Hadd's Approach to Distance Training

Part I

Let's start from the very beginning. A male (or female) approaches me for training. It could be you. (If I use he/she in the following posts in this thread, please note that either of them apply equally well to both sexes. What I am saying works for male and females.)

Now I am not a college coach, only used to young studs aged 18 years and up. Which is good, because I get to see a wide spectrum of runners, many of them past-30 and wanting to get back into it again. This has allowed me to gain experience of coaching all ages and all fitness levels and gives me wider knowledge of heart rates (HR) (and not find, as with teenagers, that everyone's HRmax is simply, "over-200"). Note that many on Letsrun fall into this category, wanting to get back in the saddle and work to improve their times in their 30s and 40s…

Yet I do coach young kids; youngest boy and girl 15 years old, then 17-18 and on up to early 20s… So some of this might in places apply to teenagers. (Having said that, if you are already getting coached, I would recommend that you do what your coach tells you, and don't chop and change ideas with every book/schedule you read. You cannot beat consistency over time.)

So, a male or female approaches me… I generally want to know some background before agreeing to take them on. Usually I ask for recent race performances. But I am not just looking at the times here, more importantly I want to see the relationship between the race times and distances.

I may get numbers for events like this:
From a young runner; 400m, 800m, 1500m, 5k (maybe)
From an older (road) runner; 5k (maybe), 10k, HM and marathon (maybe)

Right away I'm really looking to see what's wrong. (If there is nothing "wrong", there will be a limited amount I can do for the guy). Not what is wrong with the times (eg: they're slow), but what is wrong with the relationships between the times a) there may not be a relationship, or b) the relationship might be too loose.

Let's look at what I mean:

Here are some times I might receive (all number are actual real-life examples)
Young runner: 56.x (400), 2.09 (800), 4.37 (1500), 38.30 (10k)
Older runner: 17.02 (5k), 36.45 (10k), 1.24 (HM), 3.10+ (marathon)

Many of you will have seen equivalence tables somewhere. Tables that give points per performance per distance and allow comparisons between (e.g.) 800m and marathon. The Hungarian Tables are one such example. Mercier tables are another.

But no-one suggests that a single person can be equally good at all distances across the board (apart from rarities like Rod Dixon). Your genetic strengths tend to weigh you more in one

direction (speed) or the other (endurance). So, some people's performances get better as the race gets longer (or shorter). And this is beyond/in excess of a training effect, they are just more gifted aerobically (or anaerobically).

BUT there should still be some form of relationship across distances, and this is what I look for when I hear someone's PR's.

Frank Horwill once defined this sort of relationship by saying that if a runner slowed up by 16 secs/mile at any distance (actually, I believe he said 4 secs per 400m lap), that runner could then keep going for twice the distance. (Note that better trained runners slow up LESS than 4 secs per lap to go twice the distance…)

So, according to Horwill, if you can run 5.00 for one mile, you can run at 5.16m/m for 3k/2 miles and 5.32m/m for 5k, and 5.48 for 10k, and 6.04 for 10 miles and 6.20 for marathon (plus or minus a second here or there). This is what I mean when there should be a "relationship" between race performances (assuming good/similar level of training for each event).

For better-trained runners, the relationship is even tighter. I have coached one runner like the example just given; has a 4.59 one mile PR. Who can run 5k at 5.20m/m (instead of Horwill's 5.31). And 10k at 5.31, HM at 5.40 and marathon at 5.59m/m (instead of Horwill's rule of thumb 6.20m/m). But this runner's one mile to 5k distances are seldom trained for, or raced, so there might be some secs still to come off of both of them.

Think of it roughly like a clock face: Your one mile PR should be at 12, your 5k PR pace should be at quarter-past (+15 secs), your 10k PR should be at half-past (again, +15 secs), your HM PR should be at quarter-to (again + 15 secs), and your marathon PR should be once again at the top of the hour. (This also fits in with the old rule of thumb that your marathon PR pace should be mile PR pace + 60 secs/mile)

So what is wrong with our runners above? (remember, Horwill said slow up by 4 secs/lap to go twice the distance. We'll use his rule of thumb here.)
Young runner: 56.x (400), 2.09 (800), 4.37 (1500), 38.30 (10k)
400m = 56 secs
800m = 2.09 (should be 2.00 from 400 time)
1500m = 4.37 (should be 4.00 from 400m time or 4.16 from 800m time)
10k = 38.30 Fuggedabouddit…

So, our young guy gets rapidly worse as the race distance increases showing he is poor aerobically. Note that he gets worse even on the next distance up, showing how poor his aerobic conditioning/capacity is. He has NO relationship between his race performances.

Older runner: 17.02 (5k), 36.45 (10k), 1.24 (HM), 3.10+ (marathon)
5k = 17.02 (5.28m/m)
10k = 36.45 (5.55m/m – should be 5.44m/m from 5k time)
HM = 1.24 (6.24m/m – should be 6.00m/m from 5k time and 6.11 from 10k time)
Mar = 3.10 (7.15m/m – should be 6.40 from HM time and 6.27 from 10k time)

Like our young guy, this runner is also poor aerobically. He too has NO relationship between his performances. What we COULD have found is a relationship between 5k-10k-HM but NO relationship between HM-marathon (just meaning that he was not as well prepared for the longer distance as he was for the HM).

Now these times are all plus/minus a few seconds, not hard and fast. So we do not need to quibble on whether it should be +15 or +17 secs/mile. The point I want to stress is the existence of a relationship. I don't hold hard and fast to Horwill's 16 secs/mile (as I have shown, for better runners it might be 12-15 secs/mile or tighter still). But I do agree with his concept of a relationship between performances at all distances. I am always working towards it with runners I coach (at least within the range of events in which they wish to be competitive). This relationship can tell a lot about how well prepared a particular runner is for a given event.

Note that there can be two things "wrong" with your PR's. One, as shown, there can be no evidence of a relationship (usually meaning your aerobic ability is wayyyyy poor). Or there can be a relationship, but it is too loose (instead of slowing up/adding 16 secs/mile to run double the distance, you slow up/add 20-24 secs/mile). In this second instance, your aerobic ability is less poor, but still needs work.

To sum up; if you are well trained aerobically, you do not fall apart (as in the earlier examples) when the race gets longer. And here some of you may like to do a quick check and see how your own performances compare…

So, on seeing these, or similar, numbers, I expect to hear at least one (and maybe both) of two things from the athlete concerned:
1. Low mileage background in training
2. Whatever mileage being done is being run "too fast" (for performance level)

Part II

So, if we find that our runner has little or no evidence of a relationship between his/her race performances (especially if this is so as the distance gets longer), we can be very sure the problem is in his legs.

If you waded your way through the long thread I referred you to above, you will realize that this means the mitochondria, capillaries and aerobic enzymes your training should have created in your leg muscles, did not happen. Whatever trainin

g you have done to this point has not been as effective as it could have been. Usually, I have found, for two reasons (as given above):
1. You don't run enough mileage.
2. You train too fast.

