VITAL STATISTICS:

prediction vs performance

In the May issue of *Rf*, three hard-training runners committed to print their goal finish times for Brighton and London marathons – targets that had been scientifically determined by physiological tests at the University of Brighton's Marathon Support Unit. Did their performances live up to predictions?

● **Words:** David Bradford

The group of 15 runners who signed up to the University of Brighton's Marathon Support Unit (MSU) in winter 2011 did so to try and establish a scientific profile of their fitness and, in turn, ascertain a realistic finishing time for the April marathons they had entered. Each of them underwent two rounds of laboratory tests during their 12-16 weeks of preparatory training; by the end of March, final reports were written and targets set. All that was left to do was run their races.

The main case study in May's 'Vital Statistics' feature was 31-year-old graphic designer Tom Morris. Tom is a club-mate – we both compete for Lewes AC – so I was personally interested in his debut road marathon attempt. He had decided months ago to run the Brighton Marathon, and opted to sign up for MSU support because he wanted to find out precisely what his body was capable of, so as to establish a challenging yet achievable target time and avoid a repeat of his experience in the 2011 Beachy Head Marathon, where he set out too fast and consequently faded.

The MSU tests revealed that Tom's VO2max (maximal oxygen uptake) was 70ml/kg/min, which is on the cusp of international athlete-level, so there were no worries in that department. His running economy (RE) – the amount of oxygen used per kilogramme of bodyweight per kilometre of running – was measured as 204ml/kg/km, which was likewise deemed a respectable figure. Finally, Tom's lactate threshold (LT) – the point at which demand for oxygen begins to outstrip supply and lactate starts to accumulate in the blood – occurred at 14.8kph (6:30/mile pace).

This LT pace was the figure on which the MSU based Tom's marathon target: 6:30/mile pace, which equates to a finish time of 2hrs 50mins. Running the entire distance at this pace, to finish 10mins under the three-hour mark, was his optimum achievable goal, according to the MSU's data. Although there was no guarantee of success, this goal time – supported by a raft of test data – was certified realistic. But Tom had other ideas…

His training had gone exceptionally well; he was regularly running 30min tempo runs at 5:40/mile pace, achieved a scorching PB at the 0.4-mile-too-long Brighton Half Marathon, of 1hr 17mins (5:42/mile), and completed a 20-mile training run in 2hrs 01min (6:02/mile). His confidence was brimming, and the MSU's goal pace of 6:30/mile seemed frankly too easy. I shared Tom's optimism; I had witnessed much of his training, and was so impressed that I tempted fate by predicting a marathon performance of 2hrs 42mins (6:11/mile). How would my prediction – "club-mate's instinct" – stack up against an estimate grounded in laboratory science?

"At the start, a small group took off at slightly faster than 6:00/mile pace," recalls Tom. "I let them go, as I was determined to stick to my goal pace of 6:00/mile or just above."

In case you missed that casually-dropped-in confession, he had set himself a target of 6:00/mile pace – equating to a finish time of 2hrs 37mins, a massive 13mins faster than the MSU's advised target. Ambitious indeed!

"I felt very comfortable over the first 15 miles," Tom continues, "albeit a little uneasy because my heart-rate

Chris Parry © www.marathon-photos.com

was averaging 8bpm faster than on my 20-mile practice run, but I put that down to race-day excitement. I went through halfway in 78mins 40secs." At that pace, he was on-target to finish in just over 2hrs 37mins. I was at the roadside at halfway, and noted the 13.1-mile split was fast but felt pleased rather than worried, as Tom looked relaxed, composed, and was running his own race.

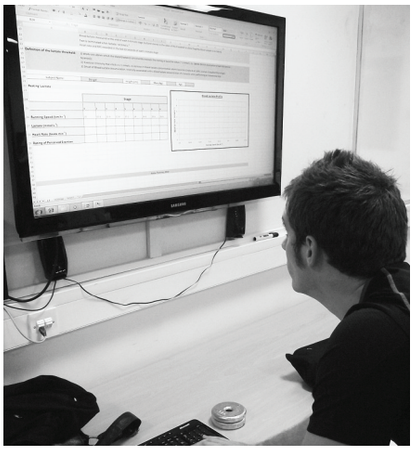
Some might say there's a sense of predictability to the way this tale is shaping up; they would imply that Tom's pace was over-ambitious, if not 'suicidal'. I don't wholly agree; what happened next was not a straightforward example of self-inflicted wall-hitting. Tom explains: "I took a water pouch at mile 15, which exploded like a torrent into my mouth. I swallowed it all, reflexively. Within a mile, I was in agony with a severe stitch."

