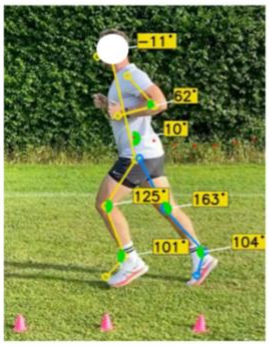
Synergie Coaching



Run Analysis

Athlete:

Date:

Location:

Take Homes

Metric	RAG rating	Comment
Predicted VO_2	**43.2**	40-49yrs V. Good = 44-51 40-49yrs Excellent = 48-15
Cadence	**192-200**	High cadence assists in landing mid foot.
Ground Contact Time	**0.158-0.185**	Times less than 0.2 is ideal.
Vertical Oscillation	**Not supplied**	Acceptable range is 5-10cm.
Pacing	**Needs practice.**	Started too fast. 14% drop off fastest – slowest rep.
Posture/Head	**Good**	Look slightly downwards
Hips/Legs	**Good**	Reduced Rear Flexion when tired
Arm Drive	**Needs amending**	Arms too closed off, close to shoulder. Need to carry forearms lower.

Run Training Ideas

Working to a modified polarized training model means;

75% of your run training volume to be done at a pace around 4.45/k or less.
Should be able to talk & hold a conversation with long sentences.
For example – 60-75 min run where you can easily breathe through your nose and do not have to mouth breathe.

10% done around Threshold Pace of 4.45/k.
For example, running for 5 to 6km at that pace or repeated runs of 5 to 15 minutes each around the 4.40/k pace with 1 to 3 minutes of rest between the runs.

15% of your run training volume should be done at paces around 4.24/k or faster to either improve your VO_2 or your running speed efficiency.
For example, runs of 3 to 5 minutes each, with jog recoveries of similar duration or 90s around the 4/10k pace with a three-minute jog recovery.

Long Runs & Threshold Runs can drop in pretty much anywhere into your schedule; the VO_2/Speed-Efficiency session you want to do as fresh as you can, given the paces.
Over a 10–14-day period I'd include 2 x Long Run; 2 x Threshold; 1 x VO_2/Speed-efficiency session. If pushed for time you could drop a Threshold run.

I'd start to incorporate a run specific warm up as well, something like
https://youtu.be/8dIHS_UVfQ4

Have a read and get back to me with any questions, we can always arrange a catch-up call to talk through things.

Why Assess?
Assessments & analysis allow you as the athlete to gauge what will help you excel; it gives you a chance to assess specific areas of your run to reduce injury risk and to improve your performance. The addition of biometric analysis enhances your ability to ensure that you are training at the correct paces or zones. This combination allows for real time adjustments to paces which should improve performance.
Assessment & analysis allow for specific information to be used in your training, it is the application of that information that enables excellence.

There are numerous ways to assess or predict your VO_2, the graduated assessment chosen not only provides sufficient information to assess your VO_2, but also provides data to look at your pace awareness and some run biomechanics, such as Cadence, (steps per minute); Ground Contact Time (GCT) and Vertical Oscillation.

These are discussed fully at the end of this document but in summary:

VO_{2max} is the maximum amount of oxygen that your body can take in and use during higher intensity exercise.
Your speed or performance velocity is dependent upon your ability to use as much of your VO_2 as possible when running at your optimum pace below your lactate threshold, sometimes referred to as you vVO2 pace.
A higher VO_2max allows one to produce more energy, thereby performing more work. For example, when running a 5km race, you should be working at 90-100% of your VO_{2max}.

Various factors can influence VO_2max, including heredity, training, age, gender, and body composition. $VO_{2\ max}$ tends to decrease after the age of 30. Research has shown the average decrease was 0.46 ml/kg/min per year for men (1.2%) and 0.54 ml/kg/min for women (1.7%).

Research shows that running between 160-180 steps per minute **(cadence)** is likely to reduce your injury risk, as well as improving your efficiency over distances from 800m to marathon.

