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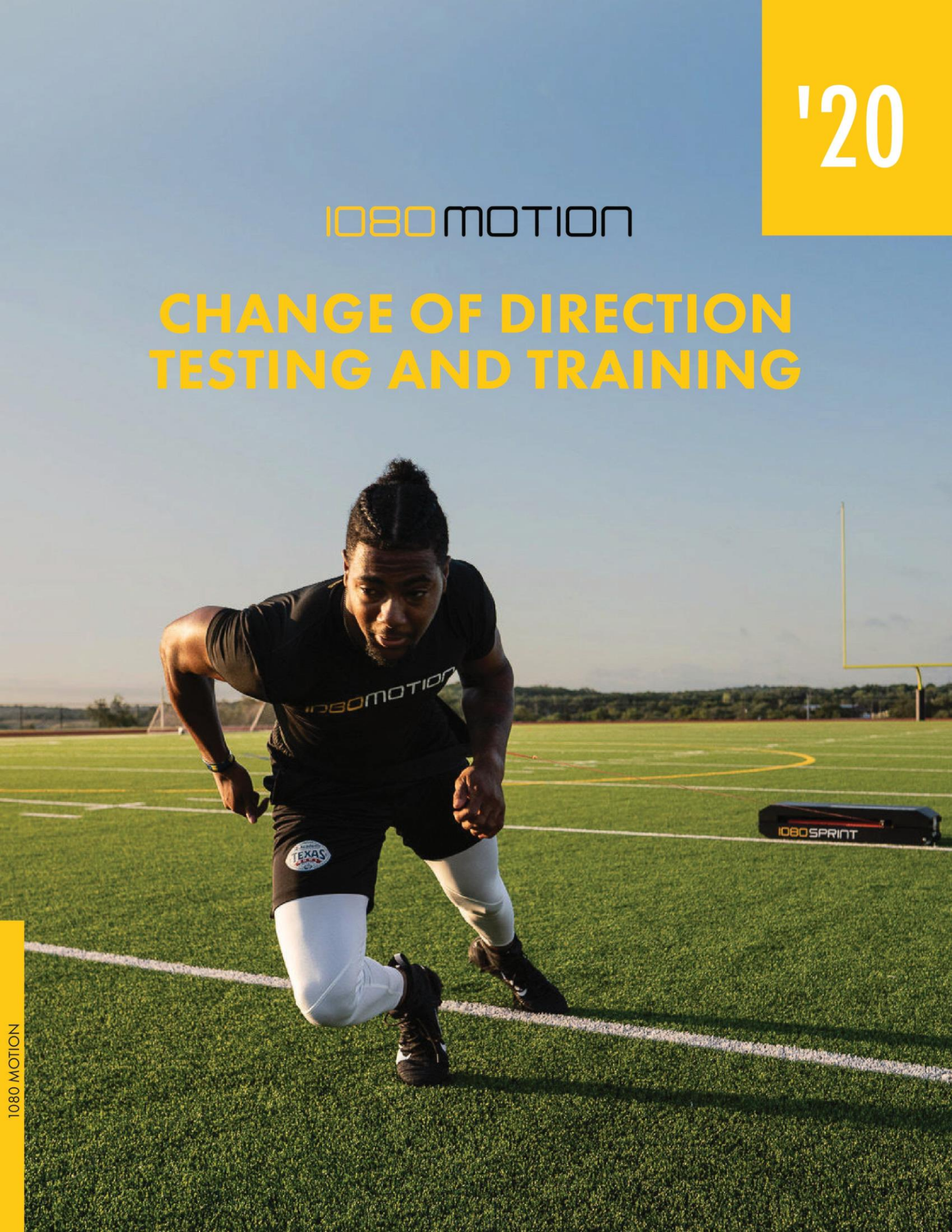
1080MOTION

CHANGE OF DIRECTION TESTING AND TRAINING



1080 MOTION

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WHO WE ARE

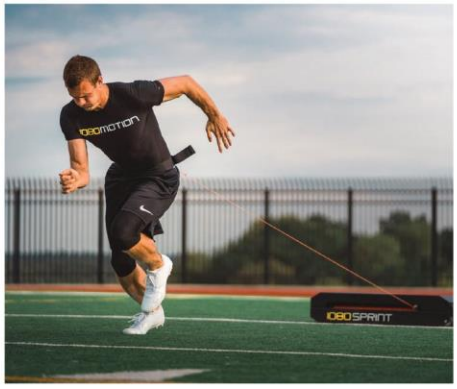
1080 is a Swedish company revolutionizing strength training. We are the leader in robotic technology solutions for neuromuscular testing and training in sports and rehabilitation. The intelligence in our solutions resides in the software and algorithms designed to test, analyze and train physical factors of performance. As a pioneer in pushing the boundaries in performance training and rehabilitation, our development efforts are always focused on bringing professional users the best and most efficient ways of working with athletes and patients.