Way back in 1973, physiologist David Costill and his coworkers introduced what they termed, the "fractional utilization" of VO2max. Which really just means, how much of their VO2max can each runner actually use in a distance event. The argument was made that those who could use the greatest fraction (percent) of their VO2max stood every chance of being among the faster runners. This "fractional utilization" we now know is basically made up of a runner's lactate threshold (LT) and their particular economy.

As the authors state, "At all running speeds above 70% VO2max, the faster runners were found to accumulate less blood lactate than the slower runners at similar speeds and relative percentages of their aerobic capacities. The findings suggest that successful distance running is dependent on the economical utilization of a highly developed aerobic capacity and the ability to employ a large fraction of that capacity with minimal accumulation of lactic acid."

Simply put, the more you can use of your maximum aerobic potential in a race, the better you will perform.

As recently as 1997, this paper by Costill was cited by J.A. Hawley et al in a paper aimed at enhancing endurance performance.
As the authors state, "It would appear that the fraction of VO2peak or power than an athlete can sustain for prolonged periods is inversely related to the accumulation of lactate in the working musculature." (more lactate = lower % VO2max that can be sustained = stop sooner; less lactate = higher % VO2max = maintain for longer).
They go on, "For example, in well-trained endurance athletes, there is little or no increase in blood (and presumably muscle) lactate concentration until the work rate elicits close to 85% VO2peak. Direct support for this comes from the data of Coetzer et al (1993) who reported that black African distance runners had lower blood lactate concentrations after submaximal (21km/hr) and maximal (24km/hr) exercise compared with white runners, despite similar running economies. Elite Kenyan distance runners have also been found to have lower lactate levels than top Scandinavian distance runners during both submaximal and maximal exercise."

Sooooo. Let's sum all this up, it's very simple.

1. Better trained runners can maintain a higher percentage of their VO2max (85% or higher) in a marathon than lesser trained runners.
2. They can do so because their blood lactate AT ANY PACE or any percentage of VO2max is lower than the blood lactate of less well-trained runners (ie: they are not "tougher" and just somehow putting up with more discomfort than the runners around them, they are actually more "comfortable", under less lactate "stress", than all other runners at the same pace/intensity).

This also agrees with a large amount of sport science studies which show a very high correlation between the lactate threshold and performance in distance events. The higher (faster) the running pace at the LT, the faster the pace in distance races.

Sjodin and Svedenhag (1985) in a review on the physiology of marathon running agreed, "the 'threshold' is the single best predictor of performance in long-distance running, including the marathon." Once again, fast pace at LT = fast pace in a distance race.

As I repeatedly stressed in my long earlier thread, the training to improve your VO2max (essentially the stroke volume of your heart) is NOT the same training as that required to raise your LT (increase capillaries, mitochondria and aerobic enzymes in your muscles). The speeds required are totally different. LT training is one case in which faster is NOT better.

So. To go back to our hypothetical runner. After I find out the PR's of the runner who has approached me, (and assuming he/she has no good relationship between performances), I lactate test him.

Now don't be concerned, I only bring this in here to explain exactly why our young runner (and possibly yourself) cannot maintain a positive relationship across performances. In short, his LT is weak. It will NOT be necessary for you to undergo lactate testing to know how to proceed to improve your own training and your LT.

You see, I know from his poor race results that my new runner is building lactate long before he should (which is why, as I have tried to explain above, there is NO relationship). Remember, high lactate = poor long distance race ability.

So, somewhere along the way as he increases his running pace, his blood lactate is climbing (earlier than it should and at slower paces than it should). I know this. His results are telling me this, even before I test him. If I can determine when that happens, at what pace/effort that is happening, I will then know exactly how to train him to make the lactate at that pace begin to stay low, and not climb until he runs at a faster pace. And then a faster pace... and a faster pace...

Think of it like this. If your LT is low (at slow pace relative to VO2max), you are "borrowing" from your anaerobic ability to help your aerobic ability maintain the particular pace you are running at. Like having an overdraft at the bank because you cannot live within your monthly wage. But as the race distance gets longer, you cannot borrow more and more, but can only borrow less and less. Until at the marathon, which is 99% aerobic, you cannot borrow at all and

your poor aerobic ability is exposed and you are left wondering why the pace is so slow compared to (eg) your 10k.

Now here I would have liked to explain the mechanics of how to test, because although you will not need to be lactate tested, the knowledge of how to do so will be important further down the line. However, for you to understand it fully, you would need to see some charts, which I am unable to post. Fortunately I am able to refer you to a website that does a very good job of explaining the rationale and the lactate testing procedure in a very clear manner. If you would genuinely like to improve your training (and race performances), spend some time and go and read the information on the linked site. It is only a single page of text and charts (although there are other links that some of you might like to explore, although doing so is not necessary). I expect to have to refer to the knowledge the single page contains in later parts.

http://www.lactate.com/pitesbas.html

Final summation: if you cannot maintain a good relationship across race performances it is because your LT is not good enough (not a high enough percentage of your personal VO2max). Your LT is dependent on adaptations in your leg muscles caused by training. If you have a poor LT, your adaptations have not occurred well enough (despite even years of training). As will be better explained later, these adaptations are intensity dependent (train too fast, they won't happen).

My apologies if this appears long-winded, but it is a long-held belief of mine that runners train better if they understand WHY they are doing such-and-such training.

Addendum To Part II

Let's look at some major negative effects of "borrowing" from your anaerobic ability in a distance event (anything from 5k upwards). (For those of you who do not think you are doing this, just note that if you have a poor(er) pace relationship as the distances increase, you are.)

1. When the muscle cells in your legs build up too much acidity (caused by running anaerobically), those cells shut down since the acidity inhibits enzymatic action and contractibility in the cell and energy breakdown can no longer continue. So, the more you are trying to stoke the boilers, pour on the speed, and fire on all cylinders, the more some of those cylinders are shutting down. This is not so if you use those self-same cells/fibres aerobically.

2. Breaking a molecule of glucose down into energy anaerobically is horrendously wasteful of fuel. It will result in fuel economy the equivalent of "2 miles per gallon". Breaking that exact same glucose molecule down into fuel aerobically results in "36 miles per gallon". If you are going far enough (HM or marathon), you better be as economical as possible and get as many miles as possible per gallon because otherwise you are going to run out of fuel and crash long before the finish line. Note that the muscle cells that are operating anaerobically will be unable to access your huge store of fat as a fuel (which would give you wayyy better than even 36 mpg). Fuel which would ensure you get to the 20 mile mark and still find you can pour it on.

Think of it like this. Put the smallest compact car you can think of, and a Ferrari, side by side. Empty both fuel tanks, give both of them one gallon of fuel and tell them to go as far as possible. Which is gonna win?

Since your LT measures at what pace you change over from aerobic to (increasingly more) anaerobically-fueled running, it is also a measure of when you stop being economical and become more and more uneconomical. So, we can also say that a low (poor) LT also means poor fuel economy.

Many of you will be able to give examples of guys (I know at least two) who can crank out 20 mile long runs at 6.00m/m and yet not finish a marathon at that pace. Why? Because, due to their precise fuel economy (or lack thereof) they cannot store enough CHO to get them through the final 6.2 miles. Their fuel economy, and therefore their LT, is too low.