Ground Contact Time (GCT) is the length of time your foot is in contact with the ground when running. Your ground contact correlates significantly with both running economy and maximal running speed**;** faster distance runners are capable of sub-200ms ground contact times. Most runners will record a GCT between 200 and 300 milliseconds, ideally you want to be spending less time on the ground.

Vertical Oscillation is how much your body moves up & down when running, your vertical displacement. While some degree of vertical movement when you run is obviously natural, too much or too little of it can lead to inefficiencies, such as shuffling your feet if too low, and an over-expenditure in energy if too high. Below 5 centimeters and over 10 centimeters is inefficient.

Key thing is not to fixate on one metric alone but to see how they compare, for example, cross – reference your speed with your HR with your Ground Contact Time with your vertical oscillation AND your cadence.

Warm Up.

Remember the RAMP principles of the warmup.

R- Raise your heart rate; breathing rate and awareness, getting switched on to what comes next.
A- Activate the muscles that will be used in the session.
M- Mobilise the joints that will be used in the session.
P- Potentiate/Powerful movements such as sprints/jumps.

We started with backwards (retro) running in the warmup to ensure we raised awareness & switched on, backwards running can help improve posture as well as activating quad & calves whilst increasing hip mobility, compared to running forward. Backwards running also places a higher demand on your cardiovascular system than running forwards, so can be a quick way to get things "Raised"

We did some banded overhead & hinged/rotated arm pulses to Activate & Mobilise the shoulders, as well as some lateral banded leg swings, before bringing in some "Spotty Dogs", Jumping Jacks/Star Jumps and Drop Squats to ensure we had included some compound movements in different planes.

We finished off by increasing the pace every 100m until you were at race pace, covering the more powerful Potentiation aspect of the warmup.

The warmup lasted approximately 25 minutes.

Key Point

Ideally your run warm up will last between 20-30 minutes, broken down as
R phase ~ 5 - 10 min.
A + M combined phases – 4-5 exercises with 8-12 reps per exercise ~ 5-10 mins and
P phase ~ 5-10 minutes.
We want to minimize the time between concluding our warmup and the race starting to 5-10 minutes.
If we are waiting more than 12 minutes, commence a secondary, shorter warm up.

Some ideas here about a run specific warm up https://youtu.be/8dIHS_UVfQ4

Pace Awareness

You indicated that you tend to start running at too fast a pace and then struggle to maintain the pace. In conjunction with the lactate profiling, that will be used to give recommendations on your training zones, we also looked at your ability to work through different paces.
Based on your recent HYROX time, we set the paces of your 5 x 1200m as shown in Table 1.
Table1 also captures the run metrics from either your own wearable device or the Ochy.io app.

Table 1: Data from 1200m run repeats.