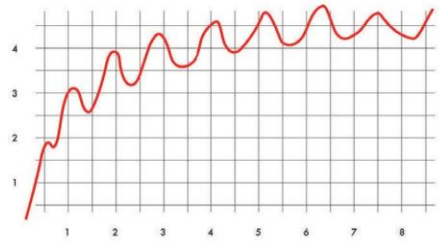
1080 MOTION

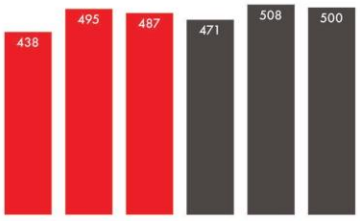
Evolution of 1080 Sprint

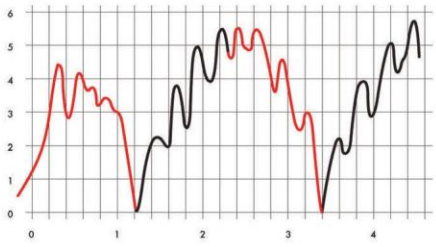
Continuous Linear + Discrete Repetitions + Multi-directional phases & turns

Sprint, Bound, Shuffle, Swim, Skate	Jump, Push, Pull, Rotate, Lunge	Change-of-direction









Power | Force | Speed

A Pivot

Precision testing and training with directional CoD loading

The 1080 Sprint has evolved. After first being used primarily as a tool for linear sprinting, the system has grown into a multi-use platform for sports performance. The latest advance is the Change of Direction (CoD) feature, which allows precise loading and pinpoint testing of the specific abilities of CoD.

Drive out. Brace. Plant. Cut. Burst. Stop on a dime. Dynamic CoD ability is crucial for performance in field sports, but the methods and tools to train, assess, and understand this fundamental part of athleticism have been limited outside of advanced sports laboratories. Current research also highlights that traditional CoD field tests (such as the total time over a 5-10-5 or 5-0-5) are skewed towards straight sprinting rather than CoD performance. These measurements of total time tilt favorably toward those who accelerate and run fast, but fail to narrow down on specific deceleration and turning abilities.

The 1080 Sprint can load CoD and capture all parts of a drill, allowing data visualization and comprehensive understanding of each component of directional change.

You get better at what you train, maximizing training outcomes through exposure to optimal levels of external load. CoD development is no exception. Based on this fundamental principle, training CoD without additional resistance or assistance may be suboptimal for your athletes—and the same is true when crudely loading a turn or deceleration with a bungee cord or a weighted vest. The 1080 Sprint, on the other hand, provides finely-tuned directional loading: each different direction in a CoD movement can have its own unique load settings. This allows coaches, trainers, and physical therapists to hone in on an optimal load and work at that level until repeat testing suggests the next adjustment.

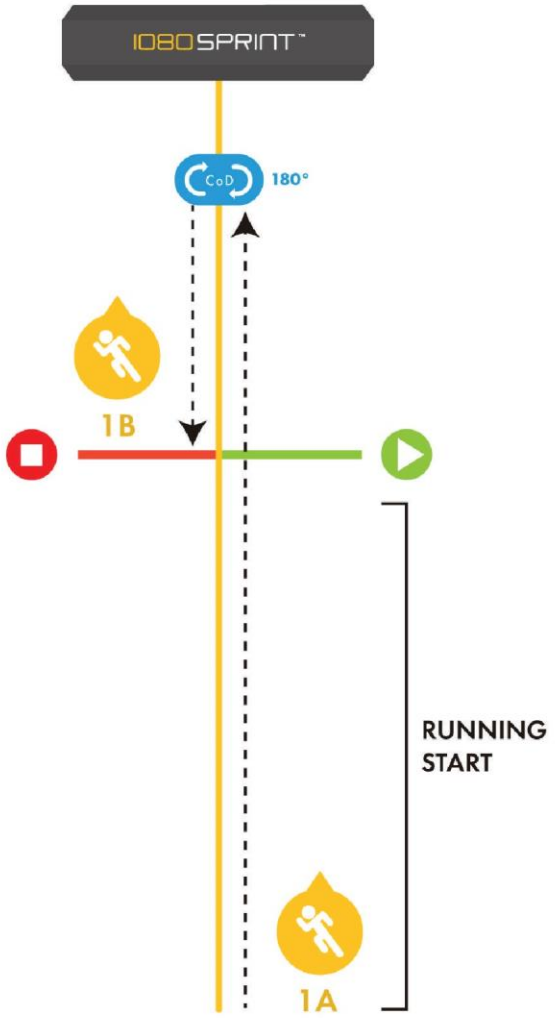


Diagram 1

5-0-5 with 10m runup start.

Time to Change Direction

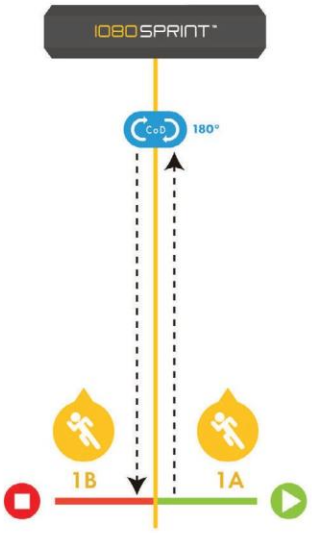
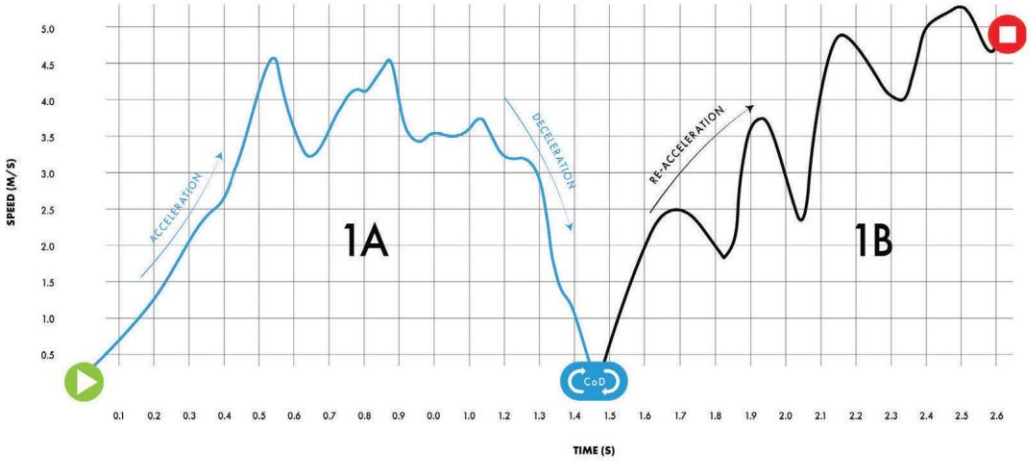


Diagram 2

An example of a modified 5-0-5 test (standstill start) starting towards the machine with 6 kg pulling force (1A) and 3 kg resisting force (1B).



