should not do any specific physical training, other than O-technique sessions. The speed is supposed to follow developments in my orienteering technique. Again, this is one of the accepted world views. I happen to disagree with it, but it doesn’t mean it’s wrong. The view that physical and technical gains must go together is widespread but not predominant. This paper, and references therein, will be of little use to you if you subscribe to this philosophy. I do not expect to convince anyone from the “other” camp, and they should probably not be reading this paper anyway. But let me answer this argument: If I do speedwork, my running will get faster, but without a corresponding increase in how fast I can orienteer, I’ll make mistakes and my orienteering race results will not improve.

Suppose your “top” running pace is $X_1$ min/km, and the top pace at which you can confidently navigate is $Y_1$ min/km ($Y_1 > X_1$, slower). The reason you do not make many mistakes at $Y_1$ is that the pace feels comfortable; your mental activity does not have to fight for your organism’s resources because not too many of them are devoted to running at $Y_1$ (your brain consumes a disproportionate amount of glucose even when you are stationary!) Compare this allocation of resources to running at $X_1$, when your muscles demand most of your blood supply.

Suppose now, as a result of training, your top pace improves to $X_2 < X_1$. You shouldn’t, however, go out and O-race at $X_2$—certainly you’ll make a lot of mistakes!, just like you didn’t race at your “full” speed, $X_1$, before your training took place. Instead, you should O-race at some lower speed, $Y_2$. It is highly likely that this new O-race pace will be faster than your previous O-race pace: $Y_2 < Y_1$. 
Indeed, as your top speed increases, it becomes easier to back off this speed and devote some of your organism’s resources to the mental tasks. The pace that was previously hard becomes easier, and you can navigate at a pace at which you could not. This is because a task that took up all the resources before, $X_1$, now takes less, and more resources can be devoted to the navigation at any speed! See?

Yet another argument for separating the physical and technical aspects comes, usually unexpect-edly, for those orienteers who find that they can be quite good at “pure” running racing. There have been several US juniors and ex-juniors on NCAA Division I cross country and track teams in the 1990s, although none in the very recent past. The opportunity to be on your college’s track or cross country team is going to be immensely beneficial to you as an orienteer; this chance is lost if one insists on only training with a map. Running varsity in college clearly make you a better runner. But training alongside very good runners, getting expert advice from professional coaches, and competing with the best in the nation and the world goes a long way towards boosting one’s motivation for training, and not just for running, but for O as well, for the lifetime.

3 Where is all this stuff coming from?

There are several excellent books that outline the latest in the best methodology for “pure” running training. These books are based on sound and extensive scientific research, and most have a list of papers in the end that one can consult for the details of the particular studies mentioned in the books. These books are written by accomplished runners, exercise physiologists, or both. The advice given in these books is based on the simple fact that however different runners may be, there are common ways in which a human body functions in order to perform the task of running. Understanding these ways leads to knowledge on how to best prepare an athlete for running faster; this knowledge is useful to all who run, be they recreational runners, elite marathons, or orienteers.

Unfortunately, to the best of my knowledge, no such books exist in English for the physical part of orienteering training: the available material is either dated, incomplete, or biased towards the author’s opinions against published research. That’s because orienteers are such a small community. There probably are good books in Scandinavian languages, which I cannot read (shame). However, if we accept the point of view that running success is an important component of one’s orienteering performance, we should be able to take the knowledge from the running books and apply it, with small but significant changes, to our training as orienteers.

So, here are the books:


Everyone should read the first the book on this list. The current understanding of optimal training is all there, condensed into 288 pages. The book explains complex physiological concepts on the level of a high-school athlete, while sacrificing very little. You do not really need a background in any science to understand the book. Despite this, the book is very quantitative in its prescriptions.
You’ll have a day-to-day training schedule after reading the book that you can stick to, with recommendations on exactly how fast or slow to do every run of the week. The book also tells you how to modify this schedule if setbacks occur, how to taper properly, and how to prepare for and execute road races—this last part not very important to us orienteers.

The second book on the list is best used as a companion to Daniels’s book, and quotes the latter in many places. Where Daniels has strict prescriptions, Pfitzinger and Douglas tend to give the athlete a bit more leeway in planning the training sessions. Their book explains some of the physiology in greater detail than Daniels, but you need to have read Daniels before taking up any other book on the list.

The third book is a collection of articles on selected topics in optimal training. It is quite dry and assumes some reader background in the important concepts. It works great to fill in the missing pieces in many assumptions that Daniels makes without much explanation. The other book on the list by Pfitzinger and Douglas is mostly aimed at marathoners and the advice is specific to that distance. However, there are bits of wisdom that haven’t made it into their first book, applicable to all runners. The last book is encyclopedic and is best used if the reader has a significant background in sports physiology, molecular biology, and biochemistry. It is a textbook for elite coaches. If you have any questions remaining after reading the first four books, this one may have all the answers (but the understanding of such may not come easy).

The other class of sources I use is orienteers’ web pages. Several elite athletes put some or all of their training on the web. I like Vroni König and Janne Salmi’s web page, http://www.suunnistus.net/konigsalmi, the most. It is in English; although it lacks detailed training reports, it has Janne and Vroni’s general training philosophy, and summaries of recent training and competition. Some of Holger Hott Johansen’s views on training are on the Canadian Team’s page at http://personal.nbnet.nb.ca/mtfells/wisdom/plans.html. OrienteeringOnline.net frequently has interviews with elite orienteers in which they answer questions about their training. On other pages, such as AttackPoint.org and OKansas (http://okansas.blogspot.com), orienteers discuss the best training methodology. The latter site, run by Mike Eglinski, tends to mostly quote athletes and coaches from the “other camp”, putting emphasis on training with a map and/or in the terrain above all. Lively discussions ensue.

It is important to note that these websites have mostly opinions and the descriptions and results of individual training approaches, and not hard science. Copying others’ training may or may not work for you. But knowing the general scientific principles beneath optimal training, and applying them intelligently, is very likely to work for most.

**4 What is it that makes someone fast?**

What propels us forward when we run is our muscles. So maybe it’s the muscles that are responsible for someone’s running speed. You know, strong muscles. Then it’s easy to know how to train: lift weights! The more time in the gym, the faster you get! None of that boring running—get a muscular body and become fast as a gazelle at the same time!

Um, you probably already know that things don’t work out this way. Stronger muscles help a runner (and an orienteer), but none of the buffed-up Mr. Universes have been known to turn out particularly fast 5-km times. (On the contrary, those Kenyans all seem so skinny…) Muscles are fueled by glycogen (a form of carbohydrate stored in the body) and oxygen. So, maybe eating more carbohydrates is the key? You know, load up on pasta every evening, and become fast as a gazelle! (This was an attempt at a bad joke.)

So, what’s left is oxygen. You know, the stuff in the air that you breathe. Most of the variety in running capability between individuals is explained by the different abilities of their bodies to
deliver oxygen to the working muscles, and by the different abilities of the muscles to utilize this oxygen. The oxygen gets drawn into the lungs, mixes with blood, and binds to a molecule called hemoglobin. Oxygen-rich blood is pumped by the heart through blood vessels to the muscles. There, the muscles extract the oxygen and use it in chemical reactions that ultimately produce energy and waste products. The energy propels you forward (or upward, in case you are rock climbing... but this is written for runners), and the waste products need to be pumped out and extracted from your blood. If the waste is not disposed of properly, you feel worse and slow down. This is a very simplified picture of what happens when you run. (Same stuff happens when you walk around the room, but at a different intensity.)

In order to run fast, then, it is important that your heart be able to transport a large amount of oxygen to your muscles, and the muscles be able to extract and metabolize that oxygen. It is also important that your body be able to dispose of the waste, most important of which to runners are lactic acid and carbon dioxide. However, this is not the whole picture. After all, there is nothing specific to running in the picture; swimmers or skiers need the same things. Those muscles are important, after all; as a runner, there are specific groups of muscles that you need to develop, as compared to a swimmer or a skier.

Even if two runners have the same, or similar, capacities of their hearts and the “right” muscles, we all know that the task of running in the woods comes easier to some but not others. Some flow effortlessly through boulder fields and soft mossy ground, whereas others get tired easily and slow down when faced with challenging footing. That thing one needs for successful running through terrain is called running economy, and is a measure of how much energy one needs to expend in order to move through terrain (or, in the case of “pure” runners, along a road or a track) at a given speed. Running economy is closely related to the biomechanics of running.

If you consider this picture, a number of things come through. There are several important systems of your organism that are responsible for running. Many systems are responsible for your well-being, but only a few help you run fast. These systems are (from Daniels p. 32):

- The cardiovascular system:
  - the heart; and
  - the blood vessels:
    * mostly the small (capillary) vessels that permeate the running muscles;

- The aerobic capacity:
  - not a “true” part of the organism, but a measure of the maximum amount of oxygen your body can deliver to the muscles and the muscles can process;

- The lactate system:
  - not a “true” part of the organism, but a combination of processes and cells that are responsible for holding down (or not) the concentration of lactic acid in your blood;

- The muscular system:
  - mostly the leg muscles, but also
  - the rest of the muscles in your body, to different degrees;

- The running economy:
  - not a “true” part of the organism, but a measure of energy expenditure necessary to run on a chosen surface at a certain speed.
I omitted one system of Daniels, the “pure” running speed. The pure speed is a measure of how fast the individual biomechanics of an athlete would ultimately allow this athlete to run. This maximum speed is closely related to anaerobic (oxygen-less) capacity, and is of decreasing importance to runners as the duration of their event increases. For orienteers, this maximum speed is usually only achieved in the finish chute; moving at this speed on uneven ground carries an immensely increased risk of injury. Therefore, I do not believe training to develop this system is of much importance to us, and I won’t discuss the system (or the anaerobic capacity).

The strange “aerobic capacity” animal is separate from the overall cardiovascular system, and for a good reason. Even if someone has a well-developed heart and capillary vessels, this person will not necessarily be able to run (or ski, or cycle) fast, unless these heart and vessels have the capability of delivering a large amount of oxygen to the muscles and the muscles can actually use this oxygen. As mentioned in Section 6, many types of training will develop the cardiovascular system, but only one type does the best job to develop the aerobic capacity.