This next part was not even planned to be included when I began this thread, but I had a thought that Flagpole's 8.00m/m run was going to be harder for him than his 7.40m/m, and I knew I had a personal experience that should explain to him (and perhaps others) why this might have happened.

I will start therefore with a personal anecdote and then explain why things occurred as they did afterwards.

For those who did not notice that Part II was numbered in the title of the post, I will also put the part number in the text. So...

Part III

I have always ridden motorcycles. I tend to ride them pretty hard. I live in a rural area, so this usually means throwing the bike like a maniac round the twisty country roads. Great fun. The part of me that loves doing this has not aged one whit. All this just to explain that occasionally I come off the bike, sometimes spectacularly.

One such time (and not the last), almost 8 years ago, involved some broken bones and a prolonged spell out of training. It was six months before I felt like getting back into it, and when I did, it was winter and miserable. So I postponed it some more (which was suprisingly easy to do).

When I did go out for the first few runs, they were a major struggle and I could not remember ever running so slow in my whole life. I had still been coaching all the while I was out of running, and had recently started a couple of new young guys. Although I tell them I really don't care what training they have done before they come to me (and that I was going to test them myself and form my own opinion), they (and others) are pleased to show me their old training schedules and often show up to first day of training with a printout. (It usually turns out they are mad keen to show me how fast they can run a session of 400s).

Perhaps because I was browsing some of these printouts, added to the depressing fact I seemed to have slipped back so far in what was now one whole year off training, but I decided to try something a bit different. I am nothing if not a student of the sport, I knew how I coached, and what worked for me, but I also knew there were many other ways that claimed to get you fit. I had read all manners of training schedules over the years. So I decided to put myself on a low mileage/high intensity schedule and hammer my old ass back into shape in the shortest time possible. What can I say? It suited my temperament at the time.

I formulated a week that included; a 3-mile run as fast as possible (and trying to improve the time each week); a 45-min hilly route run as intense as I could make it; and a 90-min run at best possible steady pace (without struggling or crashing and having to back off at any point). Three other days were just 30-45 mins at a reasonable lick. No slow easy runs in the whole week. One day a week off.

I kept this up for 3 months. Along the way I took part in some shorter faster stuff with the younger kids during training. I realised though that there were some days when I just could not keep up the pace on the 45min or 90 min runs in training, and would just bag those runs and turn for home.

A year previously, I had been used to long runs with the 2.35-2.45 marathon group, but I was now acutely aware that I could not yet go back out with them, but I did accept the good-natured cajolling of the 3.00-3.15 marathon group to join them for one of their 2hr+ long runs (±8.00-8.15m/m).

Now, as all runners do, I had already figured out that my 3-milers were by now at 5.30-5.40 pace, the 45 min run was 6.00m/m± and the 90 min run was somewhere around 6.40m/m or so.

Even the easy runs were rarely slower than 7.00m/m. You would have thought 8.00m/m would be a breeze...

It was one of the worst runs of my entire life. I can still recall it. All the way I wanted to either stop and walk, or speed up to normal 90-min pace and get my ass out of there. The rest of the group were laughing and joking and I was gritting my teeth because it felt like my legs were made of wood and someone had tied a piano to my back. Luckily, I was not too suprised and I knew why I felt so bad...

Way back in the late 1960s a professor called John Holloszy got some rats to run on a treadmill for various lengths of time up to 2hrs per day at around 50-75% of the rats' VO2max (easy running, therefore). After 12 weeks, he found that the rats had increased the mitochondria (vital for aerobic energy production) in their running muscles (compared to control rats that did no training). This was a seminal piece of work, because it explained why runners get better with training.

The next question was logical. How long should people run for to optimally cause this effect? Back to Holloszy and his fellow researchers who formed 4 groups of rats to train: one group running 10mins/day, a second running 30mins/day, a third running 60mins and a fourth running 2hrs/day. All at the same easy 50-60% VO2max, and for 5 days/week for 13 weeks.
Perhaps logically, the 2hr-group had the greatest increase in mitochondria at the end of the training period.
In a tough endurance test at the end of the training, the 10-min rats managed 22 mins, the 30-min group 41 mins, the 60-min rats could run hard for 50 mins and the 2hr-rats kept going for 111 mins. It was now apparent that time to exhaustion (all rats running the same pace) was directly related to mitochondria development (which itself was directly related to time spent training).

But what about intensity? Were mitochondria only created while running long and slow?
In 1982, a guy called Gary Dudley decided to explore this question. He had several groups of rats training five days/week (but only for 8 weeks). Like Holloszy, he also used a range of different training durations, from 5-90 mins per day. However UNLIKE Holloszy (whose rats all trained at the same pace) he also used a range of training intensities. Dudley's rats trained at either 100%, 85%, 70%, 50% or 40% VO2max. He also examined how different intensities and different durations affected different muscle types (fast twitch white, fast twitch red or "intermediate", and slow twitch).

The results were interesting and each fibre type responded differently:
Improvements in mitochondria in fast twitch white fibres began while running at 80% VO2max (but not slower, presumably because they were not recruited) and increased exponentially as the pace climbed to 100% VO2max.
However improvements in fast twitch red (intermediate) fibres maximised at sub-max paces (85% VO2max) and did not get better with increased speed.
And the best way to cause improvements in slow-twitch fibres was to run long and slow at 70% VO2max (adaptation began from as low as 50% VO2max pace). Faster was not better. Although Dudley found that 90 mins was not better than 60 mins, Holloszy had shown that 2hrs was definitely better than one hour (which ties in nicely with Lydiard-type training recommendations

that one 2hr run was better than 2 x 60 mins — you have to admit that the guy had great intuition born of his experience trying out different training on himself).

So, (some of you may be way ahead of me already). Why was my 8.00m/m run so difficult? Well, all my training in the 3 months leading up to it had been relatively hard. I had not trained slow enough for my slow twitch fibres to become stimulated to build huge amounts of mitochondria. My fast twitch red were becoming okay (I was reasonably good for 3-6m fast), but I could not access those fast powerful fibres at 8.00m/m. The intensity was too low. I was being forced to use my slow-twitch fibres... and they were not trained for any kind of endurance, and certainly not 2hrs.

It seems paradoxical, that I can be okay at 7.00m/m, but not at 8.15m/m, but here is one example. I was okay if I ran hard enough to force my body to recruit my fast twitch red fibres (and as long as they had enough glycogen). Like most distance runners I have relatively few fast twitch white fibres, so they were little help, and in all my 3 months of training my slow twitch were being by-passed on every training run. (Or rather, recruited, but swamped/overworked). The intensity of each training run was too high for them to be stimulated optimally to best create mitochondria in themselves (and thus improve). So when I ran at a pace that I was forced to access ONLY them, I was sunk.

Following this run, I threw out the intensity and went back to training sensibly. In 10 weeks I was more like my old (younger?) self.

So, to sum up:
To improve your LT (which will have a direct impact on your race performances), you must increase the motochondria in your running muscles (in a neat move, the optimal training to improve mitochondria is also the optimal training to improve capillary density).