TOTAL TIME	TOTAL DISTANCE COVERED (CENTER OF MASS)	PHASE	DISTANCE	PHASE TIME	SPEED (AVG)	FORCE (AVG)	POWER (AVG)	RESISTANCE SETTINGS
2.62 S	8.1 M	1A	4.06 M	1.47 S	2.76 M/S	20.4 N	47 W	6 KG ASSISTED
		1B	4.04 M	1.14 S	3.54 M/S	46.4 N	169 W	3 KG RESISTED

Figure 1: Example graph showing speed over time, step by step. Real time data includes total time and distance (representing Center of Mass (COM), displacement) as well as time, distance, speed, force and power for each phase of the 5-0-5.

Above is an example of a modified 5-0-5 test (standstill start), starting towards the machine with 6 kg assisted pulling force (1A-assistance) and 3 kg resisting force (1B-resistance). See Figure 1.

Executing a single turn? Multiple turns at different angles? The 1080 Sprint's software is equipped for training and testing across a range of movements. You can start from a standstill or a runup, use any length of segments or splits, and independently set the horizontal force running towards and away from the 1080 Sprint. To train and measure CoD endurance, for example, you can measure five consecutive 5-10-5's as one single test and obtain data on the total of ten turns, as well as all of the movements in between. With this information, you can gauge how resilient athletes are in maintaining their ability to repetitively change direction.

The rest of this paper will dive deeper into CoD. Whether you are a performance coach, a rehab professional, or a sports scientist, our aim is to propose simple, meaningful methods of testing and training to enhance and understand CoD ability.

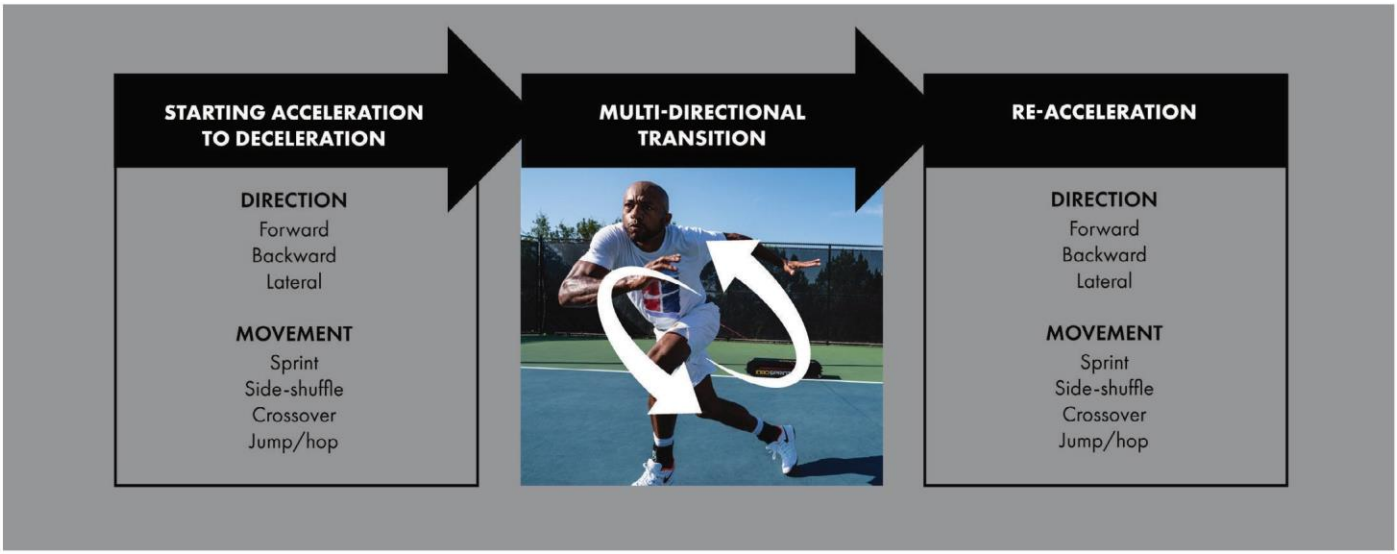


Figure 2: Framework of how direction and movement pattern can be the same or different before or after a transition in a change of direction test or task. Distances for each phase and the number of turns will vary.

Current Status: Testing and Training

What is Change of Direction?

Change of Direction (CoD) refers to the skills and abilities needed to change movement direction, velocity, or pattern. Assuming a start from a standstill, CoD involves an initial acceleration to deceleration phase before a transition (stopping or cutting in a new direction), followed by a subsequent re-acceleration. In one such sequence, the movement pattern can be the same throughout (such as just sprinting or just a side-shuffle) or be different before and after the transition, such as a side-shuffle followed by a sprint. Figure 2 provides an overview of typical CoD combinations.

Traditional CoD testing

Traditional CoD tests involve one or more of the sequences presented in Figure 2, with overall time as the primary outcome measurement (via stopwatches, wearable technology, photocells, etc.). Radars and lasers have been used to provide continuous data of CoD tests, but on a more limited basis. Since deceleration and acceleration are separate qualities, obtaining phase-specific information (i.e., speed, acceleration) of different movement patterns in different directions provides actionable insights for what to target in training.