The aerobic capacity can be measured quantitatively. It is the maximum amount, or volume, of oxygen that you consume per unit time, divided by your mass. In other words, it is the maximum rate at which you consume oxygen. This rate is denoted by $\dot{V}O_2_{\text{max}}$; the V-dot symbolizes a volume rate. It is usually pronounced “V-dot-O-two-max”, or shortened to “V-O-two-max”. The units for $\dot{V}O_2_{\text{max}}$ are milliliters per minute per kilogram; the volume is in milliliters, the volume rate is in ml/min, and $\dot{V}O_2_{\text{max}}$ is in ml/(min·kg). The capacity is physically measured on a treadmill with a gas analyzer. The instrument measures the amounts of oxygen and carbon dioxide in the air you inhale and exhale. Daniels has a discussion of $\dot{V}O_2_{\text{max}}$ starting on page 42.

The lactate capacity can also be measured quantitatively. As your running speed increases, so does the rate at which your muscles generate lactate. The amount of lactic acid in your blood also increases. However, for slower running speeds, your body can dispose of lactate as quickly as this lactate is accumulated; if you hold a steady pace, the concentration of lactate in your blood stays constant. If you go faster than a certain pace, however, the lactate system will not be able to cope with the increased production of the acid, and the lactate will accumulate in your blood with time. For a while, you’ll still be able to hold your chosen pace, but at some point you’ll be forced to slow down. The maximum speed at which you can go while holding a steady blood lactate concentration is called the lactate, or anaerobic, threshold. It is commonly referred to as “the threshold”. The threshold is measured as a speed, in meters per second, or as a pace, in min/km or min/mile.

In the listing above, a curious reader will notice that the first system is of importance to athletes in virtually any sport. The aerobic capacity is relevant for endurance sports, such as x-country skiing, cycling, and swimming; x-country skiers and cyclists are known to have some of the highest measured values of $\dot{V}O_2_{\text{max}}$. The lactate system is of increasing importance as the duration of the event gets longer, but still applies to other endurance sports as well as to running and orienteering. The specifics of running distinguish the particular muscles important to runners. These muscles are not exactly the same as the ones, say, cyclists use! However, there is a large overlap in active muscle groups between runners and orienteers. Where orienteering stands apart from “regular” running is the in-the-woods economy.

So, how do we make all those systems better? All of the ones listed respond well to training. By applying a certain stress to a system, it will eventually respond in a way that makes this system perform better (Daniels, p. 18). It turns out that different systems respond best to different types of

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1There are other thresholds, and some literature calls the lactate threshold a different name. Moreover, some authors distinguish between the anaerobic threshold and the lactate threshold. For a detailed discussion, see [5] pp. 92–101.

2The actual measurement of the threshold is usually done on a treadmill. It is easier to hold a certain pace on a treadmill compared to a track because of the lack of air resistance. Thus if one runs at an effort that corresponds to the threshold, her track speed will be a few seconds per km slower than the treadmill speed. The speed in the woods, or in hilly terrain, at a threshold effort can be considerably slower than the speed on a track.
stress. Thus by training separate systems separately, it is possible to achieve performance that would
take longer to achieve if one were to apply the same type of stress over and over.

What follows is a summary of training activities that exercise scientists and successful coaches and
athletes think are the best to develop the systems. In Section 5, I’ll go over the relative importance of
the different systems, and the related types of training, to an orienteer. Subsequent Sections 6–13 will
discuss each type of training, some in brief, some in more detail.

5 Oh, this pyramid thing.

5.1 What do different types of training do for me?

I’ll describe the following training:

1. Easy and long runs (Section 6);
2. “Marathon-pace” runs and easy/hard combinations (Section 7);
3. Threshold-pace runs and intervals (Section 8);
4. Orienteering race-pace training (Section 9);
5. \( \dot{V}O_2 \text{ max intervals} \) (Section 10);
6. Short intervals (repetitions) and fartlek (Section 11);
7. Cross-training (Section 12); and
8. Strength training (Section 13).

The intensity of running increases in the progression from easy runs to short repetitions. Cross-
training and strength training can be done at any intensity.

Where do these types of training fit? Every training session you complete should have a pur-
pose. Easy runs develop your cardiovascular system. They make the heart muscle stronger. They
stimulate the growth of a network of small blood vessels, capillaries, around and inside your run-
ning muscles. When you race, this network will enable more blood and oxygen to be delivered to
the muscles, and more waste products to be extracted from the muscles. Because of this, it is said
that easy runs provide the base for all other training. Armed with a proper amount of base training,
an athlete can tackle other, harder types of training more efficiently, that is, with a greater payoff in
speed. Base training also allows one to do hard sessions and face a reduced risk of injury; easy runs
prepare the organism for the stress of speedwork and races, while incurring very little of such stress
by themselves.

Easy runs also flush out the products of metabolism and dead or rejected tissue that accumulate
after hard training sessions. Yet another effect of those runs, compounded over years, is to improve
running economy (Pfitzinger, Douglas (1999), p. 38). This effect cannot be achieved over one or two
seasons of training.

Long runs are done at the same intensity as easy runs. Simply put, these runs allow one to be
able to run for a longer time. They improve glycogen storage in the muscles; they may not make
the running muscles “stronger” in the weightlifter’s meaning of the word, but they produce a better
muscle, one that can function for a longer time. Long runs also improve fat utilization. Your organism
can burn fat on the run, but fat produces less energy than glycogen. In an athlete who does not have
a background of specific training aimed at extending the duration of glycogen metabolism, glycogen
stores get depleted after about 80 minutes of intense running. If you are technically accurate and very
fast, that’s just about enough time to finish an IOF Long or a USOF Blue course. If not, you need an additional source of energy to carry you through the remainder of the race. That’s where fat comes to rescue. But without training aimed at getting used to running off the fat, the transition to this metabolism will be very hard; you’ll “hit the wall” and slow down. After appropriate long training, however, you’ll be able to maintain your race intensity for two hours or longer.

Easy and long runs are of the highest importance to an orienteer, after orienteering races and O-training sessions at race pace.

**Marathon-pace runs** go one step further in advancing your capability to run long. Despite the name, those runs are not just for “paved” marathon runners. Done at a higher intensity than “easy” long runs, these runs stress the cardiovascular system and the muscles in a way that develops the metabolism necessary to last for more than 80 minutes. This capability is of primary interest to marathoners, but also to orienteers who would like to be able to be competitive on an IOF Long course or on a USOF Long course (which is longer than an IOF Long, formerly known as Classic). Marathon-pace (MP) runs are more effective than long runs alone, but also carry an increased risk of injury compared to easy runs. A variation of marathon-pace runs consists of an easy run, followed by a faster-paced threshold run (see the next paragraph), followed by an easy run; or a threshold run, followed by an easy run, followed by a threshold run. These workouts stimulate much the same systems as steady-pace MP runs. Yet another variation that serves to develop the same systems starts out an an easy pace and gradually progresses to a higher pace. In almost all cases, MP and mixed-pace runs are more than 90 minutes in duration.

**Threshold runs** are of the next-highest importance to an orienteer after easy and long runs, and here’s why. The threshold is the maximum pace, or effort, at which the rate of production of blood lactate still does not exceed the body’s capacity to remove it from the blood. Most successful orienteers race, on average, at a pace just above the threshold for the Middle course, or at a pace just below the threshold for the Long (Classic) course. (The “on average” refers to the average pace, or effort, maintained for the duration of an O-race.) This is because mental tasks become progressively harder as one attempts to increase the speed beyond the threshold. There are speeds beyond the threshold, but other than in a park-O, racing at those speeds is generally not a good idea.

The faster you can run at threshold, then, the faster you can go in an O-race. Surprisingly enough, the best training aimed at improving the threshold pace consists of running at, or just above, one’s threshold speed, or effort. Running at threshold improves your body’s lactate system, that is, the ability of your body to remove lactic acid from your blood. This type of running also allows your muscles to function more efficiently within the presence of lactic acid in your system.

**Orienteering race-pace runs** will go slightly faster than threshold pace for good orienteers. I do not believe there is a need for separate O-pace sessions, other than your “regular” O-races and technique training at race pace.

But since good orienteers go above the threshold for at least some portion of their races (see Section 10 for a discussion of Reference [6]), how is one going to train for this above-threshold pace with only threshold-pace runs? The answer lies in $\dot{V}O_{2\text{max}}$ intervals. These intervals are the best type of training to develop your aerobic capacity. The goal of a set of intervals is to spend some time going at a speed that is close to 100% of your aerobic capacity. The payoff is an increase in this capacity, or the maximum rate of oxygen utilization. As this capacity increases, so does the pace that corresponds to the athlete running at 100% of the capacity: more oxygen to the muscles equals faster running! The so-called submaximum paces improve as well. For example, suppose that your threshold corresponds to utilizing 90% of $\dot{V}O_{2\text{max}}$. Suppose further that you race slightly above the threshold, at a rate of oxygen utilization that equals 92% of $\dot{V}O_{2\text{max}}$. If you improve your $\dot{V}O_{2\text{max}}$, the pace that corresponds to running at 100% of $\dot{V}O_{2\text{max}}$ will improve. But so will also the pace that corresponds to running at 92% of $\dot{V}O_{2\text{max}}$, or your orienteering race pace.
It is important to note that even if one does not do specific \( \dot{V}O_2 \) max training, there still is a way to improve one’s race performance. (A good reason not to do \( \dot{V}O_2 \) max intervals is a significantly increased risk of injury associated with this type of training.) The key is to do threshold runs. For untrained runners, the threshold can correspond to oxygen utilization of less than 70% of the maximum aerobic capacity. By doing threshold training, this value can be increased to more than 85% of the maximum. Suppose that after you’ve done your training, your threshold percentage indeed increased, but the \( \dot{V}O_2 \) max did not. You will still be able to race at a significantly increased rate of oxygen utilization, and as a result, race at a higher speed.

However, once an athlete has increased her threshold oxygen utilization to be close to 90% of the maximum aerobic capacity, further gains in race speed can only be made by advancing \( \dot{V}O_2 \) max. Unfortunately, there is no free lunch.

Repeats (short intervals) are done at a pace that exceeds the pace that corresponds to \( \dot{V}O_2 \) max. Is there such a thing? Can you really go faster than the fastest pace? The apparent paradox comes from the fact that the aerobic mechanism of energy production is not the only one available to a runner. For example, 200-m runners generate most of the energy necessary for the dash anaerobically, that is, without utilizing oxygen. The anaerobic mechanism allows one to go faster than the fastest pace that can be achieved aerobically, that is, faster than the \( \dot{V}O_2 \) max pace.