He soldiered on but slowed considerably to about 7:00/mile pace. The stitch didn't ease until about mile-21, and the damage by then was done. "I was in bits, my legs were cramping, and only the sight of Palace Pier in the distance kept me going." He finished in 2hrs 47mins 39secs – not the sub-2-40 he'd hoped for, but still more than 2mins faster than the MSU forecast.

Given that Tom beat the MSU's target (and attempted to obliterate it), was it overly conservative, in his view? Or does he regret not obeying the science, which might have led to him having a more controlled, less painful race?

"The MSU prediction was cautious, but it was based on results from the lab – at the second assessment, I'd turned up in a physically tired state, after a tough week of training, which may have had an effect on the results. Because of that, I made a judgement based on where I thought my fitness was, not on what the MSU told me."

Running 'off-message' was a bold strategy – some might say foolhardy – but it almost worked. If Tom had stuck rigidly to the MSU's advice, he would have recorded a slower finish time.



In light of this, was the MSU's advice helpful? "Yes, Alex [Bliss] was very helpful, and I think I could have benefitted more if I had been less stubborn and more careful in my preparation for the lab assessments."

Tom's experience is interesting; it shows that physiological test results do not lie but may mislead – they give a snapshot of the body's condition at a particular time on a particular day, rather than a complete picture of an athlete's fitness and potential. The value of an assessment programme like the MSU is in giving marathon runners a better understanding of the physiological processes and markers that constitute 'fitness', allowing them to train more intelligently – as well as providing a sensible, if not 'best-case-scenario', target finish time.

"Overall, the MSU was a thorough education in how to train effectively for a marathon, using concrete reference points," reflects Tom. "It was another learning experience and, as with the marathon, I would like to do it again, if only to prove I can do it better!"

Scientist's response

The MSU's chief physiologist Alex Bliss gives his reaction to Tom's performance

"After the race, Tom admitted he was unimpressed with his pacing strategy. Looking at his mile splits, he set off far too fast, running at 16.5kph (6:00/mile) pace, whereas our data suggested that 15-15.5kph (6:15-6:30/mile) should have been his target speed. In the lab, running at 16.5kph placed him at a blood lactate concentration of around 4mmol/l. This is sometimes referred as OBLA, or the onset of blood lactate accumulation. We know that once lactate rises to this point, the ability to persist with exercise is limited. This intensity of exercise is more closely associated with 10k runs than with marathons. Tom acknowledges that if he had been a bit more conservative in the early stages, his performance would have been more consistent across the 26 miles."

CASE STUDY DAVE ROGERS

The MSU set Dave a Brighton Marathon target of 3hrs 32mins. He didn't just achieve that goal but over-performed in dazzling style, running 3hrs 13mins

When we last heard from Dave, back in March, he was training hard but reported that his progress had been disrupted in January by a calf injury. Things were going OK, but he could hardly have hoped to outperform his MSU-set goal by 19mins. How an Earth did he do it?

"Training had gone well since the injury and I felt good going into the marathon," says Dave. "I had no niggles and was the lightest I'd been for any marathon I'd run. I was determined to get a fast time and, having seen the qualifying time for Boston (3hrs 15mins), I set my pace at 7:30/mile."

This motivation of qualifying for Boston seems to have had a powerful effect. Did he feel good throughout the race?

"At halfway, I was slightly ahead of the 3:15 guys but felt comfortable so kept cracking on. The later parts of the course, around Shoreham Power Station, were a bit soul-destroying. In all my previous marathons, my pace had dropped off by this point, but I was running with a couple of other guys and still feeling strong."