In addition to testing vertical displacements, force plates may also be used to partially assess change of direction movement. These can measure the forces involved in the last one or two steps leading up to and after the turn, but do not capture the full CoD sequence from start to finish. Force plates are also generally lab-based equipment, which cannot easily be used to assess CoD in the field.

The systems traditionally used to assess CoD either do not provide phase-specific information, have limited application to field-based conditions, or do not possess the capacity to systematically apply horizontal load to the movement. In fact, accurate and systematic application of horizontal loading has not been applied to change of direction. Considering the widespread application of external loading to vertical movement patterns, the logical progression would be to apply loading to horizontal movement patterns in a systematic manner as well—especially considering that vertical and horizontal force generation are two different qualities.

Actionable Insights

1080 Sprint technology advantage

1080 Sprint is a portable, motorized, electrical resistance system that can be used effectively across a range of environments to target sport-specific CoD performance. Turf, indoor flooring, hardwood, clay, grass—wherever your athletes train and compete. The unit connects to the athlete via a tether at the waist and continuously measures horizontal physical and temporal data at 333 Hz. The data reflects the center of mass movement during each phase of acceleration, deceleration, and transition: measurements of different center of mass variables during CoD tests that have been called for by coaches, trainers, and researchers alike. Training and testing can be optimized to target the desired response from each individual athlete, ranging from very light to very heavy external loads (1 – 45kg).
1080 Sprint immediately presents both graphically and numerically the following phase-specific variables:*

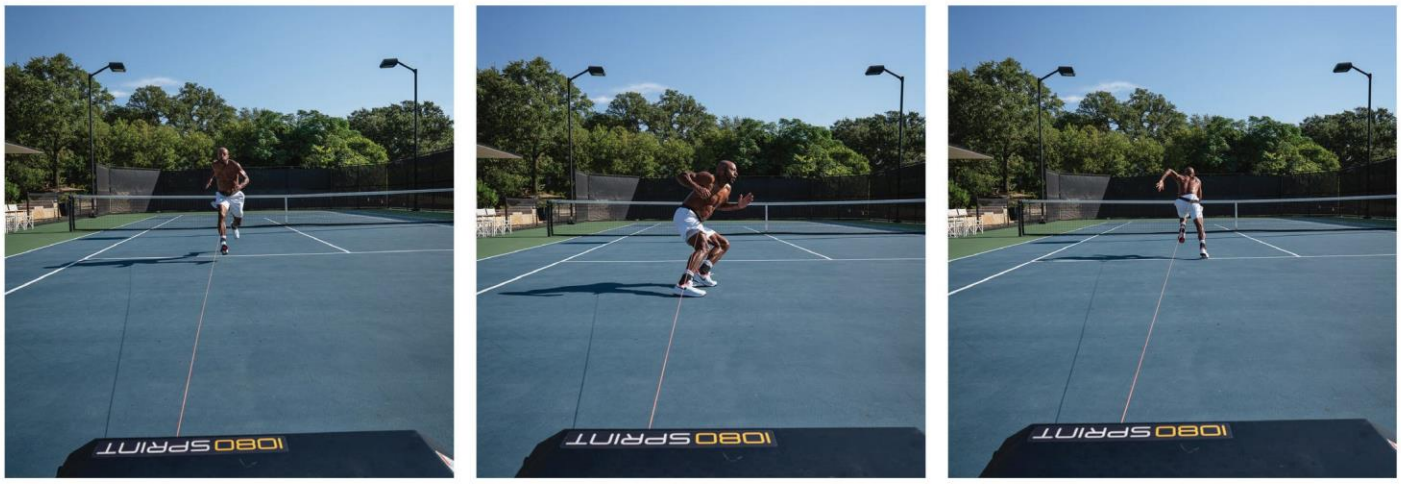
- Displacement (m)
- Time (s)
- Speed (m/s)
- Force (N)
- Power (W)

*All variables can be exported for further analysis.

In traditional CoD testing with timing gates, a major source of measurement error is the starting procedure with standstill starts. Even a very short "flying start" will have a significant impact on timing. By contrast, the 1080 Sprint uses a method that triggers the measurement when the athlete reaches a speed of 0.2 m/s, which then yields highly consistent data.

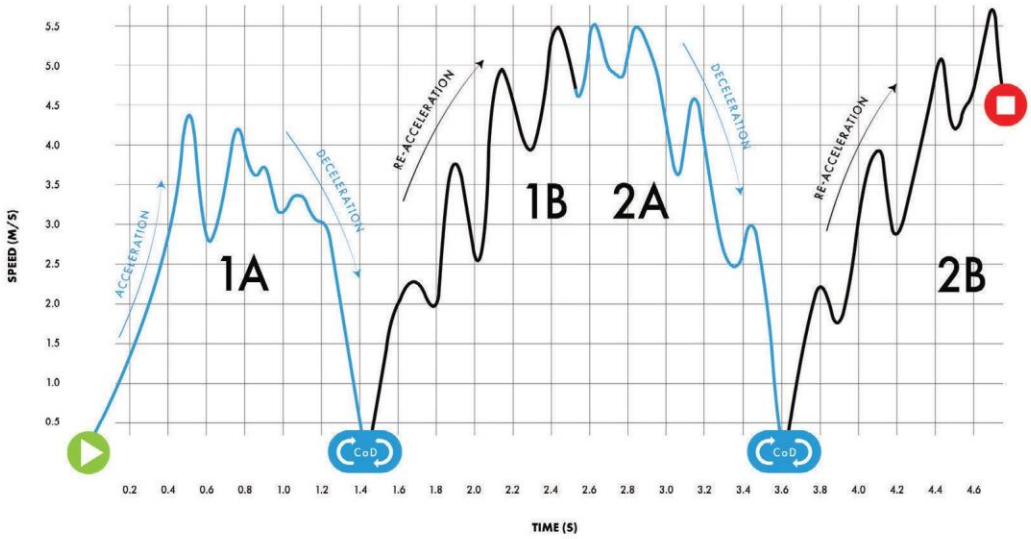
Photo above: Side-shuffle at 45 degree angle away from 1080 Sprint with 5 kg resistance.