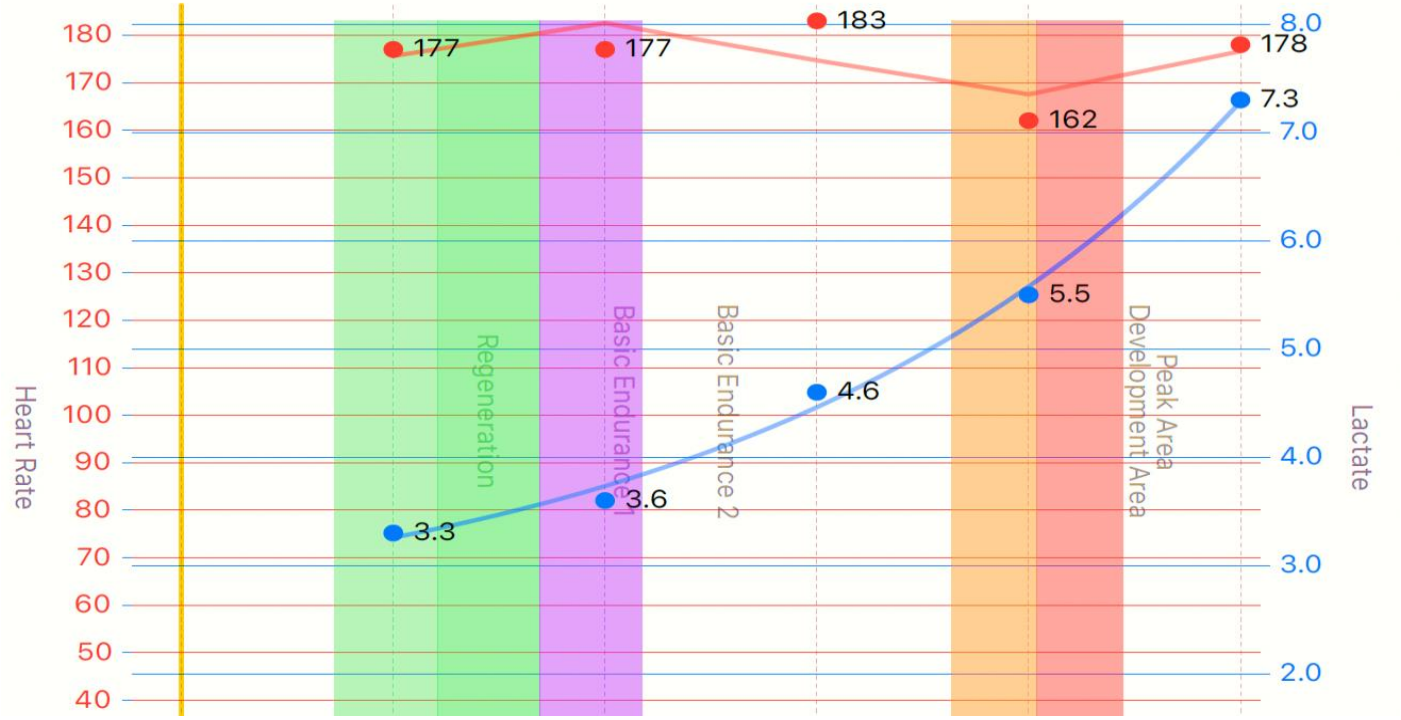
	1200m time (min.sec)	Approx km/hr	HR (bpm)	BLa (mmols)	Cadence (spm)	GCT (s)	Vertical Oscillation(cm)
Pre-Warm Up	N/A	N/A	N/A	0.5	N/A	N/A	N/A
Post Warm Up	N/A	N/A	N/A	2.2	N/A	N/A	N/A
1st Rep (5.15/1200m pace required)	4.33	13.68	177	3.3	195	0.158	Not Recorded (NR)
2nd Rep (5.05)	4.49	12.96	177	3.6	192 (Manual count)	NR	NR
3rd Rep (4.55)	4.44	12.96	183	4.6	200 (Manual count)	NR	NR
4th Rep (4.45)	4.44	12.96	162	5.5	NR	NR	NR
5th Rep – Best Effort	4.13	14.69	178	7.3	197	0.185	NR
10min Post – Test	N/A	N/A	N/A	3.7	N/A	N/A	N/A

Paces were set based on your average 1km HYROX time of 4.07/k. 4.07/k = 5 min 1200m

The 1st 1200 rep equates to your average pace plus 15s, so well within what would be estimated as your **Threshold Pace**.
By getting faster by 5s each 1200 effort means that we took you from Threshold Pace, through the paces we would recommend for 800-1200 **Intervals** up into the paces we would use for 200-800m **Repetitions.**

Your pace awareness certainly impacted on your blood lactate values but we managed to get a line of best fit, as shown in Graph 2.

Table 2. HR compared to Blood Lactate (BLa). [Analysis completed using Lactate Express app.]



What does it all mean?

At rest you are still producing lactate, although the concentration will be low, yours measured at 0.5mmol.