"THE LAST MILE HURT LIKE HELL AND WAS ALL A BLUR, BUT I KNEW I MIGHT NEVER HAVE A BETTER CHANCE TO RUN SUB-3:15"

Chris Parry @www.marathon-photos.com

The pain did arrive eventually, of course. "The last mile hurt like hell and was all a blur, but I knew I might never have a better chance to run sub-3:15, so nothing was going to stop me. Needless to say, I'm glad I pushed that hard."

Given that he ended up running so much faster than the pace predicted for him, was the MSU a worthwhile part of his preparation?

"Yes, it was. I found it very useful, as it gave me the science behind the theory, and provided me with a focus."

But why was there such a disparity between the MSU's prediction and the time he ran?

"I had four or five weeks' solid training after my final MSU assessment, and lost another 6lbs, so I don't think my lower time should be much of a shock."

SCIENTIST SAYS: *"Dave was an interesting case," comments Bliss. "I bumped into him the day before the marathon and he looked like a completely different person! He had lost nearly 4kg since his last assessment. Assuming no change in his cardiovascular function, this would have improved his VO2max by almost 4ml/kg/min. This drastic weight loss was a high-risk strategy leading up to the race but worked well for Dave. It was great to see him smash his PB in the race, having never previously run sub-3-30, even if it did throw the prediction out the window!"*

'Double it and add seven'

An alternative way to predict your marathon time

Pro US coach Greg McMillan believes that the best way to predict marathon time is to take a recent half-marathon performance, double it and add five to seven minutes. Similarly, the eminent sports physiologist Tim Noakes recommends multiplying half-marathon time by 2.11. Tom's most recent half-marathon was in February, at Brighton, where his time on the over-distance course was equivalent to 1hr 15mins, which, using the McMillan/Noakes method, equates to a predicted marathon time of around 2hrs 38mins. (www.mcmillanrunning.com)

CASE STUDY FIONA BUGLER

Predicted a sub-3hrs clocking by the MSU, Fiona was sorely disappointed to have to declare herself out of the Virgin London Marathon just three days before the race.

It's every athlete's worst nightmare: getting into great shape and then being forced to withdraw at the eleventh hour. "It was a combination of things," explains Fiona. "The marathon coincided with me moving house. I put my back out during the move, on top of having a tight hamstring and borderline chest infection."

Training had gone well, but this triple whammy of niggles came at the worst possible time. "I didn't want just another 3:15. If I was going to run it, I wanted to do myself justice, run well and get a PB. I just couldn't be confident of doing that."

Fiona believes the MSU helped her, in a subtle way, by providing external reassurance – "proof of what I thought I already knew". She intends to capitalise on her fitness gains by running the Berlin Marathon in September.

Competitors in the Brighton Marathon

pic credit: Paul Shanley

Prediction vs performance: How the stats stacked up

	TOM MORRIS	DAVE ROGERS	FIONA BUGLER
Age	31	39	44
Height	5ft 7ins	6ft 0ins	5ft 5ins
Weight (on race day)	69kg (10st 12lbs)	84kg (13st 3lbs)	53.5kg (8st 6lbs)
VO2max* (ml/kg/min)	70	53	56
Lactate Threshold* (kph)	14.8	11.9	14.3
Running Economy * (ml/kg/km)	204	187	171
MSU-estimated finish time (hh:mm)	2:50 (6:30/mile)	3:32 (8:05/mile)	2:57 (6:45/mile)
Actual finish time (hh:mm:ss)	2:47:39 (6:24/mile)	3:13:13 (7:22/mile)	DNS
Performance discrepancy (mm:ss)	2:21	18:47	n/a

*As tested at final assessment, in late-March.

Class of 2012/13

If you're interested in signing up with the MSU, you can register your interest by emailing marathonsupportunit@brighton.ac.uk. The number of places will be limited to 30. The cost of the programme is still to be decided, but will be in the region of £200-£400.

THANKS | MANY THANKS TO ALEX BLISS FOR GIVING RF ACCESS TO THE MSU LAB AND PARTICIPANTS, AND TO EVERYONE ELSE INVOLVED WITH THE PROGRAMME: ROB HARLEY, JEANNE DEKERLE, STUDENTS ON THE HB525 MODULE, SUSANNAH DAVIDSON AND DAN TEMPLE.