The length of segments is optional with the software—you decide where to place the markers as endpoints. The 1080 Sprint system will then identify where the CoD takes place with high accuracy, which allows for measuring COM displacement (i.e., the distance the athlete's center of mass is being transported within the target endpoints). We believe that if an athlete can execute the task by reaching the targets within a lower total distance, it might be indicative of a better technical execution of the movement. The 1080 Sprint measures this distance, and this phase-specific data also reveals information about Left -and Right-side asymmetry. With this information, you can analyze the progress of an individual athlete and also compare individuals within a group.



Photos: 1080 Sprint measures how fast an athlete moves before and after a turn during a CoD drill.

Fig. 3



TOTAL TIME	TOTAL DISTANCE COVERED (CENTER OF MASS)	PHASE	DISTANCE	PHASE TIME	SPEED (AVG)	FORCE (AVG)	POWER (AVG)	RESISTANCE SETTINGS
4.76 S	15.7 M	1A	3.77 M	1.44 S	2.62 M/S	21.3 N	47.3 W	3 KG ASSISTED
		1B	3.74 M	1.08 S	3.47 M/S	47.2 N	169 W	3 KG RESISTED
		2A	4.12 M	1.10 S	3.76 M/S	38.4 N	158 W	3 KG RESISTED
		2B	4.09 M	1.15 S	3.56 M/S	14.5 N	48.3 W	3 KG ASSISTED

Figure 3: Graphical and numerical results from a 5-10-5 test.

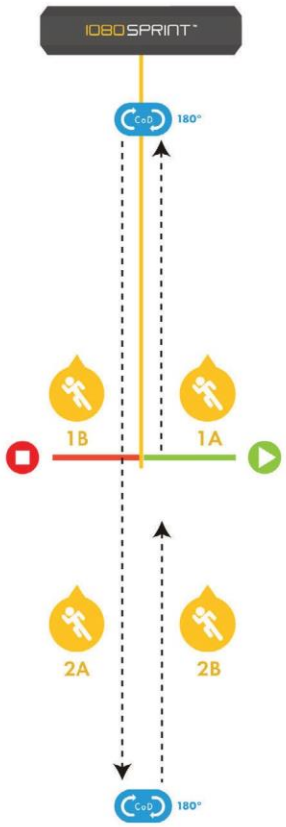


Diagram 3

5-10-5 test.

Multiple turns

The 5-10-5 test (starting from standstill) is a simple test consisting of two directional changes over separate phases of 5, 10, and 5 meters (or yards). Figure 3.

Though the data presented on the graph is from sprinting, each phase can utilize different movement patterns and variations on transitions, all of which can be easily defined and accurately presented. In addition, the angle of the turns can also be modified beyond a standard 180-degree pivot. What movements are critical in your sport? A flash backdoor cut to the rim in basketball; a taut down-and-in route in football; a rundown between home and third in baseball: 1080 Sprint offers the freedom to test and train CoD of different movement patterns in symmetrical or asymmetrical phases (i.e., 5-0-5 vs. 5-10-5) while applying different angular transitions (i.e., 5-0-5 with a 135 degree turn).

Each of these cuts, angles, patterns, and movement variations can be executed with horizontal resistance or assistance to make the pivot more or less demanding. Running towards the machine will make both the deceleration phase and the subsequent re-acceleration out of the turn more demanding in a loaded CoD exercise.

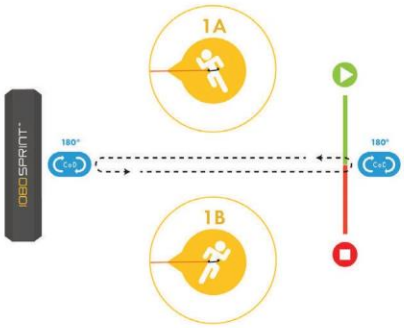


Diagram 4

A loaded and less demanding turn depending on direction.

Photo left

A swiveling 360 belt enables changing direction while connected to 1080 Sprint.

Photo below

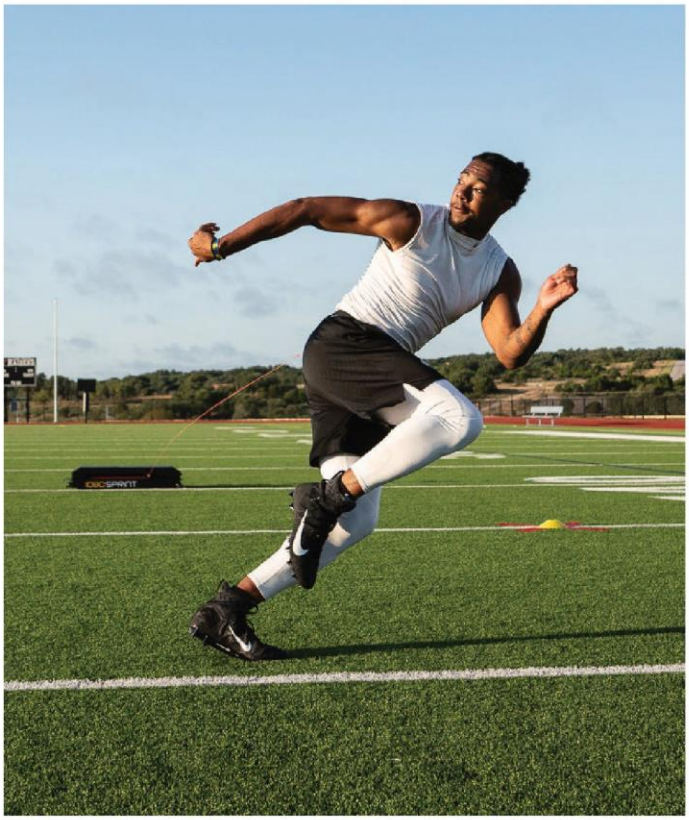
Right foot touching the transition line marked between two cones.