When you start to exercise, your aerobic energy system becomes more active. This aerobic energy system combusts lactate. As a result, lactate concentrations may be lower at low exercise intensities than after your warmup.
When you increase the intensity a bit further, your glycolytic energy system becomes more active too. This anaerobic energy system produces lactate. As a result, lactate concentrations will rise at some point. This is the first lactate threshold, LT1.
Lactate Threshold 1 (LT1) is also often defined as the exercise intensity at which blood lactate concentration equals 2 mmol/l. You will also see this described as Aerobic Threshold (AeT) or “steady state” training zone.

In the context of endurance training, LT1 is marked as the first rise in lactate concentration compared to resting lactate concentrations. You can be considered at or below LT1 if the samples are rising by less than 0.5 mmol.
LT2, which occurs at higher exercise intensities, usually where sample taken are rising by 1.0mmol or more. At LT2 your lactate will continue to rise until exhaustion.

After the warmup you were at 2.2mmols, theoretically already moving out of LT1 towards LT2.
After the first effort you had an increase of more than 1.0mmols above the warmup value and another increase of 1.0mmol between 2nd & 3rd rep.
As all three 1200m were run at a similar pace this is a good indication that your Threshold Pace is around the 4.47/k pace.

Your Results

You can see that your pacing was out on 3/5 of the efforts, no doubt if you had your watch with you, it would have made it easier.
Given your current HYROX training & racing, you can see that you want to start fast. However, you can see from the 5th effort, that while you may be running faster it is not biomechanically efficient, given your Ground Contact Time has increased from 0.158 to 0.185, so spending a lot longer on the ground despite running at a higher cadence.

Considering the explainer on LT1, you can see that after the warmup you were at 2.2mmols and that continued to increase.

This is an indicator that you either need to

(i) Improve your lactate clearance and fat combustion at any given exercise intensity, meaning you should increase your aerobic energy contribution. This will result in an increase of LT1 or

(ii) you should decrease your anaerobic energy supply. This will also result in an increase of LT1.

You can improve your aerobic energy contribution by doing longer, slower sessions or higher intensity VO_{2max} sessions or you can decrease your anaerobic energy supply by doing exercise below your anaerobic threshold or training with reduced carbs but make sure you maintain your protein intake. Low CHO may also have an increased cortisol response which can lead to muscle breakdown.

Current Recommended Running Paces

Your fastest 1200m was 4.13 (3.28/k) and your slowest was 4.49 (3.58/k), averaging out at 4.37 across the 1200m (3.48/k). Fastest to slowest was approximately a 14% drop off in pace. Ideally, we want to limit any drop off to 8-10%.

Based on your average pace your estimated VO_{2max} is 43.2 and it is recommended that you set your current training paces as follows:

Table 3. Recommended Training Paces.

	Pace	Description
Easy	**5.45 – 6.19/k (Approx 10k/hr)**	**Intensity: Generally, in the range of 65-79% of your HRmax.** Easy running is a comfortable, conversational pace, which certainly may vary daily, depending on how you are feeling, and the weather and terrain with which you are faced. **Purpose:** Running at your Easy pace promotes physiological benefits that build a solid base from which higher-intensity training can be performed. The heart muscle is strengthened, and the muscles being exercised receive increased blood supplies and increase their ability to process the oxygen delivered through the cardiovascular system
Threshold	**4.47/k (Approx 12k/hr)**	**Intensity: Generally, in the range of 88-92% of HRmax.** Threshold pace is comfortably hard running for either a steady 3-4 miles (or 5 to 6km) or repeated runs of 5 to 15 minutes each, with 1 to 3 minutes of rest between the runs. **Purpose:** To improve endurance.
Intervals	**4.24/k (Approx 13-14k/hr)**	**Variety: VO_{2max} Intervals.** **Intensity: Generally, in the range of 98-100% of HRmax.** Intervals are "hard", but not all-out running by any means. Intervals are like a pace that you could maintain for about 10-12 minutes in a serious race. Intervals are best if they involve runs of 3 to 5 minutes each (800m and 1000m workout efforts are common), with jog recoveries of similar duration. If a workout calls for "hard" runs, then go by feel and, conservatively imagine 5k race pace, as the intensity of each run.