But it seems that I already mentioned in Section 4 that the anaerobic mechanism is not important to us orienteers, other than for the run-in from the last control? Indeed, the goal of doing repeats is not to train your anaerobic system (which is not one of the important ones). It turns out that faster-than-max repeats may improve one’s running economy. The reasoning goes like this: In order to go really fast, you need to eliminate all the unnecessary leg, arm, and torso motion, and only perform the essential movement that propels you forward. As you are in the second half of the repeat and the going gets really hard (pay back the debt from going too fast!), the intense pressure of maintaining the same amplitude of motion as in the beginning of the repeat will work with your muscles and motor nerves to force you to move in the most efficient way.

Because running economy is tightly connected to biomechanics, and the biomechanics of running in the woods are different from those of running on a track, short repeats should be done on a surface that approximates in-the-woods running closely, but a surface not so broken that you are going to get injured. Jörgen Mårtensson is rumored to have had a loop in his back yard, a piece of crappy woods with incredibly rocky footing, that he did really fast repeats on. They must have helped.

Yet another benefit of doing short repeats is that they work on your muscular system—the strength of your running muscles. Remember those 200-m runners? They don’t have that muscle definition out of nowhere. Yes, they lift weights because they need those muscles for the race. But racing short distances, in itself, also serves as a kind of strength training not unlike weightlifting—you use your leg muscles to forcefully push your body forward. In order to increase this strength-training effect, short repeats are commonly done uphill—these are the “hills” of your cross-country days. If you train your muscles in this way, you’ll also become a better hill runner, not something of negligible importance to us orienteers.

I discuss “pure” strength training in brief in Section 13 after mentioning cross-training in Section 12. The former obviously serves to develop your muscular system.

5.2 But there’s more than running!

Yet another principle goes with those on Page 1:

5. Specific training produces specific response.

As Daniels notes on p. 18, this is mostly common sense. For example, if your training consists exclusively of 200-m repeats, you’ll advance as a sprinter but not much as a distance runner. How-
ever, if your training program has mostly easy and threshold runs, adding short repeats will help you gain muscle strength and running economy, so the end result of adding repeats to your training will benefit your goal of racing orienteering faster.

The above principle of specificity seems to indicate that the closer your training is to your chosen activity, the better. Thus O-races and technique training at O-race pace, and threshold runs are the most effective types of training an orienteer can do. What this means is that for an hour invested in any type of training, the biggest payoff (the largest increase in speed) will come from these two types.

Why not just do O-races and threshold, then, and ignore other types of training? The reason is that there is not just one system responsible for your performance, but many. All of those systems need to be trained and improved in order for your performance to improve. Yes, suppose you only do easy runs; speed gains will be slow (if any). However, a good training program must include easy runs in order to build up the cardiovascular base. Now suppose you only do threshold runs. Gains to your race speed will come relatively quickly. But so will an increased chance of injury. Without a base, you will most likely end up injured after a few weeks of intense O-racing. As you nourish the injury, the newly gained fitness is going to dissipate away, and you’ll be facing a new start from a lower level. In a better scenario, your rapid progress will slow down and stop, as the upward motion of the threshold encounters resistance from the non-improving $\dot{V}O_2_{\text{max}}$. But in order to improve $\dot{V}O_2_{\text{max}}$, you need to do intervals, and you almost certainly will get injured after a few sessions if you don’t have the base. Thus there really is no way around skipping any of the important types of training (Sections 6, 8–11, and 13) if you want to get faster and if you want the gains in performance to stick.

Specificity is indeed common sense yet widely ignored by many coaches and athletes. For example, many orienteers expect significant gains in in-the-woods running speed from low- or high-intensity cross-training. Low-intensity cross-training, such as slow cycling, certainly has a place in a well-balanced training program as a replacement for easy or long runs; it is even more appropriate if one is injured and needs a low-impact activity to replace running. However, as we know, few speed gains are to come from easy running alone, and this will also be the result for low-intensity cycling. Also, the “other” benefit of easy runs, the compounded increase in running economy, cannot come from an activity that is different biomechanically, such as cycling.

What about high-intensity cross-training? Fast cycling certainly trains one to be a better cyclist; but what about training to be a better runner? Moreover, one can do $\dot{V}O_2_{\text{max}}$ intervals on a bike, and we know these can be very effective as cyclists tend to have higher $\dot{V}O_2_{\text{max}}$ values than distance runners. Can these make you a faster orienteer? My belief, along with Daniels (p. 167), is that nothing can substitute “pure” running on an hour-per-hour basis for the payoff. More on this contentious subject in Section 12.

There are, however, exceptions to the rule that come when the activity that most closely approximates race conditions is just too inhuman to use as a training exercise. Notably, marathoneers generally do not run a marathon every week “just for training” (although 5-km runners can and do run tune-up races of their exact competition length every week or every other week). Most MP runs are limited to 25–32 km. Along the same lines, it would be brutal to ask someone to race on an IOF Ultra-Long (USOF Long) course every weekend if she wanted to prepare for such a race. But it is entirely possible to include a run of 90–100 minutes into one’s weekly preparation routine in order to get ready for an IOF Long (USOF Classic) course, as such effort is generally within most people’s capabilities, even at ages as young as 17.
5.3 Isn’t orienteering different?

5.3.1 The ground is broken! And there are dead trees everywhere.

What is it so special about orienteering, as compared to “plain” running? We race in the woods, on uneven footing. We have to jump over logs and slog through swamps. And there’s always vegetation, twisting and turning your body to get through and around undergrowth.

Because of this, an orienteer will use slightly different muscles compared to a “smooth”-surface runner. We use more of the abdominal, back, and internal (core) muscles. Because of the need to face the climb, orienteers also tend to have better-developed upper-leg muscles, often at the expense of the lower-leg ones. And we are markedly better than an average runner in the downhill department.

The system responsible for how well you can get through uneven terrain is running economy. If runner Amy is more economical than runner Bill, that is, uses less oxygen to move at a given speed on a given surface, then if Amy and Bill are using the same amount of oxygen, Amy will be moving faster than Bill. Consider, for example, a road runner and an orienteer who both have the same \( \dot{V}O_2 \) max. Even though their aerobic capacity is the same, it does not necessarily mean that they can run at the same speed on the same surface. Suppose both athletes are going all-out, so that their oxygen utilization rate is equal to their \( \dot{V}O_2 \) max. The road runner, through her background of specific training, will most likely have a better economy on the road and will be able to move faster than the orienteer. This is because her muscles are “tuned” in a way that allows them to be used most efficiently to support this specific range of movements. The orienteer, on the other hand, will have a bunch of muscles that are under-utilized while road racing. These muscles will sap away oxygen that could be used by the important “road” muscles; the orienteer will most likely be less economical on the road than the runner. The orienteer will then be slower on the road, while consuming exactly the same amount of oxygen as the runner.

Suppose now the two are racing all-out in the woods. The orienteer, because of her terrain-specific running training, will be more economical in the woods, and move faster than the runner. The latter will most likely not have developed the muscles necessary for getting over dead trees, up and down hills, and pushing off soft ground.

Running economy is what determines how well the oxygen you use contributes to your forward motion. Therefore, training directed at specifically improving in-the-woods speed should mostly consist of running-economy training. That is, short intervals (may be hills) and easy runs, on the appropriate training surface.

Because of the variety of challenges posed by the terrain, orienteers can benefit from additional strength and agility developed by a routine of stretching, strength, and jumping exercises. There are many coaches out there who have developed programs directed at improving the specific muscle groups used while running through terrain. However, I believe that the most important gains are to come from running, in accordance with the principle of specificity.

For training systems other than running economy, it does not appear to be important to rigidly stick to surfaces and conditions similar to what you encounter in orienteering. Indeed, cyclists have ways to boost their \( \dot{V}O_2 \) max to values unseen in the running world, while doing very little running on any type of surface. This does not mean that you won’t get good gains from doing intervals at your \( \dot{V}O_2 \) max pace through terrain; it just seems to imply that for training aerobic capacity, the choice of surface is not really important. In accordance with the principle of specificity, you will get better gains in your in-the-woods running performance from doing \( \dot{V}O_2 \) max work in the terrain, compared to doing these intervals on a track, compared to doing them on a stationary bicycle. The primary system stressed by training in these setting is the same; however, it is coached to perform under particular conditions, and will perform best under those conditions in competition. There is, however, a tradeoff involved with trying to do all high-speed training in the terrain, discussed in Section 10.

Yet another thing that distinguishes O from “plain” running is the relative intensity at which we
5.3.2 Is O really slower than running?

Consider an orienteering course that is planned correctly, that is, provides for coarse navigation for large parts of most legs and for fine navigation upon approach to the controls. Also consider a runner who executes most legs correctly, that is, runs quickly to a chosen attack point using coarse navigation and reading large features, and then reduces speed to handle fine navigation closer to the control circle. As more mental tasks come into demand, the speed of the runner decreases; however, there is no reason to slow down if the mental tasks do not require much attention. A technically well-prepared orienteer will spend most of each leg above the threshold effort, and the fine-nav portions of the legs at or below the threshold. Of course, mistakes happen, and the runner can come to a complete stop, so the above scenario is the best case.

As the duration of the course increases, it becomes harder to maintain the same speed as one would keep up for a shorter course. The average pace for an error-free elite runner on an IOF Middle course is well above the threshold (Reference [7]), but not quite as high as the $\dot{V}O_2\text{max}$ pace; whereas the average error-free pace on a Classic course is close to the threshold (Reference [8]). Compare this with studies ([3], pp. 116–117) for 5-km runners who were found to race close to their $\dot{V}O_2\text{max}$ pace, considerably above the threshold. It is also known that 15-km and half-marathon runners race at around the threshold pace ([1], p. 258).

Comparing the duration of these events, we see that both runners and orienteers who race for an hour to an hour and a half, go at around their threshold pace, whereas for much shorter distances, runners go close to the $\dot{V}O_2\text{max}$ pace and orienteers, somewhere in-between threshold pace and $\dot{V}O_2\text{max}$ pace.\(^3\)

We have to conclude that energy demands are largely similar between runners and orienteers for events of longer duration, and are a bit different as the course length decreases. One would expect, then, that the total aerobic capacity would be very important to 5-km runners, but to 15-km runners, the aerobic capacity would not be as important as the performance of the lactate system; and that the aerobic capacity would be of less importance to orienteers than the lactate system, regardless of the course duration.