The more mitochondria, the less lactate at every running pace. But mitochondrial adaptation in each fibre type is training-intensity dependent. If you want to maximise the number of mitochondria in each fibre type, you must train at the correct pace for that type. (remember; the more mitochondria, the less lactate; the less lactate, the faster the racing pace and the more economical you are at any pace, meaning you can keep that pace up for longer.)

Part IV

Let's move from the Why to the How To...

And in contrast to the accepted method, let's start from the end. I have repeatedly stressed throughout this thread and the preceding one (see link to it from Part I), that there is a huge improvement in performance that can be made from purely aerobic training, if you get it right. A huge improvement wayyy before any faster work is done. In the example that follows I want to stress that what was achieved was done without any of the sort of sessions that many of you might expect.

So when you read what follows, just bear in mind that there were no sessions of repeat 1,000s, no repeat miles, no "tempo" runs (at least in the accepted sense of 10k-pace +15 secs). Just lots of controlled aerobic training (detailed examples of the training will follow)

All the figures and timelines that I will quote are genuine and I want to use the example of my friend Giuseppe (whom I'll refer to as Joe, for the purposes of this thread).

A little over 5 years ago I coached Joe to two 2.27 marathons. We had expected the second race (some 6 months after the first) to be sub-2.25, but raceday proved to be extremely wild and windy and Joe ran his heart out and yet just broke his earlier 2.27 by a bare 2 seconds.

We would have ducked the race under normal conditions and found another, but it was a fall marathon and we did not have a fall-back. Life being what it is, there was no guarantee how things would be if we waited till the following spring. Work, injury, illness... anything could happen in four/five months. Joe made the decision to race, and I admired him for doing so. Some months after the race I moved house, away from the area and we lost touch.

Early last year my wife raced near Rome and Joe came across her after the finish line and we all met up that evening for a meal and a chat about old times. We had all enjoyed many long runs together all those years ago, so we had much to recall and talked late into the night.

Joe ruefully admitted that he had put on 20 pounds and was now approaching 35 years of age. He was also mired in work, since he was the financial controller of his family's printing business and was having to hassle many clients for lack of payment on time. A relaxed, easy-going guy, Joe admitted that the stress of having to constantly argue with clients was getting to him and serious training had long been forgotten. It was at least two years since he had had any kind of fitness and now he was down to maybe 20 miles per week, if that. And slow!?! (many of us could tell similar stories).

Anyway, we parted after swapping email addresses and telephone numbers. During the evening Joe had several times remarked that his best running days were behind him, but my wife (older than him by a few years) had admonished him every time, repeatedly telling him he was talking nonsense. All he needed, she said, was to make the decision to begin, and with the right training it would all come back.

A few weeks after I got back home, I got an email from Joe saying that he was going to go for one more serious marathon. We had got him hyped and he had been able to think of little else. I told him before he began to look at his working life and figure out how he was going to find 90 mins to 2hrs per day for training. I also told him to ease his way (taking as long as he liked) to get to 50mpw and then I would give him a written schedule from there. (Examples of the schedules will follow).

One thing that concerned him (and I) was how we would monitor his growing fitness without jumping into regular races. Since he had worked with me in the past, he knew all about lactate testing and HR training. After some thinking, I told him we would be able to do the same, only without the blood tests. If we were really careful, I said, and he kept me informed of everything, it would work. He agreed to try. He argued with his brothers, telling them he was going to alter his work hours to suit his training. Grudgingly, they agreed.

Elsewhere, on another thread, I had explained why I liked the period in lactate tests to be a minimum of 8 mins long. I have long used a protocol that consists of repeat runs over 2400m at slowly increasing intensities (with pauses after each period to draw blood). (Note: you really should have followed and read the lactate link I put up earlier to be able to fully understand the discussion from this point on. Don't worry, it's not difficult and it's well worth the read).

Once Joe got to 50mpw, I told him to perform the following mini-test (he knew the protocol). Go to a track on a windless day, as rested as if for a race, and do the following:
Run 2400m at a steady 140 HR (Stop 90 secs and record time)
Run 2400m at a steady 150 HR (Stop 90 secs and record time)
Run 2400m at a steady 160 HR (Stop 90 secs and record time)
Run 2400m at a steady 170 HR (Stop 90 secs and record time)
Run 2400m at a steady 180 HR (Stop 90 secs and record time)
At all times, adjust the running pace to maintain a stable HR. On each new stage slowly edge the HR up (ie: it is ok if the HR takes the first 600-800m to reach target level), then simply maintain HR. DO NOT start fast and have to slow to maintain target HR.

Joe got back into things in mid-April, and ramped to 50mpw of easy jogging pretty quick. I got him to do the mini-test on 11 May and periodically thereafter (bearing in mind the ~6 week period for mitochondrial growth). The numbers below detail his progression in running speed at each date and each HR. The times are in mins/mile. Joe's oganised training began immediately after the first test.

In 12 weeks ± Joe improved his HR vs running pace at all intensities. A pace that required 150 HR initially, only required 140 HR a brief 12 weeks later. This was true across the board. A pace that used to require 180 HR now required less than 170 HR...

Dates — 140 — 150 — 160 — 170 — 180
11May – 7.56 – 7.22 – 6.42 – 6.05 – 5.40
06Jun – 8.03 – 7.17 – 6.36 – 6.01 – 5.33
29Jun – 7.23 – 6.49 – 6.12 – 5.42 – 5.18
04Aug – 7.18 – 6.36 – 6.00 – 5.33 – 5.10

Six weeks after this last test (and less than 20 weeks after beginning organised training), Joe entered a marathon with instructions just to sit quiet with the 2.20-low group and stop at halfway. He ran 71.xx.

Managing to finish less than 2 mins off his all-time half marathon PR after only 20 weeks organised training, Joe began to see how his sub-2.25 dream could still happen.

Discussion:
Before I get into the exact details of Joe's training, let me pre-empt one question you might have: how was Joe able to run 5.33m/m with 170 HR when it used to require 180 HR to run at 5.40m/m?

If you have read and understood all that I have posted, you should have a good idea of why this occurs, but let me just review it quickly.
A prime function of your heart is to deliver oxygen to your active muscles. Your muscles then use this oxygen combined with glycogen or fat to create energy to run. If your muscles are inefficient at doing this, you will not get as much running energy per unit of oxygen as you could.
Think of your heart as a pump that is told what to do by the muscles. "We need more oxygen!" say the muscles and the heart beats faster. "We have enough", they say and the heart rate stays low.
To break one unit of glucose down into energy anaerobically (WITHOUT oxygen) you get two units of energy (let's say that you get 2 paces/strides up the road before you need more energy). If you break that self-same unit of glucose down into energy aerobically (WITH oxygen) you get 36 paces up the road before you need more energy. Obviously this is much better. So if you can make what used to be an anaerobic pace into an aerobic pace, you are a much superior runner and can keep this pace up for much further.

But even better, if you were so efficient that you could break down one unit of fat into energy (instead of glucose) you would get 460 paces up the road before needing more energy. And your HR would be wayyyyy low at the same time.
Now 100% fat-burning isn't going to happen, but I hope you can understand that the higher a percentage of fat there is (along with a percentage of glucose/glycogen) in the fuel mix you burn at marathon race pace, the more comfortable you will be, the longer you will keep up the pace, and the faster you will run.