VITAL STATISTICS

Q: How do you set the right target, train optimally and run the perfect marathon? **A:** By getting your fitness scientifically tested and your potential plotted. Well, that's the theory of Brighton University's Marathon Support Unit. *Rf* investigates

● Words: David Bradford

What's your target time for the marathon? If you've entered a spring marathon, you should by now have a firm answer to that question. Having a realistic goal time is crucial: it allows you to put in place a pacing strategy, which could make the difference between nailing a glorious PB and being scooped up by the sweeper truck. But what is the right target for you? How do you know exactly how effective your training has been and, in turn, what you are capable of come the day? One solution is to take the guesswork out of the equation and let science do the target-setting; namely, by undergoing a full complement of physiological tests. That's the high-tech approach taken by the inaugural clients of the University of Brighton's Marathon Support Unit (MSU).

I decided to follow the progress of one of the MSU's most ambitious participants, my club-mate and training buddy Tom Morris, who is hoping to run sub-2hrs 45mins in the Brighton Marathon in April. Tom is 31-years-old and has been running for only two years, but at the time of signing up with the MSU, in December 2011, was already putting in 50-60 miles per week and had a 10k PB of 35.07. He has raced over 26.2 miles only once before, last year, in the notoriously tough, off-road Beachy Head Marathon, where he ended up disappointed with his pacing; having led the way during the early stages, he slowed painfully and finished sixth in 3hrs 20mins.

"After my Beachy Head experience, I wanted to really find out my capabilities as a runner," says Tom. "I'd made the mistake of thinking that I can perform at a higher level than my body will actually let me."

He hopes that through testing he will be able to close the gap between his mind's ambition and his body's capacity.

"I wanted to be told, 'This is what you can do! Here it is in cold, hard science!', so I could channel my hard work intelligently into a good marathon experience. I want to avoid another Beachy Head scenario."

Once enrolled into the MSU, having signed the disclaimers and coughed up the requisite £250, there are four steps: an initial round of physiological tests; eight weeks of training following an MSU-devised, bespoke schedule; a further bout of tests; and a final 11-week spell of training. In addition, seminars are interspersed throughout the programme, covering subjects such as nutrition and injury prevention. By the time the second set of tests is complete, at the end of January, participants have an intimate knowledge of their physical parameters and, more importantly, a scientifically calculated goal marathon time. So, what are the tests and how do they provide a realistic basis for target-setting?

Height and weight

The first procedure is a simple height and weight check. "What's my ideal weight?" is a question most of us have at some point pondered. There is no definitive answer, as it depends on body type and relative proportions of fat and muscle. That said, low body-fat and a Body Mass Index (BMI) at the lower end of the 'healthy' band is obviously preferable. Tom is 5ft 7ins tall, and at his first test weighed 11st 3lbs (71kg). Eight weeks later, at test two, his weight had dropped to 11st 0lbs (70kg), giving him a BMI of 23.7 – that's at the upper end of 'healthy', but he used to lift weights regularly, so is more muscular than most.

"I'm aware that I don't have the classic runner's body," Tom acknowledges. "Even though I'm lighter now than I've ever been, with the least muscle mass, I'm still bulky."

Distance runners have big appetites, and Tom is aware of the pitfalls (and hunger pains) associated with restricting calories.

"I don't even try to diet. I'm aware of what I eat, but I enjoy training hard, so I'll continue to eat the way I do, and if weight drops off, brilliant."

TEST 1 LACTATE THRESHOLD

What does it mean?

This is the key marker for marathon runners. Lactate threshold (LT) is defined as the point at which the body's demand for oxygen begins to outstrip supply.* Running faster than LT is ultimately unsustainable.

"Lactate threshold is the point at which lactate starts to accumulate in the blood, usually at about 70 per cent of maximum oxygen uptake, in a well-trained individual," explains MSU founder Alex Bliss. "At rest and during exercise at intensities below LT, lactate is produced and removed by the body at equal rates. In theory, exercise below LT can occur indefinitely, assuming motivation, hydration and fuel supply remain sufficient."

Physiologists like Bliss are able to detect where LT occurs by testing athletes' blood and noting the point at which lactate begins to accumulate, which is associated with the onset of fatigue. Provided you're running sub-LT, you should be able to sustain your pace until other factors such as glycogen depletion slow you down – hopefully much later on. As you've probably deduced, LT is the best predictor of realistic marathon pace.