In fact, Pfitzinger and Douglas (1999) note that exercise physiologists used to think that the $\dot{V}O_2\text{max}$ number alone predicted the performance of distance runners. It turned out (Reference [9]) that a much better predictor of performance was the pace at the threshold. This pace is influenced by only two numbers: the oxygen consumption at the threshold, and the running economy. (Oxygen times economy equals speed; we’ll get to this shortly.) In Reference [7], Gjerset and colleagues found out that out of a number of physiological parameters, the largest correlation between the parameter and orienteering race performance was indeed for the pace at the threshold.\(^4\)

Therefore, the following parameters directly influence one’s competition speed in the terrain:

1. The rate of oxygen utilization at the threshold.
2. The running economy in the terrain at the threshold.
3. How close to (or how far above) the threshold one can navigate.

\(^3\)The comparison isn’t exactly fair, as the Middle course is won in 25 minutes whereas the 5 km is shorter than 15 minutes for the group surveyed in [3]. Elite road runners do slow down to under $\dot{V}O_2\text{max}$ pace for an event of about 25-min duration, such as the 8 km. For our purposes, however, the difference is smaller; most junior orienteers would take closer to 20 minutes for a 5 km, while still most likely going close to $\dot{V}O_2\text{max}$ pace, and would not reach this pace on a Middle course that they run in 25 minutes.

\(^4\)Even more notable is the fact that Gjerset and company measured the threshold pace on a treadmill, not in the terrain. “Smooth” running capability must have something in common with one’s orienteering performance, after all.
The first two parameters contribute to one’s lactate-threshold speed. The first of those numbers, denoted by \( LT\dot{V}_O \), is closely connected to one’s \( \dot{V}_{O_2} \), but does not equal \( \dot{V}_{O_2} \), as the threshold pace is below the maximum pace, the rate of oxygen utilization at the threshold is less than the maximum rate. However, training that improves \( \dot{V}_{O_2} \) will also improve \( LT\dot{V}_O \). The last parameter is beyond the scope of physical training.

One can improve the threshold speed by training the maximum aerobic capacity, the result of the training being that both \( \dot{V}_{O_2} \) and \( LT\dot{V}_O \) will go up. One can also train the lactate system specifically, by running at the threshold, the end result being that \( LT\dot{V}_O \) will go up without much of an increase in \( \dot{V}_{O_2} \). Finally, one can improve the running economy at the threshold by doing running economy-specific training; the end result will be that \( LT\dot{V}_O \) will remain largely unchanged, but the economy will improve, and so will the speed at the threshold. We should also note that \( \dot{V}_{O_2} \)-specific training carries a much greater risk of injury than lactate-system training.

What follows is that among different kinds of “speedwork” outlined in Sections 8–11, orienteers should devote most of their time to training the lactate system (threshold runs), followed by training the running economy (repeats in terrain and easy runs), followed by training the aerobic capacity (\( \dot{V}_{O_2} \) intervals). For injury-prone athletes, easy runs should be emphasized over repeats for running-economy training. And very young juniors should probably pass on \( \dot{V}_{O_2} \) training for the time being, until they can build some base over a number of years.

### 5.4 The Pyramid

The relative importance of the different types of training, and their relative intensity, are most clearly presented as The Running Pyramid.

The easy and long runs provide a foundation on which the rest of training must reside. The letters \( E \), \( MP \), \( T \), \( O \), \( I \), and \( R \) denote the recommended speeds at which you should perform the respective training; more on that below. The regions of training intensity that are crossed out are “no-man’s land”; you are advised against training at these intensities, and for the following reason. Every training session should have a goal of developing certain systems of the body; some exercises and intensities work best for certain goals, such as developing the maximum aerobic capacity, and some will give you less payoff. Suppose, for example, that you would like to develop the aerobic capacity but run your intervals faster than the \( \dot{V}_{O_2} \), which means that you are asking for more oxygen than your body can transport to the muscles. Your workouts will still help you develop aerobic capacity. However, two things will happen. First, you will run an increased risk of injury from running too fast. Second, you will not be able to do as many intervals as you’d do at the proper intensity, or will have to shorten their length below what is optimal (Section 10) for developing \( \dot{V}_{O_2} \).

The reason the bottom, “Intensity 1”, is crossed out is explained in Section 6. The sand-textured regions denote the types of training that I believe are best done in the terrain, on a relevant surface. As mentioned, \( R \) is probably more important to you than \( I \). And \( MP \) can be skipped altogether, unless you train for IOF Long.

So, exactly how fast should you go for these runs? Before directing you to the answer to this question, I’ll first note that the Pyramid (as I drew it) has three vertical scales; in addition to “AttackPoint Intensity” are \( \dot{V}_{O_2} \) percent and “speed”.

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5. Why did I put them in this order of importance? For “pure” runners, calculations of relative improvement in their performance attributable to equal percents of improvement in different systems are given in [3], p. 58, and the result is about the same for LT, \( \dot{V}_{O_2} \), and the economy. Therefore, you choose the important types of training in the order of the least likelyhood of injury, that is, in the order of decreasing intensity sustained over the course of the training session—repeat sessions tend to have lesser average intensity than \( \dot{V}_{O_2} \) intervals.

6. My personal take on it; other sensible schemes of scoring the intensity are certainly possible, differing from my scale by no more than one notch.
“$\dot{V}O_2\text{max}$ percent”? And where did it come from? The “$\dot{V}O_2\text{max}$ percent” is the ratio of your oxygen utilization at the speed to your maximum rate, $\dot{V}O_2\text{max}$. The values in the Figure came from Daniels, p. 53; I added an educated guess for oxygen utilization while O-racing, and some changes that I made to account for the fact that orienteers may be, in a certain way, different. The more oxygen you utilize (the higher your $\dot{V}O_2\text{max}$ percent), the faster you go. In fact, for most runners, the speed that results from using a certain percentage of $\dot{V}O_2\text{max}$ is about equal to their speed at $\dot{V}O_2\text{max}$, multiplied by that same percentage, plus a small number of percent. E.g. Daniels states that using 70% of your $\dot{V}O_2\text{max}$ yields about 75% of your speed at $\dot{V}O_2\text{max}$. Note that the heart rate (HR) is missing from the vertical scale. Many places will advise you to run certain sessions at a certain percentage of your maximum HR. Daniels explains (on pp. 71–74) that these rigid recommendations may not be useful in all cases. In other words, training strictly “by the heart rate” may not always be appropriate.

We need to answer one more question before proceeding to the numbers for training intensities, and that is, what is the exact relation between oxygen use and speed? **SPEED IS THE PRODUCT OF OXYGEN USE AND RUNNING ECONOMY.** A runner can be fast because her body can deliver a

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7 Actually, the use of the term “product” in the mathematical sense in the above statement is incorrect. If you recall, the running economy is defined, numerically, as the rate of oxygen consumption at a certain speed. For a given speed, some runners will use more oxygen and some, less; we can talk about relative running economies at that speed, relative to some “standard” runner. These relative numbers will be dimensionless (usually less than one), or in percent (usually less than 100%). If you take the “economy” in the statement above to mean “relative economy”, the sentence starts to make more sense; but this cannot be the whole story. Relative running economies depend on the speed at which they were taken; some
lot of oxygen to her muscles, and her muscles can use it; or, a runner can be fast because despite a smaller oxygen capacity compared to other runners, her body can make a good use of the oxygen to produce forward movement in an economical way.

However, race performances of two runners with different oxygen capabilities and different economies can be the same. In 1979, Daniels and Gilbert [10] derived a number, which they called Vdot, from athletes’ race performances at common distances. This number is the best available characteristic of one’s running abilities for a range of distances. The number is predictive; that is, knowing your performance for 5 km gives you a value for Vdot, and using this value, you can predict your times for 3 km and 10 km with good accuracy. The Vdot looks a lot like a product of the individual’s $\dot{V}O_{2\max}$ and some kind of running economy. Vdot comes, in fact, from a mathematical fit to economy curves, that is, plots of runners’ oxygen utilization versus speed.

For example, the next-to-last time I personally was tested on a treadmill with a gas analyzer (1999), I was found to have a $\dot{V}O_{2\max}$ value of 63 ml/(min-kg). On the next day, I raced a 5 km on a treadmill in 18:02. Using the table in Daniels’s book, pp. 63–64, I find that my 5-km performance corresponds to a Vdot value of 56. The hypothetical “standard” runner, one who is “100%” economical, and possesses the same $\dot{V}O_{2\max}$ as me, would have a Vdot of 63 and would run the 5 km in 16:20. It is my understanding that most runners’ Vdot is smaller than their $\dot{V}O_{2\max}$ (in ml/(min-kg)). However, some individuals have a better Vdot number than $\dot{V}O_{2\max}$. These people are the most economical runners we know—should we think of them as “super-economical”? For example, Frank Shorter’s performance at the Montreal Olympics equals a Vdot of 78, yet his highest recorded $\dot{V}O_{2\max}$ was 71.4 ml/(min-kg) [4]. Paula Radcliffe’s world marathon record equals a Vdot of 73, yet her $\dot{V}O_{2\max}$ was measured in the high 60’s (a bit before the record, however).

In his book, Daniels presents tables that detail training intensities for E, MP, T, I, and R sessions based on your current Vdot (pp. 66–67). The fact that training intensities should be prescribed based on a combination, closely related to race performance, of oxygen capacity and running economy, makes sense: the faster you can perform in the ultimate conditions of a race, the better your body is able to accommodate increased training loads. The faster you get, the faster you need to train to get even faster; but not too fast, or else you get tired or injured. Training intensities for your sessions should be chosen as close to these tables as possible.8

For example, my current (February 2003) Vdot, as measured from my 29:19 performance at a 8-km race on February 22, is 57. This Vdot demands that I do E runs at 7:25/mile, MP at 6:31/mile, T sessions at 6:09/mile, I intervals at 3:31/km (no mile pace—mile $\dot{V}O_{2\max}$ intervals are too long for me to expect safe recovery afterwards), and R repeats at 79 s/lap (one lap is 400 or 402 m). (Taking into account the comment, I should probably do T at 5:59/mile.) All these intensities are for running on a track or on a road.