Research has shown that short, straight sprinting performance has a high correlation with CoD performance—suggesting that the ability to decelerate and turn is not challenged properly compared to accelerating. Since loads can be set independently, performance professionals have an opportunity to specifically target the braking phase of the CoD by applying a high pulling force in the deceleration with the athlete running towards the 1080 Sprint. For a different training effect, lower demands on deceleration and acceleration after the turn will be imposed if the initial acceleration is directed away from the machine.

With all these possibilities in place, new testing and training strategies can be developed to contain movement patterns with transitions in different directions and phases specific to sports performance. Figure 2 can be used as a template for such developments.

Applications in the Field

Athletic performance often depends on the execution of unique, position-specific CoD skills. These skills can be impacted by adding the 1080 Sprint as a training stimulus and then monitoring performance through the various phases of a CoD drill. The numerical data, visual feedback, and loading options are effective coaching tools for perfecting technical skills like foot placement, stiffness, or the direction of force application into the ground. Target specific qualities of performance in each phase of initial acceleration, deceleration, and re-acceleration by adjusting the load settings for the different directions. Further train balance and stability with a focus on getting into or maintaining desired body postures.



CoD on the Gridiron: Pass Protection in Football

At PACE Fitness Academy in Indianapolis, Eric Allen specializes in working with athletes to increase speed at the point of attack. Call it burst.

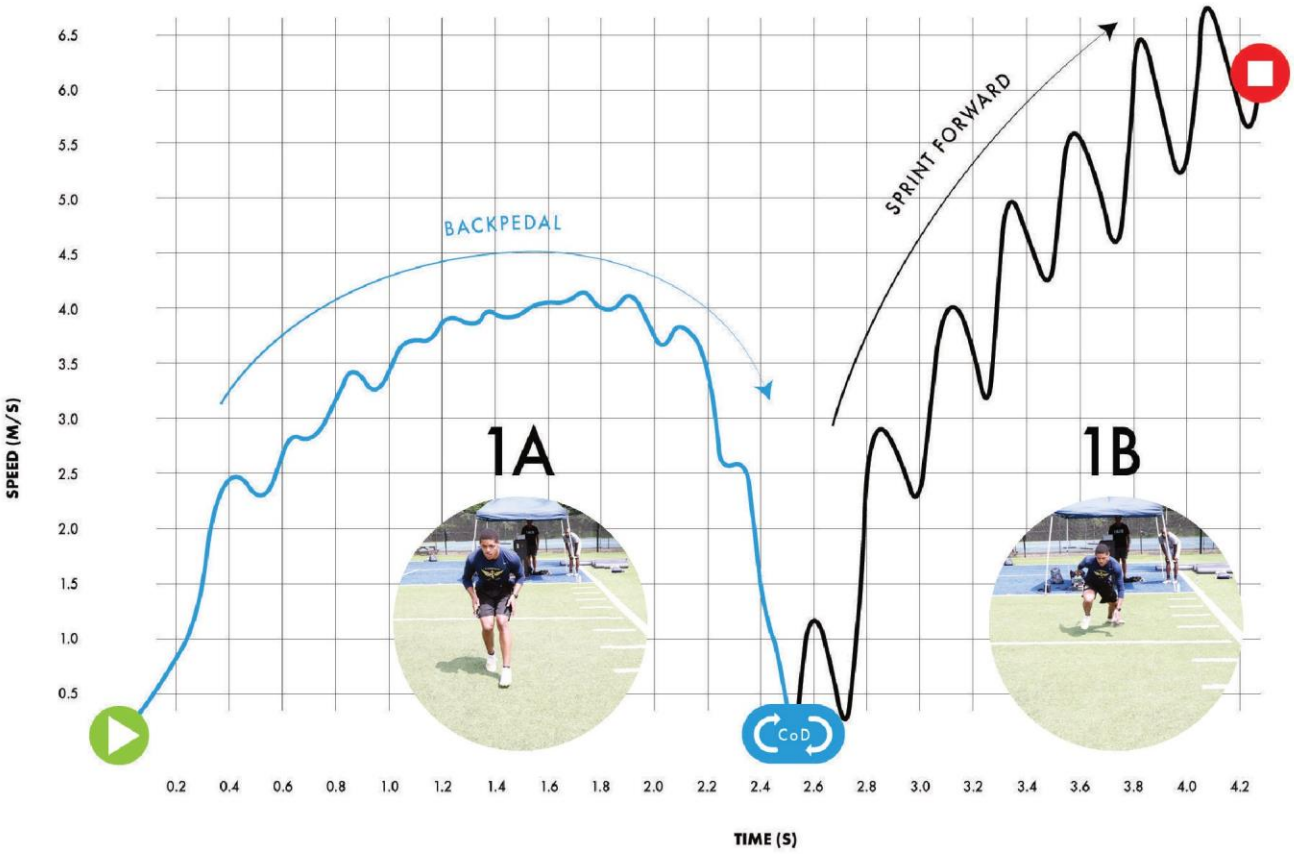
Allen coaches his athletes on proper CoD fundamentals and how to seamlessly transition into a sprint. Seeking to assess and quantify progress in this game-changing ability, Allen designed a CoD test using 1080 Sprint that could replicate and evaluate his training methods. With this, he records and analyzes three key areas of performance on the football field:

- Horizontal force produced during the backpedal
- Deceleration
- Ability to cover ground during the first step of the initial re-acceleration

Allen tests his athletes by having them perform a backpedal toward the 1080 Sprint unit, finishing with a transition forward into a sprint. When a player is too slow in their backpedal, performing resisted backpedaling drills will ultimately improve horizontal force application. Covering a short distance after the transition, Allen emphasizes improved ground coverage during re-acceleration by adding load to the forward sprint :

1. Improves balance at transition
2. Trains overall ankle strength

When slow acceleration and low speed are observed in the re-acceleration phase, Allen then programs linear sprinting with resistance.



TOTAL TIME	TOTAL DISTANCE COVERED (CENTER OF MASS)	PHASE	DISTANCE	PHASE TIME	SPEED (AVG)	FORCE (AVG)	POWER (AVG)	RESISTANCE SETTINGS
4.32 S	15.3 M	1A	7.65 M	2.53 S	3.03 M/S	12.0 N	29.1 W	1.8 KG ASSISTED
		1B	7.63 M	1.79 S	4.27 M/S	44.9 N	194 W	1.8 KG RESISTED

Figure 4: Graphical and numerical results from a backpedal to sprint CoD drill.

Applications in the Field

CoD on the Court: Close-out to Side-shuffle in Basketball

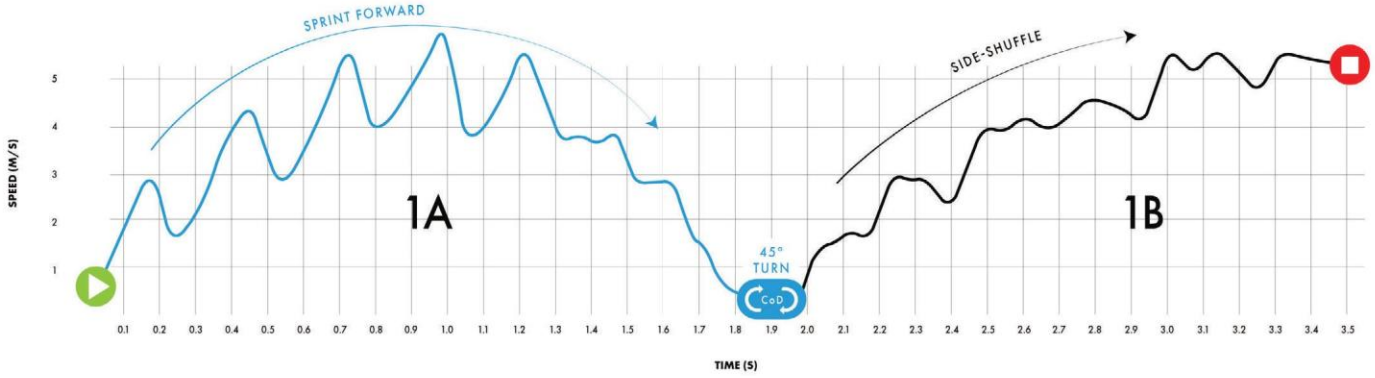
The ball swings from the baseline to an open shooter at the top of the key. Whether playing a man-to-man or a zone scheme, the near defender must immediately accelerate and "close out" the shooter to prevent an open look at the basket—all while simultaneously bracing to break down for a lateral side-shuffle should that ball-handler instead make a move off the dribble or a quick pass and cut.

This game-specific transition can be trained with 1080 Sprint CoD. The athlete starts toward the machine with pulling assistance to target the deceleration demands of that movement, followed by the re-acceleration into a side-shuffle at different angles. This sports-specific exercise allows:

- The athlete to expend less effort in the initial acceleration due to the assistance
- The coach to obtain valuable data relating to the athlete's acceleration and deceleration in this movement pattern

In particular, coaches can analyze the maximum speed reached during this first phase of the movement combined with the time or distance required to stop to gain useful insights into deceleration capacity. This quality can then be trained by increasing the pulling force and/or decreasing the available deceleration distance.

With the same setup, to emphasize the transition to the side-shuffle, coaches can provide greater pulling force than resisted load (up to 3x). Working with basketball players, coaches can specifically target the side shuffle as a part of the re-acceleration, in particular testing and training the explosiveness in the first two steps.



TOTAL TIME	TOTAL DISTANCE COVERED (CENTER OF MASS)	PHASE	DISTANCE	PHASE TIME	SPEED (AVG)	FORCE (AVG)	POWER (AVG)	RESISTANCE SETTINGS
3.51 S	12.4 M	1A	6.22 M	1.94 S	3.22 M/S	29.1 N	70.7 W	3 KG ASSISTED
		1B	6.23 M	1.57 S	3.96 M/S	60.8 N	236.0 W	3 KG RESISTED

Figure 5: Graphical and numerical results from a sprint to side-shuffle CoD drill.

CoD in Return-to-Play:
Implications for Rehabilitation in Post-operative ACL Reconstruction (ACLR)

At Re_Building by NWRA in Salem, OR, Kyle Davey specializes in bridging the gap between rehabilitation and performance. With athletes retuning from knee surgery, once they are cleared for cutting drills, Davey works with both physical therapists and the patient on testing readiness to perform CoD.