		Purpose: Stress your aerobic power (VO_{2max}). At proper Interval intensity, it takes about two minutes to gear up to functioning at VO_{2max}, so the ideal duration of an "Interval" is 3-5 minutes each to ensure proper time at the desired intensity. The reason not to go past 5-minutes is to prevent too much anaerobic involvement, which can result in too much increase in blood-lactate concentration and defeat the purpose of the workout. **Sample Workout:** 6 x 2 minutes I (1 min jog), 5 x 3 minutes I (2 min jog), 4 x 4 minutes I (3 min jog)
Repetitions	**4.09/k (Approx 15k/hr)**	**Intensity:** Reps are fast, but not necessarily "hard", because workouts are relatively short and are followed by relatively long recoveries. Recoveries should be long enough that each run feels no more difficult than the previous run, because the purpose of Reps is to improve speed and economy. If it takes 3 minutes recovery between 400m Reps, then that is what is needed. Think of Reps pace as like current 1500m or mile race pace. **Purpose:** To improve your speed and economy. **Sample Workout:** 8 x 200m R (200m jog) or 4 x 400m R (400m jog)

Technique Assessment

For the technique assessment we did some video capture using the Ochy.io app.

I have sent the analysis of your 1st 1200m repetition & your 5th 1200m repetition through as additional PDFs.

Key points from the Ochy analysis.

- Ideally looking for your arm carriage to be about 90°, as that is the more efficient way to hold them. When tired your arms dropped to a better position, than on the 1st run.
- Back Leg Swing was more effective on the 1st run, with the heel coming closer to your butt. That helps initiate the swing and drive at the front of your running stride.
- Ground Contact time was less that 200ms – so good consistency with that, although you can see the difference of almost 0.3s.
- Cadence was high at 195-197 steps per minute, this ties in with the short ground contact time and mid foot landing position.

Posture

As we discussed, having the mobility, balance and strength to hold good posture when you run will improve your efficiency and allow you to go faster and further for the same amount of effort. Good posture will also help your breathing, which will allow you maximise your oxygen usage whilst running.

To improve your posture when you are running, imagine a piece of string attached to a helium balloon is pulling upwards from the top of your head. Looking straight ahead and slightly down, rather than upwards, will also help align your posture.

- Key Recommendation: You started looking up too much, you did speak about your “Michael Johnson” running style, something to be aware of when tired, keep looking ahead & downwards. Xref this with the arm carriage recommendations.

Foot Landing Position

Landing underneath a ‘soft’ knee and not too far in front of your centre of mass is important for good running economy. Ideally, after your initial ground contact, there should be a short absorption phase before you propel yourself forward.

No major difference between your mid-foot landing position, due to your high cadence this keeps the foot landing under the body

- Key Recommendation: Be aware of the increase in cadence and the increase in ground contact time when fatigued, you are moving your legs quicker but staying on the ground longer. When fatigued consider increasing your stride length slightly, rather than increasing your cadence.

Hips

The hips are important because they give us balance and drive. They connect our core muscles and our legs. If the hips are not moving efficiently, the legs will not have the power or speed necessary to run well. Running with your hips forward keeps your posture aligned, which helps efficiency.

Having good hip stability in mid-stance (the point where your head is at its lowest) is important for running efficiency. This gives you a stable platform to push off from. Hips that lack stability can also affect postural alignment.

When running we are looking for a rear leg hip extension of at least 18°, preferred range ideally being between 20-30°

No major issues observed.

Arms

Having an efficient arm and upper body action helps with balance and speed. Good upper body rotation helps counteract the rotational forces created at push off (the point where you're just about to leave the ground), leading to more efficient forward propulsion.