However, we orienteers need to do some of the training in the woods, and in hilly terrain; we all know that the effort required to run at 5 min/km on a road does not equal the effort for 5 min/km through the woods. Even though we would like to do most of the types of training “pure” runners do, how are we supposed to know the proper intensity? We can’t just use the pace tables directly. Here’s where heart rate monitors come to the rescue. The “effort” is properly quantified by your oxygen consumption, or percent $\dot{V}O_{2\max}$. However, if environmental conditions are similar, running at a certain

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8For orienteers with a long experience of O-pace and threshold training, Daniels’s prescriptions for T pace may be incorrect. If one does a lot of T and O training, the threshold will move up in speed without much of an increase in $\dot{V}O_{2\max}$. The ratio of the threshold speed to $\dot{V}O_{2\max}$ speed for orienteers may be considerably better than that for the “average” runner. There is another way to look at this: the $\dot{V}O_{2\max}$ values for orienteers tend to be abysmal, owing to lack of $\dot{V}O_{2\max}$-specific training compared to runners with similar thresholds. I find it necessary to add two points to my current Vdot to arrive at the proper T pace.
percent of your $\dot{V}O_2_{\text{max}}$ will always elicit a certain percent of your maximum HR. Therefore, if you "calibrate" your HR for the different training intensities in Daniels’s tables, you will know what the proper “training zones” are for running at the same effort in the terrain. The only exception to this rule is $R$ repeats, which are mostly done anaerobically—you heart only gets “up to speed” as you do the interval and the HR taken in the middle or at the end of a repeat can vary greatly based on how fresh or tired you are. In order to learn the proper pace for $R$ in the terrain, it is best to do several sessions at the prescribed $R$ pace on a track. Then, do the rest of your $R$ training in the terrain, and try to go as fast as you have to feel the same way you felt on a track.

The potential pitfalls of only gauging training effort by HR zones are as follows. Firstly, the environmental conditions are not constant. On a hot day, your heart will struggle higher to be able to pump enough blood around to cool you. If you strive for a set heart rate, you’ll have to take your session slower compared to a cool day. One can argue that that’s what you want, to go slower on a hot day. But the “proper” target seems to me to be to reduce the duration of your run or the number of intervals, but still go at the prescribed pace, in order to get the optimal training response from the correct systems. In the same way, your HR will be higher on a treadmill where there’s no air flow to cool you. Secondly, your set zones may change as the training season progresses. The maximum HR does not change appreciably over the course of one season; moreover, for fit runners, the maximum HR does not decrease appreciably between late teens and mid-30’s of age. (The dumbed-down mass formula of $220 - \text{age}$ is a great big lie.) However, the HR that corresponds to the threshold can and should move slightly higher as the speed, and percent $\dot{V}O_2_{\text{max}}$, that correspond to your threshold improve. Thirdly (and subsequently), the HR for a certain effort also depends on the altitude, how tired you are, and even on how excited/psyched you are.

5.5 How much mileage?

It is my understanding that mileage (or training hours) in itself does not make you a better runner. What is much more important than covering a set number of miles or km in a week is that you be able to complete the quality workouts scheduled for this week. Depending on the cycle (Section 16, these will be $R$, $I$, or $T$ runs—we already assume that you average one $O$ run per week. For younger juniors without much base, the proper number of quality runs seems to be one per week, plus the orienteering, for a total of two runs spent at or above the threshold, of a duration between 30 min and one hour. Regardless of your total mileage and the number of hard workouts you do, you should attempt to run at least 5 times per week, and better yet, 6 times/week; one day of full rest is advised.

More advanced and/or older juniors who have an appropriate base can aim for two workouts per week plus the orienteering, for a total of three “hard” days per week. Four hard days seem excessive, and will probably cause staleness and/or injury. (For the same reason, you should abstain from multiple weeklong O-races; one per season is OK, more are OK if spaced by multiple weeks.) But how long should your workouts be, both in terms of time and distance? And what exactly is “appropriate base”?

Here’s where mileage calculations do come into play. Firstly, you should only increase your mileage gradually—many running publications will tell you what “gradually” means, as will Daniels (p. 83). Secondly, you will only be able to do the hard runs and not get injured if your muscles and cardiovascular system have been prepared by the compounded mileage of easy runs. Daniels suggests no more than 5% of the total weekly mileage for $R$ activity (not counting the warmup before an $R$ session, or the rest in-between repeats), no more than 8% for $I$ (if you do $I$ at all), and no more than 10% for $T$. Yet you know what the appropriate length of an O course is for your age. I personally think that base work done early in the season can allow one to relax these constraints a

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It is curious that these upper limits for $R$ and $I$ work are much higher than any orienteer I know in North America would normally do in their regular training.
Physical Training for Junior Orienteers

bit. E.g. if you spend several weeks in the winter, in the early season, doing 80–100-km weeks, you should be able to drop your weekly mileage to 50–55 km as the competition season approaches, and still be able to “enjoy” a 4 × 1200 I session.

Finally, if you really wanted to know my opinion about what mileage levels are appropriate for juniors, here it comes. But first, here’s what the best in the world do. In 2003, Janne Salmi wrote on his website that he averaged 64 km/week of running and O for the first 18 weeks of the season; an almost the same amount of time was spent x-country skiing. It is probably safe to assume that if skiing were not a readily available option, Janne would average between 100 and 120 km/week early in the season. Valentin Novikov has averaged “between 400 and 700 km/month” for every season since mid-1990s, or between 93 and 163 km/week. The numbers for women elites are smaller but not by much. But these are adult elites, you say; but the goal of training as a junior is to prepare for adult competition. I would suggest that the goal mileage of a 19–20-year-old male junior should be between 80 and 100 km/week (50–62 miles/week), and 65–80 km/week (40–50 miles) for females. Most of you are not ready for this kind of mileage, and should not attempt it tomorrow, or maybe not even two years down the road. But your training program should be aimed at, among other things, gradually preparing you to such mileage loads.

For comparison, junior (pre-college) elite middle-distance (1500, 3000 m) runners may run as low as about 50–60 km/week, a lot of it hard. On the other end of the spectrum, adult elite male marathoners (<2:10) typically run about 200 km/week (from personal communication).

6 Why run slow? We already know how to run slow!

Emil Zatopek, a multiple gold medalist at the 1952 Helsinki Olympics, said the following: “I always train fast because I want to learn how to run fast. Why should I train slow, I already know how to run slow.” So, why should one do those easy runs? The question has actually already been answered in this paper, a number of times. But before rephrasing the answers yet again, consider the following passage from Martin and Coe:

“The brutal fact is that Zatopek triumphed because he trained harder than the rest. He pioneered training with both a high volume of distance running and massive sets of short-distance repetitions. Compared with his contemporaries, his stamina was unmatched—as evidenced by his medals—but he never developed anything like the basic speed of today’s long-distance runners. His best 1500-m time was 3:52, which today can be matched by 16-year-old boys. Many of his 400-m repetitions were at paces no faster than the over-distance10 paces used by many of today’s elite-level male runners.”

We can speculate that partly because of insisting on a high pace for his base mileage, Zatopek may, in fact, have not have been able to train really fast, fast enough to develop his aerobic capacity and speed to the fullest potential.

The simplest criterion for determining whether you are really running “easy” is the ability to maintain conversation. If you can comfortably chat with your training partner, you are not going to fast. Because of their potential economy-improving effects, easy runs are best done in the terrain, or at least on a not-so-smooth road with some climb and descent.

OK, so easy runs form a base... blah blah... improve economy... and we shouldn’t run too fast. How slow can we go? Remember, E occupies a larger portion of the Pyramid, both in terms of amount and allowed spread in intensity, than other types of training. Sometimes the day after a “quality” session, it is just too darn hard to go at the prescribed E pace. Well, easy runs should not turn into hike/walk slogs. In order for easy runs to be effective at improving your in-the-woods economy, the movement of your muscles must be similar to what you achieve in competition. In

10That’s MP, or so.
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other words, run=good, walk=bad. That’s the reason that the whole Intensity 1 level is crossed out in the Pyramid. Not only is it important to avoid walking, but also the range of your motion should be not far from race running, in other words, don’t jog. One should maintain good, light leg turnover and rhythmic breathing, as per Daniels.

Intensity 1 (below E) can be useful in certain cases, such as recovering from injury, when you really can’t go any faster without breaking something. But commonly, the only goals of easy runs that Intensity 1 jogs and hikes will fulfill for you are to flush out the toxic/dead products of a hard session the day before (that’s the “recovery” part of easy). All other goals are not achievable if the intensity is too low.

Easy runs can be of any duration, but running less than 20 minutes is probably not very useful. The total amount should be enough to fill the mileage goal for the week. You should aim to run on most days of the week, except one day of full rest. If you ever get really serious, two easy runs per day are less taxing on the body than one run equal to the sum of the two distances. The range of heart rates encountered over easy runs is just too large, based on the individual’s peculiar response, or on the conditions (say, for example, you did some intervals the day before… or just partied too hard… ) to make useful recommendations. I know that for me personally, the often-recommended 70% of max HR will put me deep into rogaine territory, and to get out of there, I need to go at least at 79%.

Eric Weyman advocates Line-O as the best kind of E. Indeed, if you are forced to maintain constant contact with the map, and go through some choice vegetation/footing in the process (can’t get off the line to look for better veg!), you will certainy not be able to go too fast. The run will reap you both physical and technical benefits. Watch out, however, for slowing down too much.

Long runs should be done at the same range of intensities as easy runs. Your longest run of the week should be comparable in time with the longest O-race distance you are preparing for in the near future. Marathon-pace runs are more effective than long runs in bringing your endurance capabilities up to the task.

7 We aren’t training for a marathon, are we?

Marathon-pace runs serve to extend the racing capability you already have to longer distances. MP is not speedwork in most meanings of this word, implying that the pace should not feel very hard. It is well below the threshold, and below O-race pace. The origin of the term is that most marathoners will race their course at MP pace; but not all who train at MP are aiming at the marathon distance, or intend to race for 2.5–3.5 hours.

MP runs are more effective than simply long E in stressing your fat-metabolization mechanism, and deplete glycogen reserves faster. Because of that, after MP runs your body will learn how to replenish these stores quickly, and overcompensate for the depletion so that the total amount of glycogen you can store will increase. The next time around, your glycogen will last longer. Also, if your body learns to burn fat, you’ll be adding a little bit of “fat” energy to what you derive from glycogen even before the reserves get depleted. It is important not to slow down at the end of MP runs in order for them to be fully effective.

Other variations of training aimed at the same goal, going long, are combinations of E and T-pace runs. One combination, called “TLT” by Daniels, is just what you think—20 minutes at T pace, immediately followed by an hour or so at E, followed by another 20 min at T. This combination can also be done the other way: a long E “warmup”, 20–30 minutes at T, and more E running until the desired overall duration is reached.

However, if you plan to mostly compete in extremely hilly terrain commonly encountered in California, you may not have to do any running at all—that StairMaster is your best friend. Just kidding.
One should include MP and mixed runs into his program if he intends to race for more than 80 minutes. That covers IOF Long (Classic), even M20, and many USOF Classic Blues. Certainly, if one wants to be competitive at USOF Longs and Goats, one needs a bit of this type of training. For female junior orienteers, MP runs may not serve useful purposes (but there’s always Boston marathon…) 

The duration of MP and TLT should be as long as your chosen long race, and once a week is plenty for this type of training. Yet again, DO NOT TRY TO DO ALL “EASY” TRAINING AT MP PACE. We all know that you can run at this speed every day, at least for 30 to 60 minutes. But doing this isn’t as useful as properly structured training.