"We know that marathon runners tend to run at a velocity that's closely associated to their LT," confirms Bliss, "That's why we're setting goal marathon times based on LT pace, and we're anticipating accuracy of within three minutes."

The test

The procedure to establish LT, for MSU participants, is a 15-25 minutes treadmill run where the pace is increased by 0.8kph every three minutes. Blood samples are taken and analysed at every increment; the test ends when a significant increase in blood lactate is observed – the treadmill speed at this point determines the subject's LT pace and, in turn, their marathon target.

The result

In Tom's first test, lactate accumulation began to show when the pace hit 14.8kph (9.2mph). The result was the same in test two, except his heart-rate was 4bpm lower (150bpm) at the same speed, suggesting an improvement in cardio function. The fact Tom's blood lactate begins to climb significantly when he is running faster than 14.8kph means that the oxygen supply to his muscles is failing to meet demand; his body is starting to break down glucose anaerobically (without oxygen). In other words, the pace is tipping over into unsustainable territory. On the bright side, at (or below) this speed his body is content to keep churning out mile after mile without so much as a whimper. The implication is obvious: this is the pace at which he should try and run the marathon. 14.8kph equates to 6:30/mile pace and a finish time of 2hrs 50mins. That's slightly slower than Tom's original goal, but all is not lost; at the time of going to press, he has another six weeks' training ahead of him, so there is still time to improve.

Boost it

The best way to improve your LT is to run at or faster than goal marathon pace for periods of 20mins to an hour (altering the pace according to duration). Tom has been doing a weekly run of 8k at around 17kph (5:40/mile) – considerably faster than LT but comfortably sustainable for 30mins. He is planning to also introduce some longer runs (40-80mins) at goal marathon pace.

*NOTE: Lactate Threshold as defined by the MSU is not the same as "lactate threshold pace" (or "tempo pace") as described by many training manuals; the latter refers to a "comfortably hard" pace that can be sustained for 20-45mins.

THE ATHLETE WITH THE HIGHEST VO2MAX DOESN'T ALWAYS RUN THE FASTEST TIME

TEST 2 VO2 MAX

What does it mean?

The most-talked-about stat in running, VO2max refers to the maximum capacity of a runner's body to process oxygen, usually measured in millilitres of oxygen per kilo of bodyweight per minute. Think of it as your maximum-throttle limit, where your body's oxygen-and-fuel burners are roaring at their peak. As such, VO2max is a good indicator of 'engine size'; that is, cardiovascular capacity, the upper limit of your fitness. In shorter-distance events such as 5k, where athletes are working at close to maximum for the whole race, VO2max is critically important, but it's of lesser significance for marathon runners:

"VO2max plays a less important role during longer events such as the half-marathon or marathon," explains Bliss. "Although elite level athletes do have high VO2max profiles, this doesn't predict performance, and the athlete with the highest VO2max doesn't always run the fastest time. During longer endurance events, running economy and lactate threshold play the more critical roles."

The test

The MSU tests VO2max by setting participants to work on a treadmill and increasing the belt gradient by one per cent every minute until the point where they signal that they cannot go on. Yes, this test requires guts and grim determination. Oxygen uptake is assessed by capturing and analysing expired air – participants breathe into collector sacks called Douglas bags via a tube, with their nostrils clipped shut. Nasty!

The result

In each of his tests, initial and follow-up, Tom's VO2max was measured as nigh-on 70ml/kg/min. That figure places his fitness at borderline international-level; in other words, it's very good news – it shows that he has great potential in endurance sport and that no shortfall in the 'engine room' is holding him back.

Boost it

First maximising and then maintaining VO2max is crucial for all runners. Maintenance is the operative term for Tom, because VO2max cannot be improved indefinitely. Well-trained individuals are usually unable to increase their maximal oxygen uptake by more than a few per cent, regardless of their efforts. Keeping VO2max at its optimum is best achieved by means of regular intense workouts: intervals of 3-7mins at 95-100 per cent effort. Tom has been ticking this box on Tuesday evenings, running sessions of 6-8k total effort, comprising reps of 400-2,300m, with our training group at Lewes AC.