The short answer? Joe just got more efficient at using oxygen and breaking glucose/fat down into energy for running.

Addendum to Part IV

When Joe ran his first mini-test on 11 May, as well as emailing me the data, he also sent his opinions on the effort levels involved at each stage. At the lower end, he remarked that it was somewhat difficult to keep his HR low enough. This is often the case at first. As can be seen, Joe was very slow initially which showed how much aerobic fitness he had lost. The running

pace at this very low effort level improved in time with the training. Most runners would skip this effort level and so lose the valuable adaptations that take place.

At the higher end he found 170 to be a bit of work, and he said he would not like to have maintained the 180 HR effort for much longer. When pressed, he stated that he would be lucky to keep the 5.40m/m pace up for 5km. Definitely not further. This signifies, even without testing, that Joe had passed his lactate threshold at this pace and was now building serious amounts of lactate in his running muscles.

Less than 20 weeks later, Joe would complete a HM (at 21km, a distance that was over four times longer than the first mini-test) at faster than this 5.40m/m pace he had found so tough (HM pace was 5.28m/m). He would be able to do this because, through training, his lactate at this pace was now significantly lower than it had been in his first test. Since this was so, the "effort", the degree of difficulty to him, the stress at this pace, was greatly reduced and he had no problems maintaining this effort for 71+ mins.

Second addendum to Part IV

How can we all move our Lactate Thresholds? Actually, the question is not that simple, because for some of you it will be necessary to first establish a threshold. Think back to the lactate charts I linked you to in Part II (and here I wish I could post some charts to make this more clear).

You've got the x and y axes, and the lactate curve begins from the left and runs horizontal for a short way and then climbs at 45 deg angle. For some of you, that would be exactly what we would find if I lactate tested you; your anaerobic energy kicks in wayyy too early, and you have no good relationship between your 1500m time and your 10k / HM time.

Slightly better would be the next runner whose lactate curve stays horizontal for slightly longer (remember, the horizontal axis is running speed, so the further the curve goes to the right before climbing, the better). At a slightly better running pace, this athlete's curve then climbs at 33 deg angle.

And, of course, we have the well trained athlete whose curve stays flatter for much longer before curving upwards.

We need to train to become like the third athlete. If you have not already read and fully understood the earlier lactate link, you might want to consider drawing these 3 curves on a graph paper. Draw the x and y axes. You can mark the vertical axis 1-10. Starting from about 2 on the vertical axis, give the first athlete "A" about 2cm of horizontal line before curving/slanting upwards at 45 deg all the way to 10. Starting from about 1.5, give the second athlete "B" about 4cm of horizontal line before climbing at 33 deg again all the way to 10. Finally, give the third athlete "C" about 6cm+ of horizontal line before his slope climbs at an even flatter angle to a max of 8.

Having done this, note that if you draw any vertical line that crosses the horizontal axis anywhere on the graph you can see how much lactate each athlete has to build to run at the same

pace as the other two athletes. Runner A's lactate can be crazy high, and runner B's climbing, while runner C's lactate is still at calm levels.

How do we make runner A like runner B (and B like C)? To move the lactate curve to the right, we need to go wayyy back to just before the curve begins to turn, and train both at the point, and below (slower). Not faster. If we do this right, in six weeks the curve will move and we will be able to run faster, more easily (ie: aerobically and not by calling up some anaerobic energy).

Obviously, doing lactate tests, the effort levels at which to train are easy to find. How can we find them without lactate testing? That is what I will try to explain in Part V.

Of course, almost every running book since Lydiard has asked you to train this way, but they just say "run easy", and it has been my experience that very many runners get the definition of "easy" wrong.

Part V "A"

First up, be sure that you understand the above addendum. To move your LT (for all the reasons given earlier, reasons that show that a high LT is THE prime attribute for a good performance) you must work BELOW (slower than) the pace at which your LT currently turns.

No pain, no gain, doesn't work with LT training.

Now, how did I train Joe? If you can follow this, you can do exactly the same to yourself. I am trying to write this as carefully and simply as possible, but it's going to be wordy and full of numbers and data which you will have to sift through. Please make sure that you read it just as carefully and don't just jump in with questions, because this part of all this thread is a major key to improving your race performances. I will do my best to sum it all up at the end and put it into key points to apply to your own training.

First off, what I did with Joe was ask him to do a simple (but tough) test to determine his HRmax. I asked him to go to a track and warm up, stretch and do some strides as if preparing for a race. Then (wearing his HRM) he was to run an all-out 800m and note the highest HR recorded on his monitor. He was to rest 2 mins and run an all-out 400m. The highest number he would see as he crossed the finish-line, we would take as his HRmax. Since HRM's can sometimes be tricky and go blank or haywire at the wrong moment, he was to have someone there to be ready to immediately manually take his pulse for 6 seconds (and multiply by 10). This proved not to be necessary, since his HRM read 193.

I have taken enough lactate measurements and had people wear HRM's in marathons (even Joe himself, years earlier) that I was able to tell him that based on this HRmax his best marathon HR would be 175-177. Higher than this would not be possible/sustainable. (Note; I just got them to wear them for my information purposes, not to use as a race-pace guide, a practice I do not agree with).

A few days after this HRmax test, I got Joe to run his first 2400m test on 11 May. If you check back at Joe's results, you will note that the speed at 170 was only 6.05m/m.

For reasons of cardiac drift, I had learned that the pace at 170 in the test would pretty accurately reflect the running pace he would maintain for a marathon (assuming he was trained well) even though in the race his HR would climb to 175-177. This because for 2400m he is not having heat dispersal problems such as he will encounter if he keeps up such a pace for 2hrs+. So, assuming proper training, the pace at 170 HR (for Joe) in the 2400m test equals pace in the marathon at 175-177 HR (in other words, his best marathon pace/effort).

So, with an eventual target of sub-2.25 (5.30m/m) in the marathon, Joe's current pace at 170 on 11 May (6.05m/m) was too slow.

I told Joe that to move/improve the running pace at this HR, he had to train a lot of miles at HR's lower than 170 (and obviously, slower). He knew this anyway. It would be some time before he

would even be allowed to run at 170 HR intensity. Not until he was ready for it. And by the time he was ready for it, it would be much easier than he was finding it at present.

As noted in an earlier addendum (to Part IV), Joe found this initial test effort at 170 HR to be okay for 8-10mins, but not something he wanted to keep up for too long, maybe 30-40 mins. Indeed 180 was something he did not believe he could maintain at this early stage for even 18 mins. Both of these subjective perceptions (and Joe has a lot of running experience) were telling us that his lactate was rising even at 170 HR and was going very high at 180. If we can look back at the A-B-C graph I described above (Second addendum to part IV) we can picture Joe as being runner A (or maybe B). If you draw this graph it will become clearer. For an optimal marathon, we needed Joe to be capable of the sort of lactate curve generated by runner C.

To do this, we needed to get Joe to work at paces before his lactate curve turned. It obviously was turning BEFORE 170 for 3 reasons:
1. The pace at 170 (6.05m/m) was not the target marathon pace (5.30m/m as predicted by the relationship between Joe's other shorter distance performances, and as predicted by Joe's earlier ability from 5 years previously. We KNEW Joe was capable of 2.25 if well trained. The fact that he could not do it at present simply meant he was not well-trained. A fact we were aware of.)