8 Which side of this threshold are we on?

In some sense, \( \dot{V}O_2 \text{max} \) training is aimed at improving your “maximum” speed. You can’t, however, race at your maximum speed for a period of time long enough to complete an O-event. Threshold training allows you to run at a pace closer to your “maximum” speed, for a longer period of time. Threshold runs, also known as cruise and tempo runs, are “the” most important type of speedwork for an orienteer. If you can only do T and E, you’ll go a long way towards becoming a faster orienteer, at least in your junior years.

If you’ve never practiced running at the threshold, the concept may seem challenging at first. Yes, there’s that prescription pace… The intensity that corresponds to the threshold is best described as “comfortably hard”. That is, you should be able to feel that this is the pace you can maintain for quite a while, yet anything faster should seem like quite hard work. Because of this, threshold runs are also called steady-state runs. If one goes above the threshold, one can commonly feel the “heaviness” of lactate building up in lower-leg muscles. Another definition of T pace is that it is closest to one’s 15-km race time. Few of us have actually raced a 15 km, so that definition is not of much use. Yet another suggested duration is one hour; T pace is sometimes defined as the pace one can only maintain for one hour, but not any longer.

Continuous threshold runs should indeed take up to one hour, in accordance with Daniels’s recipes; one per week is enough if you also do your O, otherwise, two T sessions per week can be done. The morning after a threshold run, one should feel minimum soreness. If you are sore, you went too fast. This is one of the differences between T and O paces.

A variation of continuous T runs is cruise intervals. They consists of several bouts of T work, interspersed with short, one-minute or so rests. The intervals themselves can be between one mile and 20 minutes (there’s a spacetime convolution…), up to the maximum of 10% of the week’s mileage. Cruise intervals appear to be more beneficial to orienteers than “straight” T runs, and here’s why. When you do cruise intervals, you will commonly go above the threshold for the last part of the interval. Your lactate system will attempt to dump the acid during the short rest break; but the break will not be so long that you will take too much time at the beginning of the next interval to get back to the threshold.

But this is almost exactly what happens in a Long (Classic) orienteering race. During the coarse-navigation part of a leg, you run to the chosen attack point while accumulating lactic acid. Then, as you slow down for precise navigation, your system clears the acid. If your body is successful, you can maintain this pace and work rhythm for an hour or so. For more discussion on why intervals are really useful to orienteers, see Section 10. Elite orienteers actually started incorporating T intervals into their routines back in the 1970s [11].

If, however, you run at T pace for a continuous session, you will most likely be just below the threshold. This training is also useful, as it allows you to advance the rate of oxygen utilization at threshold in relation to your \( \dot{V}O_2 \text{max} \), and therefore, the speed at the threshold. Remember that most of the differences in race performance among distance runners are correlated to their pace at the
threshold (Pfitzinger and Douglas (1999), pp. 35–36)?

If you are experienced at how a “good”: fast and error-free O-race feels, you’ll note that going at, or just below, $T$ pace can feel a bit slower than $O$. Part of it is because of the lack of excitement and adrenaline that you have in an O-race; mental tasks can make physical tasks seem harder. But indeed, if you are physically and technically capable, you should race Middle (formerly known as Short) races above the threshold. If you think that threshold training alone won’t prepare you for those higher speeds, don’t worry, there are always $\dot{V}O_2_{\text{max}}$ intervals. It is important not to go too fast while doing $T$ runs or cruise intervals. You’ll note that $I$ intervals have prescriptions for length (shorter than cruise intervals) and the duration of rest periods (longer than the one minute recommended for cruise intervals). If you do your cruise intervals between $T$ and $I$ intensity, you’ll still develop your lactate system, but will get unnecessarily tired and will probably have to slow down. Don’t always try to hurt as much as possible—$I$ intervals are the time for that.

As much as threshold training is important to orienteers, here’s a final word on avoiding too much $T$. A study was done in 1998 [12] that connected overtraining with high-monotony training regimes. The study defined “training strain” as a combination of training load and training monotony. The latter is the lack of variation in the difficulty of training from day to day. (If most of you training is done at about the same pace, it will most likely be around $T$.) Seventy-seven percent of overtraining-related injuries and illnesses were found to be preceded by an increase in the monotony of training. Pfitzinger and Douglas (2001) state (p. 73) that the study “is the best evidence to date that mixing recovery days into your training program is necessary for optimal improvement without breaking down”.

9 Orienteering pace: which one do you mean?

Of course there is no Daniels prescription for $O$ pace. But I don’t believe one should do $O$-pace runs without actually orienteering, either. The best setup for doing this training is in an orienteering race, or in a training session that closely simulates the conditions in an O-race.

This last statement implies that you’ve got to watch your pace, that is, check your HRM, if doing any kind of O-technique training. If the navigation is too demanding, you’ll go slower than the threshold, and the run will not produce the same kind of physical benefits a $T$ session would have given you.

Not only is the “successful” $O$-pace different from $T$, but one also encounters more challenges to the muscles. The main cause of post-orienteering soreness may be the eccentric muscle motion (muscles lengthening) when you run downhill. Having a good terrain technique, that is, a good terrain-specific running economy may help one move without incurring much damage to the muscles.

Finally, yet another argument can be raised from the fact that you $O$ between $T$ and $I$, and from the Specificity Principle. Shouldn’t you rather do all, or most, of your speedwork at $O$ pace? Well, certain running events are raced between $T$ and $I$, too: anything between 8 km and 12 km, and possibly some outside this window. To runners preparing for such races (10 km being the most common distance), Daniels still recommends to avoid the areas in the Pyramid between $T$ and $I$. We orienteers do not have much choice. In order to train the technical and physical aspects of $O$ together, $O$-pace races and fast training sessions appear to work the best. This comes from the technical aspect, not the physical side; but who am I to know much about technical training?

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12 An economist among us may warn, “Correlation not causation!” Exercise physiology is not nearly as precise a science as economics.
10 Are these the “real” intervals?

\( \dot{V}O_{2\text{max}} \) intervals, or \( I \) sessions, are the cornerstone of speedwork for a runner. You often hear about runners getting together and doing \( X \) times \( Y \) meters with \( Z \) rest. But why are these intervals important to orienteers?

One can train the lactate system with \( \tau \) sessions, and the percentage of \( \dot{V}O_{2\text{max}} \) at which the threshold occurs will go up, slowly but steadily. One will be able to use more oxygen while running at, or just above, the threshold, and her speed at the threshold effort will go up. However, at some point, the threshold cannot advance anymore. The explanation in the next few sentences needs some references; a part of it came from personal communication with Nik Weber, DVM. As the LT\( \dot{V}O_{2} / \dot{V}O_{2\text{max}} \) ratio increases, oxygen binds stronger to your hemoglobin molecules. Even though more oxygen comes into you, some of it cannot be used by your body in the process of aerobic energy production. If insufficient \( O_2 \) is available for complete glucose breakdown, a small amount of energy can be released via a different, anaerobic mechanism, leading in the end to the formation of lactic acid (Martin and Coe, p. 62). Thus as you speed up, you will eventually hit the threshold before reaching your \( \dot{V}O_{2\text{max}} \) pace. The ratio of the oxygen rates at the threshold and at the maximum capacity thus can be reasonably expected to have a ceiling. Daniels believes that in trained athletes, this ratio is about 88%. In my personal case, I have indirectly and subjectively estimated the ratio to be in the low 90s, based on race speed information, a perceptual evaluation of my \( T \) speed, and typical conversion coefficients from speed to \( \dot{V}O_2 \) (which are related to economy).

The moral of the story is, you can’t expect a further improvement in threshold speed from only developing the lactate system. At some point, you’ll have to bite the bullet and do those \( I \) intervals in order to push \( \dot{V}O_{2\text{max}} \) up. Most likely, your threshold will still occur at the same percentage of your new \( \dot{V}O_{2\text{max}} \) gained after the specific training. But since this maximum aerobic capacity will increase, so will LT\( \dot{V}O_2 \), and so will your speed at the threshold.

Yet another justification for doing \( \dot{V}O_{2\text{max}} \) intervals for orienteers comes from study [6]. It turns out that metabolically and physiologically, orienteers are a lot more similar to shorter-distance racers, such as 3000–5000-m runners, than to marathoners or x-country skiers. This is because of the particular character of an orienteering race. If the course is planned right and you execute it properly, you’ll go faster for your run to the attack point, while going above the threshold and accumulating lactic acid in your system. You will then slow down for the “yellow” and “red”-light portions of the leg, while your body tries to clear the lactate without facing the increased stress of its production. During the coarse-nav parts, lactate does not have to be cleared; it can be buffered instead, that is, its negative action can be neutralized for a little while. But this ability to buffer lactate is exactly the one important to runners who race well above the threshold, such as 5-km athletes. They accumulate the lactate over the course of the race, as their muscles tolerate its buildup, and the time to dump the lactate is after the finish.

Thus we need some of the same qualities, and need to train some of the same systems, as 5-km runners. Recall that the 5 km is raced very close to \( \dot{V}O_{2\text{max}} \) pace. The system primarily responsible for the success of 5-km runners is the aerobic capacity. Additionally, the structure of an interval session itself is relevant to orienteers; the process of lactate accumulation, buffering of lactate during the later portions of an interval, and its clearing during the rest between intervals mimics what happens with your body in an orienteering race (although at a somewhat different intensity).

So, we need to do \( I \) intervals to train for the maximum aerobic capacity. What are the right \( X \), \( Y \), and \( Z \), then? How many intervals, how far, and how long to rest?

If your intervals are too short, your heart and lungs will never get to the work regime that they are in when you work at your maximum capacity. If you are well-rested, then as you start on an interval, a lot of energy is produced anaerobically for the first minute or so. This first minute of each interval, then, does not contribute much to training the aerobic capacity (if one takes long rests). \( I \) intervals,
then, should in most cases be longer than about 2 minutes in order to induce considerable changes in your $\dot{V}O_2\text{max}$. Stay running for too long, however, and you’ll have to slow down for the subsequent intervals, as the muscle damage accumulates and lactic acid slowly builds up; if you go too slowly, you won’t accomplish the purpose of the workout. If you take too much rest, then you’ll have to take even more than one minute to rev up to $\dot{V}O_2\text{max}$ speed—time wasted. If you take too little rest, then the same thing happens as if your intervals were too long.