Regardless of pace you had a less than 90° arm carry. By closing the angle, it means that you increase the muscle tension in your neck, biceps, triceps, shoulders and upper back. This also reduces the coordination between upper & lower body – remember that your arms help drive the legs.

We can see that your arm carriage is closed that will affect your upper body rotation.
Upper body rotation will help with backwards elbow drive – maybe beneficial in longer distance athletes as legs tire.

- Key Recommendation: Core/postural rotational strength will aid upper body rotation. Russian Twists/Dead Bugs etc.

Cadence

Cadence refers to how many steps a runner takes in one minute. Although this is very individual and pace-specific, there are some guidelines that we can follow. Cadence for a taller runner running at slower speeds is likely to be much slower than a shorter runner running at faster speeds. A cadence that is too slow can cause too much up and down movement causing a runner to waste energy. Finding a sweet spot for you as an individual is key here.
You naturally run with a high cadence (180+spm). No major issues observed.

Cool Down

Don't forget the importance of a proper cool down; it's all about the recovery process and preparing for your next workout. An effective cool down will also reduce the risk of muscle soreness in the days following exercise. Bringing your heart rate and body temperature down gradually at the end of a run to its resting level will help prevent blood from pooling in your legs. Jogging or walking for five to ten minutes at the end of your run will give your body the time it needs. If using a massage gun or foam rolling you can do that before you stretch.

Further Reading (if you want…)
Basic Run Mechanics

Cadence is 180 the key number?

The conversations around a stride rate of 180 steps per minute comes from Dr. Jack Daniels analysis of 47 elite middle-distance runners in the 1984 Olympics and is covered in his book, Daniels' Running Formula.

Daniels observed the male & female runners from 800m,1500m, 3km, 5km, 10km & marathon and concluded that the more efficient, elite runners were running at a cadence of 180spm.

https://www.human-kinetics.co.uk/9781718203662/daniels-running-formula/

Van Ouveren et al (2017) indicted that whilst 180spm may be optimal for elite level runners, that amateurs or recreational runners may find that too challenging and that 160spm was more realistic
https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0184273&type=printable

De Ruiter et al (2020) have a nice paper, albeit the sample size is small showing the difference of freely chosen step rate and optimal step rate based on efficiency, as defined by HR & speed. https://www.tandfonline.com/doi/pdf/10.1080/17461391.2019.1626911

Anderson et al (2022) did a meta-analysis of changing step rate from a clinician's perspective and found that biomechanically and in respect of knee load/pain there was evidence to suggest that increasing step rate could be beneficial.
https://link.springer.com/content/pdf/10.1186/s40798-022-00504-0.pdf

Quinn et al (2021) study with well-trained female runners indicated that changing to 180 spm did improve their running efficiency when measured due to lower oxygen consumption & lower heart rates at a higher step rate but same speed.
https://journals.lww.com/nsca-jscr/abstract/2021/09000/step_frequency_training_improves_running_economy.23.aspx?context=latestarticles

Hausswirth et al (1997) simulations with 7 elite male triathletes indicated that the triathletes with a higher stride rate were able to maintain their run speed at the end of the triathlon.
https://pubmed.ncbi.nlm.nih.gov/9298772/

Ground Contact Time (CGT).

This is the length of time your foot is in contact with the ground when running.
Your ground contact correlates significantly with both running economy and maximal running speed**;** faster distance runners are capable of sub-200ms ground contact times. Most runners will record a GCT between 200 and 300 milliseconds, ideally you want to be spending less time on the ground.

Running speed relies on the ability to apply force through the ground quickly. The faster you can apply force through the ground, the quicker you will be propelled forward.

The ground contact portion of your running gait is also known as the stance phase. The stance phase starts with the initial foot strike, continues through the 'load bearing' midstance, and ends with toe-off.