2. If Joe was well-trained, the lactate curve should not curve till just about/just after Joe's marathon pace/HR (ie: 5.30m/m and 170+). In fact, his marathon target pace and marathon HR should pretty much coincide at 170HR. The fact that they did not, showed us his LT was low.

3. Joe did not want to run for too long at 170 HR. A significant pointer that he was already above his LT.

Let me go over that again. It look complicated, but it isn't.
a) If you have a POOR relationship across race performances (as already discussed at the very start of this thread) you have a low LT compared to what it possible for you. If you do the 2400m test, you will either find that the pace at your best marathon HR is too slow (like Joe at 170) or that the effort required at that (170) HR is too much and something you cannot hope to maintain for 26 miles.

b) If you have a GOOD relationship, and your HRmax is like Joe's (193+) then your best marathon race HR will be 175 ±. If you do the 2400m test, you should find that your pace at 170 HR is very close to best marathon pace (although HR in the race might be 175+). AND you should feel that running at 170 HR is no big deal. You can maintain it comfortably for a long time without even thinking.

So, Joe's marathon pace was not where we expected it to be. And 170 HR was "too tough" at present to maintain for 26 miles. He had to train slower/easier and lift his LT which was currently very low.

Here we needed to find 2 training paces for Joe. One, we knew had to be low aerobic conditioning pace for every day, the second could be up closer to his current LT.

The low aerobic pace had to be ~50 bpm lower than his HRmax (70-75% of HRmax). Since Joe's HRmax was 193, this put his easy mileage at 145 HR (or lower). The second HR was to be a bit higher, but still under LT. This one was set at 155-160. (Note here: the LT at this point was still low, and occurring at a low HR. In time, Joe would be able to run at marathon HR 175 very very comfortably, because the lactate at that effort/HR would be low by race time. Until then, he had to work BELOW this effort and ease the comfort zone up until it reached 175+). This second intensity was set at Marathon HR minus 15-20 bpm (for now, it would be allowed to rise as Joe's fitness improved... as will be explained in the example).

As a general guide, and in my experience, this is what I have found works best. Marathon HR will be approx 15-20 beats lower than HRmax (no better). And aerobic conditioning HR needs to be another 30 bpm below THAT (and hence ~50bpm below HRmax) I will qualify this in a more general statement at the end.

When Joe's LT moved, the pace/HR at which he could train and still be under LT would also move/rise. Although his upper limit at first was 155-160, in time he would be able to train at 170HR and still be very comfortable. But not yet. He had a lot of work to do first. 170 was still too "uncomfortable" (ie: too close to, or slightly above LT).

The totally WRONG thing Joe could have done at this point was to think "right, 175 is marathon HR, I'll work at that pace until I can do more and more of it." Or he could have thought, "right, 5.30m/m is target race pace, I'll start with 2 miles at that pace and add on one per week until I can do 26..." Neither of these would have worked for him.

What he had to do in effect was find his aerobic upper limit and slowly ease it up, not by working harder, but by working just at the optimal pace/effort to stimulate his muscles to become better at providing energy at this rate. This would cause the effort at that pace to drop, to become easier and the HR at that pace to fall (and usually the pace at that HR to improve/drop). He would then slowly be ably to work at higher and higher HR's while still remaining fully aerobic and working under his LT.

In fact, for his HM, 20 weeks after starting, Joe would average 181 HR at 5.28m/m. This was a HR he was not able to maintain for longer than 18 mins at the start of training. The difference would be that by HM time, Joe's lactate at 180 HR was LOWER than his lactate at that same HR 20 weeks previously (and therefore less "stressful" and more "comfortable"). This, despite the fact that the pace at that HR was now faster.

The following information is not going to be tidy. I cannot put it in chart form, so you may need to copy it out into Excel and straighten it out a little. Or print it out and digest it slowly.

Part V "B"

Starting from 11 May (when he had reached 50mpw and conducted his first 2400m test), over the next 16 weeks, Joe's weekly mileage was as follows:
wk1 (64mpw) wk2 (67) wk3 (88) wk4 (85) wk5 (60) wk6 (103) wk7 (86) wk8 (116) wk9 (110) wk10 (98) wk11 (96) wk12 (110) wk13 (116) wk14 (67) wk15 (107) wk16 (99).

Joe was given schedules to show him how to best get from 50 mpw to 80 mpw.

Mon	60 min easy	145 HR
Tue	75 min easy	160 HR
Wed	45 mins easy	145 HR
Thu	60 mins easy	150 HR
Fri	75 mins easy	160 HR
Sat	45 mins easy	150 HR
Sun	90 mins easy	155 HR
Approx 60mpw		

Mon	75 min easy	145 HR
Tue	60 min easy	155-160 HR
Wed	60 mins easy	up to 150 HR
Thu	75 mins easy	145-150 HR
Fri	75 mins easy	160 HR
Sat	60 mins easy	14-150 HR
Sun	90 mins easy	150 HR
Approx 69mpw		

Mon	60 min easy	140-145 HR (or lower)
Tue	90 min incl. 70 @ 160 HR	
Wed	75 mins easy	140-150 HR (or lower)
Thu	75 mins easy	150-155 HR
Fri	90 min incl. 70 @ 160 HR	
Sat	75 mins easy	140-150 HR (or lower)
Sun	3 hrs easy	145-155 HR (w/60 min @ 160)
Approx 80+mpw		

We should note that Tue and Fri are preffered "work" days (although the pace was always easy/aerobic). Sunday is obviously long-run day as it is for many. The remainder of the week was just increasing miles at easy running HR.

For the first 8 weeks, Joe did not run higher than 160 HR at any time (even though he intended to race at 175 HR in the marathon). As can be seen from his 2400m tests on 29 Jun, his pace at all HR's was slowly improving. Even the paces at 170 and 180 HR were improving despite the fact that Joe had not run at that intensity AT ALL in the previous 2 months.

By wk6 he added some more easy 150HR+ running on three days per week (to go to 103mpw). Also on wk6, each Sun became simply 2hrs-2hrs30 at 150± (no longer including 60 mins @ 160 HR)

Sample weeks are as follows (mileages are approx, Joe notes times eg: 1h45mins @ 150HR±):
wk4:
Mo (8m @ 145)
Tu (10m @160)
We (12m@145)
Th (14m@145-150)
Fr (8m @ 160)
Sa (12m @ 150)
Su (2hrs @ 150 incl: 60 mins @ 160)

wk7:
Mo (10m@ 150)
Tu (12m @ 145)
We (10m @ 160)
Th (14m @ 155)
Fr (10m @ 145)
Sa (6m @ 140)
Su (2hrs 15 @ 145-150)

Over time, the running speed at each HR was slowing improving (see 2400m tests).