Daniels is very specific in the kind of I workouts he prescribes. For most of us, the intervals themselves should be no longer than 5 minutes; thus 1200s are acceptable but miles aren’t. Their total length (not including the rest/jog between the intervals) should not exceed 8% of the week’s mileage. Jogging during the rest parts is best to partly clear the lactate. And the duration of the rest periods depends on the duration of an interval; Daniels suggests between 50% and 100% of each interval’s duration. Pfizinger and Douglas (1999) are less rigid in their interval recommendations. They suggest (pp. 21–25) 4800 m to 7200 m total for the workout, with the intervals being 600 m to 1600 m and the rest/recovery taking 50% to 90% of the time it takes for each interval. I runs should be done once a week when appropriate (Section 16), but advanced runners during the cycles of directed race preparation can do two I sessions per week.

Running faster than your $\dot{V}O_2\text{max}$ speed cannot induce “better” or more changes in your aerobic capacity than running at, or just below, your $\dot{V}O_2\text{max}$ pace. For most of us, this pace is our pace when we race 3000 m to 5000 m. See tables in Daniels for more details. However, the common mistakes that American orienteers seem to tend to make with respect to I training are not {going too fast}, but rather {not going fast enough} and, most importantly, not completing enough intervals for the training to be helpful. Anyone can go out and run one or two mile intervals at our 5 km pace; this, however, is not a complete I session that would help you develop your $\dot{V}O_2\text{max}$.

It is important to maintain the target pace for your later intervals; you have to use your watch to force you to go fast even when it’s hard (but not too fast in the beginning). The pace must be controlled. For this exact reason, I do not believe that terrain is the proper setting for I training. My personal experience tells me that more often than not, intervals in the terrain gradually decay into slugfests. It is just too hard to estimate the proper pace in the beginning by the HR alone, given no track marks to guide you, so you’ll go too fast and will be worn out in the end. Also, most challenging terrains will not allow one to move at I effort for longer intervals without getting injured; some will not allow one to move at I through them at all. Even though you are best off training for $\dot{V}O_2\text{max}$ on a track or on a road, this setting will not violate the Principle of Specificity. The aerobic system can be trained by a large variety of muscle movements. Cyclists frequently do $\dot{V}O_2\text{max}$ intervals on a bike, and have the highest $\dot{V}O_2\text{max}$ values known to man (Miguel Indurain, 92 ml/(min·kg), mid-1990s).

11 Repeats, that’s laps around the track…

… or not. The goal of faster-than-maximum-aerobic-pace training is to develop running economy and to boost your running muscle strength. If you train to run very quickly, demanding a large amplitude of muscle movement, the low available oxygen for the task can force you to eliminate the unnecessary muscle excursions, leaving you with the most “natural” and efficient stride. Since running economy is tightly coupled to biomechanics, and some specific muscle sets are more important to orienteers than they are to anyone else, I believe that the proper place for repeats is in the terrain. Be careful, though, to not injure yourself from running very quickly on unfamiliar footing. I think that a familiar, well-surveyed lap, off-trail, with some uneven footing, mud, some logs to step over, and possibly some vegetation to get through is the best setting one can have to fulfil the goal of moving through terrain more economically.

So, what is it that’s special about orienteers’ biomechanics, or running technique? Firstly, some
traits are common between economical “smooth” runners and orienteers. Placing feet parallel to each other and parallel to your direction of motion seems to go a long way, as is the elimination of superficial head and shoulder rotation with each step. The most economical style also involves arms moving parallel to the body in both orienteering and “smooth” running. However, there are also differences between orienteers and runners. We commonly face 5% or more climbs, while most road runs have less than 1.5% climb. The ground is usually soft, and there are things to jump over. Because of this, orienteers tend to have overdeveloped quads and hamstrings compared to runners. A good running stride also involves little “bounce” in the center-of-mass motion, whereas for us, the “bounce” is a fact of life invoked every time we have to go over something. High knee lifts, detrimental to runners, are usually quite common to good orienteers. The lower leg also needs to be lifted more, and there is more of a lower-leg “kick”, in a good orienteer’s stride compared to a good runner. As Mike Eglinski notes, there has been ample research on what a good running technique is, but little done on what constitutes a biomechanically efficient orienteer. Of course, some are more mechanically fit for some types of terrain and not others.

Therefore, if the only terrain around you is cornfields, you may be able to still have some, but not all required, gains in terrain running economy from simply doing 200s and 400s on a track. You can then supplement your repeats with specific sets of jumping and bounding exercises, which may help you develop muscles that a track cannot. But the best gains seem to be destined to come from running short repeats in the terrain.

Finally, what about the suggested length and pace for the repeats? These should be done with full recovery; your muscles should be relatively fresh for each subsequent repeat. Daniels suggests resting for 3 or 4 times the duration of each repeat. This can conveniently be accomplished by jogging/easy running every other lap. The laps themselves should be between 200 m and 600 m, so that your splits are under 90 seconds. The pace on a track is given by Daniels’s tables, and you’ll have to do your best to replicate this effort in the terrain. But you can’t do this until you have completed several T sessions on a track. One or two R sessions per week can be done, depending on where in your framework of training cycles you are.

Fartlek is related to repeats and economy training. You do several unstructured intervals of high-intensity running in the course of an E, MP, or a T run.

12 But there’s more than running, part 2!

Aren’t there other, more-fun types of training I can do and still get faster? Say, I like cycling… or snowboard… or ultimate frisbee… I’m sure I get some benefit out of those! That is certainly true, but the question is, do you get the same benefit compared to going out for a run for the amount of time you spend cross-training. Daniels and I believe not. Several types of cross-training, however, come fairly close; these are cross-country skiing and cycling. But there are pitfalls.

Much controversy has surrounded the subject. If you do an activity other than running or “foot” orienteering, you involve different muscle groups, and possibly different energy metabolisms. These muscle groups can be somewhat close to (as in x-country skiing) or quite unrelated from (as in swimming) those involved in running. In other activities, perceived as strenuous (such as weightlifting, for example), you may be working very hard but not involving the right systems—most of the energy needed for basketball, for example, comes anaerobically. Training those “other” things is probably

13 Most runners never have to face the same kind of downhills we do. Downhill running is an area of improvement which can affect an orienteer’s race performance in a most dramatic way. This paper is sorely missing advice on downhill running. Downhill runs may be the only type of running-economy-related training that is worth practicing at an intensity below R, with much emphasis on the technique, because a successful orienteer’s muscles are mostly relaxed during downhill. It seems to me that someone, a coach or a friend, should be able to recommend areas of improvement to you by examining your downhill stride. For some people, downhill comes naturally.
not as effective to you as training the right systems. However, yet another question is whether it is possible to train systems relevant for running while doing something else. For example, cyclists, as was noted, tend to develop more aerobic capacity than runners. But they work different muscles, so that (a) they have nowhere near the economy good runners have (just watch those triathletes...), and (b) they may have good ways to utilize oxygen, but it gets consumed by the wrong muscles. So what if some muscles can use a lot of oxygen? They aren’t exactly the ones that propel you through the woods!

As with everything in this world, there are opinions and there is science, and the “accepted opinion” may or may not follow the science exactly. In their 2001 book, Pfitzinger and Douglas attempted to provide references to the relevant studies on the subject so far (pp. 88–94). For studies on swimming [13], the conclusion was that “reasonably well-trained runners can improve their running performances through cross-training, but the improvement is likely to be less than through increased running.”

Note that the increases in training time for this study were the same for the run-plus-swim group as for the control run-plus-run group. Thus swimming is less effective on the time basis in improving your running than is more running. In another study [14], a similar study was done on cycling. Some study subjects added cycling to their regimens, and some, an equal time amount of running. The improvement in 5-km race performance was exactly the same for the two groups, within the experimental error.

So, this cycling can be useful, after all? Pfitzinger and Douglas immediately caution that “although… cross-training can lead to improved performance in moderately trained or even well-trained runners, no scientific evidence exists concerning cross-training for elite runners. A… re-view… concluded that… the specificity-of-training principle likely becomes more critical the higher the level of performance… So don’t worry about having to give up your stair climber to Khalid Khannouchi the next time you’re at the health club.” The authors also think that “to get a similar workout to running requires about three times as long on a bike”.

On a personal level, I have always heard from people, such as my coach in the early 1990s, Vladimir Zherdev, that doing a lot of cycling hurt my running performance. The running stride, he argued, tends to become “heavier” as more energy is needed by the lower-leg and muscles to lift the overdeveloped quads from the ground. I became seriously interested in the subject in 1999, after a master’s student of Prof. Flynn at Purdue, the principal author of Reference [14], recruited me into a study quite along the lines of [14]. I believe that any new data obtained in this subsequent study would not have been published, had it led to conclusions not significantly different from those in [14]. I was able to undergo $\dot{V}O_2\max$ and running economy testing before and after participating in a 3 times/week, 6-week-long cycling training program. By the time of the study, I had not been doing any cycling for about a year. I was supposed to maintain the same training I already had on the “easy” days, but do three cycling workouts per week, supervised in a lab; these were closest in intensity to interval and threshold training, and a long ride at the easy effort. The cycling workouts were not an addition to my training schedule, as in [14], but rather a replacement for running workouts.

The result? After undergoing the training, my $\dot{V}O_2\max$ decreased by one point (63 → 62), while the 5-km time on a treadmill increased from 18:02 to 18:10. Unfortunately, I do not recall the values obtained for the threshold speed and the running economy before and after the cycling training. So, for me personally, the conclusion was that there was no significant improvement or degradation in performance from cycling (the decrease in performance fell below the experimental error). It was most likely due to the fact that the training regimen I underwent was not enough to advance the race performance and $\dot{V}O_2\max$; it is quite possible that the time amount of training would also have been insufficient to generate any gains had I been running instead of cycling. Yet another possible explanation, which appears less likely, is that my orienteer’s biomechanics were sufficiently different from those of a runner to not get a benefit from cycling, while a runner would have gotten some benefit. The results of the study that would make conclusions for the whole group of test subjects
were indeed never published.

However, you may be able to reduce the total stress on your body if you do low-impact cross-training on your easy days instead of running. So, I’ll agree that cross-training is good for your recovery days (see the Pyramid), and leave the subject at that.

13 Beef up those muscles! Or not.

Shouldn’t building stronger muscles through lifting weights be one of the types of training required for orienteers? Maybe. Probably. Here’s an area where I haven’t read enough, and I do not have experience to form a personal opinion. I also am not an expert on the particular exercises recommended for training the muscular system.