Ground Contact Time Balance

Ground contact time balance is the measure of how similar your left and right leg ground contact times are.
If you have times for both legs, you can look at the % balance between them.
If the times are the same, you have a 50/50 split and indicates an equal GCT for both legs.
GCT balance is rarely 50/50. Anything between 49% and 51% is considered symmetrical. However, if your GCT balance has an imbalance of more than 2%, that needs to be worked on.

Why Does Ground Contact Time matter?

Nummela et al (2007) https://pubmed.ncbi.nlm.nih.gov/17549657/ showed that whether sprinting over 30m or running 1km repeats, ground contact time was the one variable that effected both speed & efficiency in the runners. Hasegawa et al (2007) https://pubmed.ncbi.nlm.nih.gov/17685722/ showed that GCT was a key indicator in half marathon running speed. De Ruiter et al (2016) showed how running speed over 4km could be calculated from GCT.
https://www.researchgate.net/publication/308384015_Running_Speed_Can_Be_Predicted_from_Foot_Contact_Time_during_Outdoor_over_Ground_Running

GCT balance matters because symmetry matters. Elite athletes display high levels of symmetry, and the fastest runners are the most symmetrical. Asymmetry, on the other hand, is metabolically and biomechanically inefficient. This means one side of your body is working harder to compensate for the other.
For efficient forward motion, front-to-back (sagittal) movement is most effective. When an imbalance exists, energy is wasted moving your body in the frontal plane (think hip adduction) or transverse plane (think trunk rotation) to counter the asymmetry.

For example, if one leg is weaker or less flexible, we tend to compensate with excessive arm swing or trunk rotation.

The International Journal of Exercise Science published research in 2020 on the impact of GCT imbalance on running economy.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7241633/

The study showed that for each 1% imbalance in GCT, running economy was reduced by almost 4%.

To put that in perspective, for a GCT balance of 49/51 (where one leg is in contact with the ground just 2% longer than the other), the energy required to run at the same speed is 7.4% greater.

In short, balancing the time you spend on each foot matters for preventing injury and improving economy and performance.

Training specifically to reduce your ground contact time is an effective way to improve your running

Ground Contact Time is determined by three main factors:

1. The ability to apply force (power) quickly to the ground.
2. Biomechanical characteristics such as the position of the foot in relation to the center of gravity at foot strike – midfoot strike/landing rather than heel strike.
3. The stiffness of the leg at the moment of foot strike (a stiffer leg can capture more "free" energy from the ground and then reuse it),

How do you train to reduce your ground contact time? Train to increase your stride power, leg stiffness & improve your biomechanics.

1. **Identify the asymmetry.**

Use the GCT balance metric to figure out which leg is slower. The leg with the higher GCT value is spending more time in contact with the ground, this is the one to work on.

Test the asymmetry by performing a stretch or exercise on each leg. This will help you identify differences in strength, balance and flexibility.

- How long can you stand on each leg with your eyes closed?
- Does your knee turn in on one side during a lunge?

2. **Strengthen the muscles.**

To improve running symmetry and overcome imbalances in ground contact time, focus on developing muscular strength and power.
Single leg exercises like lunges and calf raises are effective at developing your weaker leg and prevent the dominant leg from taking over.

3. **Optimise Flexibility.**

Inflexibility due to injury (from scar tissue for example) increases the likelihood of asymmetry. Include flexibility training in your schedule to overcome injury related tightness.
Your range of motion should be specific to your activity.
Incorporate single leg plyometric exercises into your programme to enhance leg spring stiffness and shorten ground contact time.

4. Vary your running surfaces.

Running over monotonous terrain can exacerbate asymmetry. Run offroad and a variety of gradients to enhance proprioception, balance and strength.
If you run on a track, alternate between clockwise and anticlockwise laps to avoid asymmetry due to leaning into the curve.

5. Running add ins

Consider once a week, after an easy run, a set of short sprints – something like, 6 x 60m at full speed. To minimize the risk of pulling a hamstring, do these sprints on a steep hill, if possible.
At least once every 10 days, complete an interval run with at least 2 total miles of running in this pace range (e.g. 6 x 600m @ 3K race pace with 400m jogging recoveries).