On wk 8, we introduced a session simply designed to to get Joe used to moving faster biomechanically, without incurring high lactate. I call this 200/200 or 200-fartlek. It is done on a track and involves 200m @ approx 5k pace followed by 200m easy and continues without stopping for 25 laps (10,000m). The point is NOT to do the overall 10k in the fastest possible time (by slowing up the fast bits and speeding up the slow bits), but to maintain a healthy differential of approx 15 secs or more between the fast/slow 200s. Something like 40s and 55secs or 43s/60s.
Joe ran this on weeks 9 (38s/55s – 38.40 for the 10k); wk10 (37s/52s – 37.18 for 10k) and wk12 (37s/51s – 36.53 for 10k). This session replaced one of the 160 HR runs on those weeks, the rest of the week remained unchanged.

Up until wk 12, these 200/200 runs had been the only time Joe had run at higher than 160 HR (and even then, only for a short time).

Only on wk13 was Joe allowed to run at 165-170 HR and this replaced his 160 sessions (because we believed his LT had now moved up from 160 HR). That week (Tue) he ran a measured 10m @ 168 av and managed 58.28 and found it "easy" (indicating therefore low lactate and a pace under/slower than LT). This was NOT a race effort. He ran it again that week (Fri) and managed 58.56 (166 HRav) and found it again, "easy".

Since this intensity was now a regular part of the schedule, in wk14 (Tue) Joe ran the same 10m at HRav 171 in 57.58 and found it "very easy, legs fresh, could have kept going no problem". Also that week (Sat) he took part in a local road 5km for "fun" (something to do with impressing a girl) and ran 15.58 (5.09m/m) with a HRav of 186. He phoned me afterwards and explained he

could have kept going, but could not get faster. This is a common feeling on this kind of training which was not (yet) aimed at 5km racing.

Just note here that Joe had never AT ANY TIME run this 5km race pace (5.09) in training. So far his fastest paced training had been 10m @ 5.48 apart from 3 x 200/200s worth of 10k. This is the power of a strong LT. His third mile had been the same as his second. He had not been slowing down. I told him that after the marathon, if he wanted, he could train to knock another minute off of this time... and that got him thinking.

On wk 15 (Tue) Joe ran his 10m in 57.34 (5.45m/m) at HRav 169 (remember his marathon target was 5.30 at 175 HR, so he was getting there) and later that week (Fri) he ran 3 x 15 mins at 170 HR with 5 mins jog.

On wk16 (20 Aug) Joe ran 13 miles (HRav 168; simply as part of his 165-170 run) in 1.16 (5.50m/m). This pace was now "comfortable" and something he could keep up for much longer.

And on wk19, as already noted, Joe ran a HM (as part of a marathon) in 71.43 (5.28m/m) with an HRav of 181 (due to some cardiac drift).

Was his aerobic training finished at that point? Far from it. I figured we were only halfway there. We needed to be able to see sub-5.30 at 170HR (or lower) on the 2400m test.

Note that Joe was only now being introduced to 170 HR training/intensity. And that this was now becoming comfortable for him (ie: because the lacate at this effort was now low). Conventional wisdom would have now stated; "based on his HM time, he needs to run tempo runs every week at that pace for 20 mins..."

In truth, Joe was not yet ready for such intensity. He would do much better to just keep working away as he was. Continue for some weeks at 160-170, then slowly move that up to work at 175 HR when the time was right. Always slowly slowly raise the intensity of training, and only when you are very sure you have maximised your running pace at all the lower intensities. Do not be fooled into thinking that you only need to be fast at 175 (race) HR. You also need to be pretty quick at 160, 150 and 140 HR too.

Think of it like a tube of toothpaste. To ensure you get every last drop (of ability) you have to go to the very end of the tube and slowly squeeze your way up. Never hurrying.

If you are not as aerobically strong as you should be (you have no pace relationship as race distances get longer, as explained way back at the beginning), it can only be for one (or both) of two reasons: 1. You don't run enough miles. 2. The miles you do run are being run too fast. Fix either (or both) of those, and (aerobic) improvement will follow.

Part VI

Let me try and squeeze some more mileage from my toothpaste analogy:
If you open a brand new tube, you can squeeze anywhere and expect to get some toothpaste. Without wanting to be too simplistic, see the tube as a new runner: pretty much any training you give him or her will result in improvement (toothpaste).
It could even be possible that you are not a new runner, and have been running for some years but are now failing to improve substantially and believe that you have tapped all of your "trainability". Here it is very possible (especially if you have no pace relationship) that all you have merely achieved is to squeeze all you can from halfway up the tube. You might have done a very good job of doing so, and seen sizeable improvement (toothpaste) for some time. However you might now (mistakenly) believe that is all there is in the tube.
I think most people would agree that to get everything possible from a tube of toothpaste (to get every last drop), we need to go to the very end and squeeze/roll carefully all the way up. That, if you can excuse the analogy, is what this whole thread has been about. Maximising your trainability. So we can all walk away from the sport as "old farts" secure in the knowledge that we got out of ourselves every last bit of genetically limited potential.

Okay, the reasons why I suggest/promote this method of training are already out there, and so is an example of how effective it can be. Within that example, I believe the "how" is quite clearly discernable, but let me be more clear and give some general guidelines that almost all runners should be able to apply to themselves.

I have already mentioned that in one of Lydiard's books (Running With Lydiard, by Lydiard and Gilmour 1983) he suggests the initial one-week (mainly) aerobic training in his schedules is repeated "for as long as possible" before going on to the later parts of the programs. The advice contained in this (and the earlier) thread is my version of the training aimed to get every runner to an extremely high level of aerobic fitness. The first time it is undertaken (like "Joe") it may take some months to get to a very high level of aerobic fitness. But if this is not lost after each competition period, each subsequent "build-up" period will require less time (you start each time from a higher level). And in time will become more like 10-12 weeks instead of the (first time) 20 weeks.

I believe that if you get this first part right, then the major proportion of your training for any distance event will already be complete. You will be able to rock and roll pretty much year round. (Here we might consider such runners as Ron Clarke, as an example of this being possible). Okay, you might not be always in PR shape, but your season will not be characterized by odd peaks and deep troughs either.
All or any other (interval, speed, call it what you will) training undertaken will be done better, and achieve more, if it is added onto a correct implementation of this first stage. Of course this is not all the training you will need if you are aiming for middle distance success. But get this first

part right and you will be one mean “mutha” when you step onto the track for your first interval session. Indeed, I would refer you all to re-read and understand HRE’s comment above by Peter Snell and McFarquhar that it is very possible to even race close to your (middle distance) best simply off of this base period.

Now the guidelines I am about to offer have not been proven with the rigor of a scientific study, but have arisen as a general trend out of repeated testing and training of distance runners over the years. I have found these to be valid for runners of all ages from 17 years and over. I would not suggest applying them to runners younger than 17-18 years old.

1. Do an HRmax test on yourself (how-to example is in the text) and make every effort to ensure your complete and absolute confidence in the result (note that within 2-3 bpm of HRmax is accurate enough. Whether it is 195 or 197 will not affect how you train).
2. Perform a 2400m test on yourself (from easy training pace to a max of 5bpm higher than your particular HRmarathon- see below).. Once again ensuring you are fit, fresh, rested as if for an important race and all possible variables (wind, etc) are controlled as much as possible. Since you are going to conduct this 2400m test again and again, you must try and ensure that, as much as possible, all tests are done under near identical conditions (or else you start wondering such thoughts as, "am I faster because it was less windy this time?"). Do all you can to control against such doubts having to occur (ie: don’t test in gale force winds).