It is my opinion that what one needs in the muscular-system department is not necessarily “stronger” muscle, but “better” muscle. Fallowfield and Wilkinson state the following on pp. 51–52:

“The present consensus, though not universally accepted..., is that the rate at which the muscles can use oxygen is far greater than the rate at which the cardiovascular system can supply those muscles with oxygen... The ability of the leg muscles to use oxygen could differ markedly between two runners with... a similar \( \dot{V}O_2 \) max.

“The ability of a muscle to use oxygen at a high rate is referred to as its oxidative capacity... Veteran 10 km runners have been shown to sustain a higher %\( \dot{V}O_2 \) max than performance-matched young runners... One explanation is that the concentrations of several key aerobic enzymes are higher in the muscles of the older runners...”

Thus the most important key to making your muscles move you faster appears to be not the strength of their fibers, but their physiological/biochemical composition. And this will improve mostly with training the cardiovascular and the lactate systems, but not necessarily after weight training.

Some point out that several elite orienteers reported great gains in their orienteering results after taking up a program of weights, resistance training, stretching, and bounding exercises. However, the individuals mentioned were known to me personally to have run 10 km below 31:00 before they started their strength-training programs. It is entirely possible that the gains in in-the-terrain speed came not from stronger muscles as such, but from tuning the muscles they already had in a way that would optimize their running economy in the terrain.

Stretching is quite important to an orienteer. For an expert’s guide to stretching, both before/after your races and before/after your training exercises, see Marie-Catherine Bruno’s series in Orienteering North America, 2001–2003.

14 How do I know if I’m getting better?

The reason it is important to measure your progress is that you need to know the right Vdot to plug into Daniels’s tables, to figure out how fast you need to do the intervals, among other things. Also, quantitative signs of progress (improved race times) serve as an important morale booster to track and road runners: their training is working! All this hard work was not for nothing! Unfortunately, orienteering races may not quite work out this way. Firstly, the min/km pace achieved means nothing. Secondly, your running training may indeed be very effective, but for some reason you may be suffering from increasing technical problems as your season progresses, so that O-race times may give a false sense that you aren’t doing so well in the physical department.

For this reason, I suggest that orienteers should include a road or track race into their training routine, about every month. I am not suggesting that we turn into road racers, and I do not advise
targeting those races as important goals to prepare for them specifically. Rather, those races provide *controlled conditions* under which you can go all-out and judge how well (or not) your physical preparation has advanced. Some orienteers have a very effective way to judge their progress by a test run on a road in the terrain, or even through terrain. However, you need to be somewhat of an expert to figure out how to scale those times to a different surface so that you have a set of goal times for the various regions of your training. A road or track time works best to set goals for **I** training, which you will presumably do on a road or on track. It is this type of training that is easiest to mis-execute, at a pace too fast or too slow.

How quickly should one progress? Well, this goal should be closely correlated to your overall orienteering goals. If there are no gains in O-technique, better physical shape will still help you, but not as well as it would with improved O-technique. Therefore, it is important to set physical preparation goals with the technical aspect in mind. If you are very good technically but slow, you should aim to push hard in the fitness department. If you are not very good technically, you should still do physical training, but put emphasis on the technical stuff and not worry too much about your race times.

But if one were to be consistently good in O-technique, how fast can one improve? This depends on your age, injury history, and most importantly, whether you had been able to achieve higher Vdot values in the past than where you are now. I find out that a well-rounded training program can get me close to the rate of 1 Vdot point per month improvement. This probably is the fastest rate at which one can safely advance and not risk injury; I am also aided by the fact that I have been at my goal Vdot’s before, and lost fitness afterwards, but never by much. Obviously it is easier to progress if you are younger. And if you are already at high limits of performance, your gains will clearly slow down—just imagine if Radcliffe or Indurain kept progressing at 1 Vdot (or 1 ml/(min·kg) $\dot{V}O_2_{\text{max}}$).

15 All work and no rest make Jack a sad boy.

Indeed. Most of us, however, already take care to take enough time off. One rest day per week is important, as are several weeks of recovery between seasons and taper before important races. Improved form will come after about 2 weeks of taper. This improvement can be dramatic; lifting off the heavy stress of training will do wonders to your race performance, but this action needs to be carefully timed, otherwise you’ll either race too early, without the gains from rest coming into effect, or wait too long and your systems will degrade after days of inactivity.

But this does not mean that suddenly taking two weeks off in the middle of your training season will give you significant gains. Taper gains only come after many hard weeks of training preparation. You need to have built up the base and done all the hard workouts before you can expect gains from prolonged rest. **Section 16.** Daniels (p. 173) notes that up to 5 days taken off training completely, at any time in your training season, seem to cause no harm in your performance. But this is certainly not an additive effect. If you take off 5 days, train for 3 days, and take another 5 days off, you WILL suffer a setback.

For a curious look at how it feels when a proper taper pushes your fitness level up, check out [http://www.active.com/story.cfm?story_id=9687&sidebar=26&category=triathlon](http://www.active.com/story.cfm?story_id=9687&sidebar=26&category=triathlon)

16 Cycles... Aren’t we supposed to run?

Or, Putting it all together and Periodization. By now, you probably suspect that not all weeks in the season are created equal; you shouldn’t start the season off with a barrage of **I** training. You should build the base during the first (winter) months, then introduce speedwork in some order, and take it progressively easier as the important races of the season (JWOC and US Champs) approach.
The concept is cycles. A training **macrocycle** is one season of training. For road runners, macrocycles are tailored to the important races of the season, and are usually 18 to 26 weeks in duration. Thus runners can peak twice a season, and have some time left over between macrocycles for some rest. We orienteers can do that, too; end your macrocycle at JWOC, for example, and start a new one over afterwards to prepare for the US Champs in the fall. It is more common, however, to not have 18 weeks left in the summer and fall to prepare, and the summer heat takes its toll. Thus for us, this second macrocycle will really be an extension of the first one, and it’ll miss the initial buildup of base running; this “extra” base can be shifted to the beginning of the season, to the winter and early spring months.

A **microcycle** is one week of training. Each week is similar (you have your O on the weekend and an R session on Tuesday with your cross country team, for example), but there are week-to-week differences. Some parts of the season will be geared towards O, some towards building up the base, and some, towards tapering for competition. These are **mesocycles**. One mesocycle can conveniently encompass four or six weeks. Within a 4-week mesocycle, it is common to take 3 weeks “hard” and one week to be a rest week; Pfitzinger and Douglas suggest 75% of your normal mileage for the rest week, but since your season is long, you may as well go much lower on the mileage for the week. Remember, only a very small loss in performance will occur if you do 25%-50% of your “normal” work for the rest week, and this small drop may well be worth the recharging effect, with which comes a decreased risk of injury.

Within each mesocycle, different types of training will receive emphasis. The first 6–18 weeks of the season constitute the base-building phase. Mileage should be increased gradually when you are in the base-building phase, but orienteers commonly reach their highest-mileage weeks of the season at the end of this phase. Further increases in mileage, after you are into phases with emphasis on speedwork, may not be useful. As you start to hit more O-races, total weekly mileage should decrease. Within your speedwork-emphasis mesocycles, Daniels suggests stressing R, I, and T training, in that order. Other coaches move R to the end. In any case, a taper period should follow the speedwork before your important races of the season.

How much should you do each week? I gave you some recommendations, modified towards our orienteering environment. Every individual’s circumstances are different, however; for some, school/work load has certain periodization, and the training program is best tailored towards that schedule. Each athlete can be best helped by a dedicated coach; unfortunately, few of us have such luxury. That’s why it is important for us to absorb the relevant information around us, separate the wheat from the chaff, and work out a set of goals, and a program to reach those goals, that best fit our situation. This paper is an attempt to be helpful to you as you embark on the journey.

17 Other stuff

17.1 The ugly weight

Runners and orienteers alike need not stress about their weight. (If you do want to stress over your weight, there’s always Nancy Clark.) It is more likely that what you need in order to be successful as an orienteer is a good training program that you can follow, rather than a weight-loss diet. If you have a realistic program and you stick to it, your weight will take care of itself even if it wasn’t perfect to begin with.

However, the contrary is also true: If your training program is not challenging enough for your circumstances, you can and will gain weight, just like 80% of the American society. Simply going out and “working out” a few days is not enough. No training program that produces gains in your running speed will lead you to gain fat. But if your training is not going anywhere and is simply designed to let you stay at the same level, it is very easy to start gaining the pounds—the extra
calories you take in, as an active person, are not utilized enough.

Moreover, as I found out myself, some kinds of training programs can actually lead to an increase in weight. When I was training for the World Rogaine Champs in 2002, I did a lot of really, really long runs. (Think more than 4 hours.) These runs were not accompanied by much of other training, other than short, easy runs on weekdays, and I always took care to take 2 or 3 days of rest after the long runs. I promptly gained 13 pounds over about 3 months. But if you are not training for a rogaine, and instead focus your training on improving your in-the-woods speed for events under one hour, you have nothing to fear.

Extra weight, be it “water weight” or actual fat, or even in some cases unused muscle, will hurt your running performance. (Your organism stores 3.6 grams of water for every gram of glycogen in your muscles.) The extra weight hurts running economy; your aerobic system has to work harder, delivering more oxygen to propel the extra weight up and forward. Your biomechanics may stay the same, but biomechanics aren’t the only contribution to the economy. Your $\dot{V}O_2$ max will decrease simply because you need to divide by a larger number (remember ml/(min·kg)). The rule of thumb is a 0.3% of decrease in speed for every pound above your “normal” weight (sorry for not being metric here).

17.2 Training alone

Indeed, most successful orienteers train alone (see [15]). Having a group of like-minded people around you with similar goals and similar training schedules and paces certainly helps. Friends will push you. But few of us have control over the places in this Universe we end up. Some will have good company for training runs and some won’t.

When you train alone, it is important to stick to the proper pace based on your level of training. That’s where Daniels’s pace tables come in. On the contrary, being pushed by your friends who have much higher Vdot’s in the course of an interval or threshold run may not do you much good.

17.3 Need motivation!

Sorry, can’t help you here. I will, however, note that if your orienteering results do not seem to progress well, having a good advancement in your running preparation can be a powerful source of positive motivation. Indeed, if a part of the job of getting to be a good orienteer has been done, you can focus on the other part. Good running results can also bring you respect among your friends, and “plain” running can provide another venue for self-expression not a bit inferior to orienteering.

On this note I end.

References