A very efficient way to include some plyometrics in your training is to insert them within runs. For example, in the middle of a run, break stride and hop forward on one leg for 20 strides, then hop on the other leg. Gradually build up to 2 sets of 30 hops on each leg.

Pronation

Have a look at https://www.asics.com/gb/en-gb/running-advice/understanding-pronation-find-the-right-shoes-for-you/

Foot Strike Location

You can see that foot strike position – forefoot/midfoot/heel affect Ground Contact Time.

Skipping & higher cadence running as well as the points shown above in GCT will help you move towards a more midfoot strike.

Equally if you have been videoed running, from the side, you should be able to look at your foot position as it lands & strikes the ground. Ideally your shin (shank) should be almost vertical between ankle & knee.

You can see that there are several variables to consider in respect of the athlete –

- Height
- Gender
- Race Distance
- Running velocity
- Running biomechanics – hip/knee/foot/postural angles.
- Running Efficiency – how are you assessing this…?

It is a good jump off point as running around that cadence, for most runners will bring the foot closer to the centre of mass, so reducing overstriding.

Vertical oscillation

Factors contributing to excessive vertical oscillation include decreased gastrocnemius and soleus flexibility (or tight calf muscles), and stiff ankle joints. Tight calves will cause more vertical oscillation due to early heel rise and prevent the leg from moving into full hip extension, making you go up rather than forward.

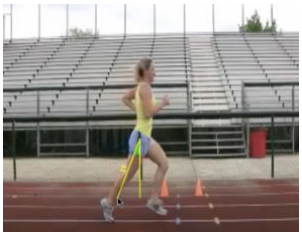
Vertical oscillation is often an indicator of biomechanical inefficiency, usually due to tight hip flexors and tight calves, having a limited ability for their foot to remain on the ground and move back behind them, means they are limited in getting a strong push-off. If the leg is restricted in extension you tend to see an increased vertical excursion. This results in overstriding, which is consistent with lower extremity injury, such as plantar fasciitis, Achilles tendinitis, or bone stress reactions or fractures.
https://pubmed.ncbi.nlm.nih.gov/30140556/

The other benefit is a reduced ground contact time that you see if athletes run their middle-distance races at 160spm. The main disadvantage of a slower turnover is that the slower you take steps, the longer you spend in the air, and the longer you're in the air, the higher you displace your body mass and the harder you hit the ground on landing.

Key things to remember is that your stride rate will vary depending upon your running speed, you'd anticipate that if running at your slow & easy long run pace you would have a slower pace & longer ground contact time, etc. than if doing 400m best effort reps.

Key thing is not to fixate on one metric alone but to see how they compare, for example, cross – reference your speed with your HR with your Ground Contact Time with your vertical oscillation AND your cadence.

Other Analysis Points to Consider

Movement	Measurement	Degrees required	Comment	Improve by
Rear Leg Extension 	From Vertical Line drawn from groin to ground to line of best from hip to rear ankle	At least 18 degrees – ideally in range 20-30°	Comment on when in run measurement taken & at what pace. If warmed up or running faster than race pace = higher degree of extension. X-Ref with athlete stride length.	Work on hip flexibility. Psoas; Quad flexibility. Work on posture. Look for forward lean of between 5-10° as that will facilitate leg extension. Butt Kicks – higher heel recovery reduces rotational torque through the hips = moving forward faster = higher cadence.
Hip Drop 	At lowest point of hip.	Measure from horizontal. Looking for less than 12°	If hips drop more than 12° it will cause lateral rotation through upper & lower body = increased injury & lower efficiency. Compare side to side. X-Ref with Ground Contact Time & Cadence as hip drop means longer on	Strengthen TFL & Glute Med to avoid hip drop.

			the ground & slower cadence.	