As a general rule, the best possible HR/pace/effort you can maintain for a full marathon (without crashing, hitting the wall, etc) will not be closer to HRmax than 15-20bpm. Getting within 20bpm of HRmax might be hard enough at first, but with proper training it is possible to get even within 15-20bpm of HRmax. Closer than this (as an average over the whole race) I would not expect you to be capable of.
So, HRmarathon is ~20bpm below HRmax, and easy running HR is another 30bpm (or more) below HRmarathon (therefore 50bpm or more below HRmax). Like this:

If your HRmax is 193 OR HIGHER, then the following applies:
HRmax: 193+ (even if over 200)
Best possible HRmarathon: 175-177 HRav (note, this is the average taken from mile 5 to mile 25, not the peak. Your HR might peak to 181 in the final miles as you throw everything onto the fire).
Suggested training HR's: Easy every day running: 145 HR or lower (If you begin really unused to this form of training, initially you might start at 150, but as soon as the pace at this HR improves, it is recommended that you reduce your easy running HR to 145 or lower). This can often feel very slow to begin with, but should improve within 3-6 weeks and continue to improve for months. You may do as much running as you wish at this HR/intensity (always being careful to avoid overuse injury).
Initial LTHR (initial lactate threshold heart rate): As with Joe in the example, begin at 155-160 and do not let the HR rise on the run. Build up the distance you can run for, over time, to 10 miles. At first, you may have to slow down within the run to maintain HR, but over the weeks and months, you should note that the running speed begins to remain more stable and you do not have to slow down (so much) to stop your HR rising. In time, the running pace at this HR (and all other HR’s above it) will also improve. Only move this HR up when your running pace vs HR

is rock steady and you (easily) are able to run 10 miles at this HR without loss of pace or rise in HR. At that point, only move the HR up by 5bpm and begin again. The slower you build up the first time, the better your pace at HRmarathon will be. Remain at each HR as long as you are seeing improvement on the 2400m test and definitely until your pace vs HR is stable. You are trying to reach a state where your predicted/expected marathon pace and your 170 HR pretty much coincide in the 2400m test. And that this pace per mile can be maintained in training for 10-15 miles at 170-175 HR without rising effort or rising HR.

For example training weeks (60, 70, even 80+ mpw), go back to Part V (B) and plug your numbers into the example weeks given for Joe's training. (Want to run more mileage? Add in some extra miles at 140-150 HR. This can be as doubles on some days, up to 8miles in the morning and 10 miles at night. All easy aerobic running.)
Rid yourself of any sign of impatience and just knuckle down to the work. Remember, a constantly dripping source of water will eventually erode solid rock. For this to work, you need your muscles to change, and change takes time. Mitochondrial growth takes ~6 weeks. So look for small change every 3 weeks or so, and significant change every 6 weeks or so. It is not suggested you 2400m test more regularly than every 6 weeks. More often is just frustrating, like someone who is trying to lose weight, jumping on the scales every morning hoping to see the pounds drop off. Just do the work and give it time to have an effect. Farmers don't pull up their potatoes every five minutes to see if they are growing…

If your HRmax is 183, read all of the above, but use the following numbers:
Best possible HRmarathon: 165-167av
Easy running: 135 HR or lower (This training HR will not change with time - it may drop, but the pace at this HR will definitely improve.)
ILTHR: Begin with 145-150 and only move it up (only by 5bpm each time) when your pace vs HR is steady and you are able to run 10 miles at the particular HR without loss of pace or rise in HR. You are eventually trying to reach a state (some weeks or months down the line) in which you can run 10 miles at HRmarathon with no rise in HR and finish confident that you could go round again at the same pace with no rise in HR or loss in pace at constant HR.

If your HRmax is 173, read all of the above, but use the following numbers:
Best possible HRmarathon: 155-157 HRav
Easy running: 125 HR or lower (This training HR will not change with time - it may drop, but the pace at this HR will definitely improve.)
ILTHR: Begin with 135-140 and only move it up (only by 5bpm each time) when your pace vs HR is steady and you are able to run 10 miles at the particular HR without loss of pace or rise in HR. You are eventually trying to reach a state (some weeks or months down the line) in which you can run 10 miles at HRmarathon with no rise in HR and finish confident that you could go round again at the same pace with no rise in HR or loss in pace at constant HR.

If your HRmax is 163, read all of the above, but use the following numbers:
Best possible HRmarathon: 145-147 HRav
Easy running: 115 HR or lower (This training HR will not change with time - it may drop, but the pace at this HR will definitely improve.)

ILTHR: Begin with 125-130 and only move it up (only by 5bpm each time) when your pace vs HR is steady and you are able to run 10 miles at the particular HR without loss of pace or rise in HR. You are eventually trying to reach a state (some weeks or months down the line) in which you can run 10 miles at HRmarathon with no rise in HR and finish confident that you could go round again at the same pace with no rise in HR or loss in pace at constant HR.

Obviously if your HRmax is one or two beats either side of the examples given, adjust the training HR's accordingly. Note that if you are not well-trained aerobically, you will very likely NOT be able to maintain the "best possible HRmarathon" as explained in the race. It is more likely you will crash at some point and be reduced to running at a much lower HR/pace.

In the final example weeks of Joe, he was able to run two times per week for 10 miles at 165-170 HR without loss of pace (all other runs being 145-150). Once he no longer saw improvement in his 2400m tests, he would take ONE of those days and slowly build up to being able to run 10 miles at 175 HR (HRmarathon). The other day would remain at HRmarathon minus 8-10bpm. Once he could handle 10 miles at HRmarathon (without loss of pace to maintain HR) once per week, he would be very close to being race ready.

How will you know when you are ready? When you can run at HRmarathon (or at least HRmarathon less 5bpm) for 10 miles+ with no drop in pace vs HR, and you KNOW you could go round again with no rise in HR to maintain pace, you can be pretty sure that your aerobic system is providing 100% of the energy being used. If you have never trained this way, you will be surprised how "comfortable" this will feel when you get it right.

At that point, and not until then, you can decide whether to aim for a marathon, or to build on top of this aerobic base to aim for some shorter race distances. It should make sense that if you are a young runner the best time to begin this build up is soon after your main competition period of the year. Those who aim for two marathons per year might adopt it as the early part of their 20-week build up towards their next marathon. Note that it was always a Lydiard belief that even middle distance runners should be capable of a fine marathon before turning to speed.

But what about "tempo" runs?
I would suggest that only when you are capable of 10 miles at HRmarathon (without loss of pace) would you think about running at so-called "tempo" pace (marathon pace minus 12 secs/mile). Indeed you might then find the following paces ideal and find a regular place for both of them in your training (like Hinderloppet): a 10-mile run at Marathon pace + 5-10 secs/mile (aka 10k pace + 35-40 secs), and 4-5 miles at Marathon pace minus 12 secs/mile (aka 10k pace + 18-20 secs mile).

Be patient. Do good work. And improvements will come.

Finito.