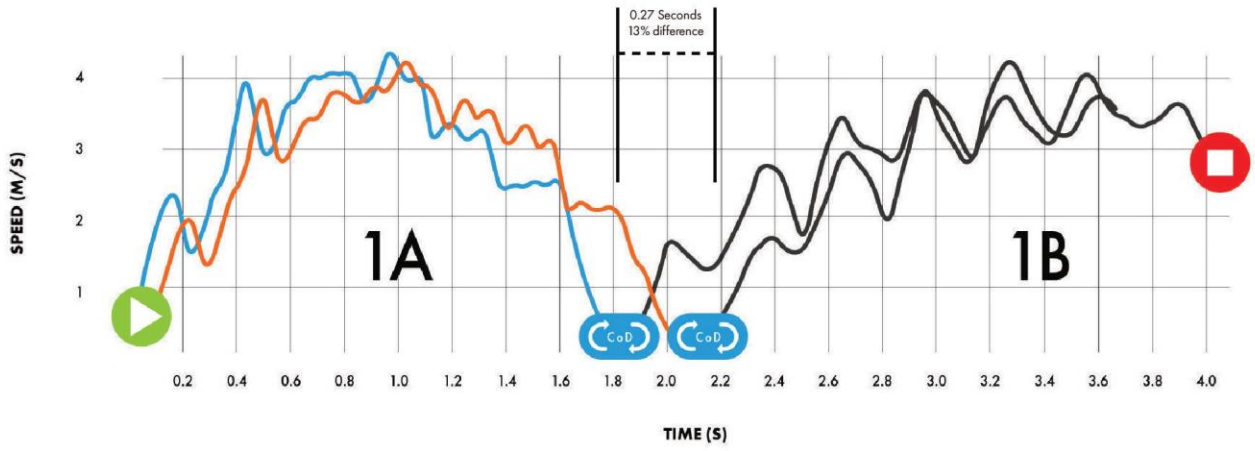
Davey tests change of direction performance with a modified 5-0-5 test at 1 kg and 5 kg of load. At each load, the patient transitions turning to the right and turning to the left for three repetitions each.

These testing procedures provide phase-specific information (i.e, time, speed, and displacement) of how the athlete performs turning either direction. Such data can be used to determine deficits, physical qualities to target (such as strength,) and also serve as guiding insight to safely progress the patient through rehabilitation. Combining quantitative data, direct observation of the test, and subjective feedback from the patient will provide the clinician with valuable information.

Turning to a specific example, Davey worked with a high school volleyball player who was 19 weeks post-operative left knee ACLR. The athlete completed testing after warm-up—in a non-fatigued state—and the outcome measurements from the 1 kg test showed small, phase-specific differences in average speed with a left turn transition (uninjured right outside plant leg compared to a right turn (left outside plant leg). Specifically, during the initial acceleration to deceleration (Phase 1A) with the right transition off the uninjured limb (right) was 0.17 seconds (8% difference) faster, with higher average speed 0.14 m/s (5% difference). Furthermore, the reacceleration phase (1B) was slightly faster with transition off the uninjured right foot (0.11 m/s, 3% difference).

Adding 5 kg of load to the test amplified differences between the right and left turns, indicating greater asymmetry in how the patient performed. Specifically, during phase 1A, the time difference increased to 0.27 seconds (13% difference) and the average speed increased 0.22 m/s (8% difference) with transition off the injured as compared to uninjured limb. This might be due to a greater displacement during phase 1A with a transition off the injured limb. This will influence measurements, but also serve as an indicator of the patient selecting a strategy to decelerate over a greater distance.

Application of 1080 Sprint in rehabilitation, specifically in CoD testing and training, can be important to quantitatively determine interventions, document progress, and determine return to play.



TOTAL TIME	TOTAL DISTANCE COVERED (CENTER OF MASS)	TURN DIRECTION	PHASE	DISTANCE	PHASE TIME	SPEED (AVG)	FORCE (AVG)	POWER (AVG)	RESISTANCE SETTINGS
3.66 S	10.2 M	RIGHT	1A	5.1 M	1.84 S	2.78 M/S	50.8 N	125 W	5 KG ASSISTED
			1B	5.1 M	1.82 S	2.80 M/S	82.3 N	227 W	5 KG RESISTED
4.05 S	10.8 M	LEFT	1A	5.41 M	2.11 S	2.56 M/S	50.2 N	115 W	5 KG ASSISTED
			1B	5.41 M	1.94 S	2.79 M/S	79.3 N	219 W	5 KG RESISTED

Figure 6: Graphical and numerical results of a modified 5-0-5 test with 5kg resistance. Increased phase measurement differences turning left (blue line) or right (orange line) at the transition.

FUTURE CONSIDERATIONS

The 1080 Sprint opens far-reaching opportunities to design and analyze CoD performance. Armed with a thorough understanding of sports-specific demands, coaches, rehab specialists, and researchers can now easily implement more meaningful tests and training. With the application of horizontal load in training programs, the efficacy of these methods beyond vertical loading can now be fully explored and quantified. In addition, tests can be synchronized and integrated into decision-making, making the creation of new agility tests another area of exploration.

Published Research
1080 Sprint

Individual Sprint Force-Velocity Profile Adaptations to In-Season Assisted and Resisted Velocity-Based Training in Professional Rugby (2020)

Increased Resisted Sprinting Load Decreases Bilateral Asymmetry in Sprinting Kinetics Among Rugby Players (2020)

The addition of -Hydroxy -Methylbutyrate (HMB) to creatine monohydrate supplementation does not improve anthropometric and performance maintenance across a collegiate rugby season (2020)

Relationships between a Load-velocity Profile and Sprint Performance in Butterfly Swimming (2020)

Acute Kinematic Effects of Sprinting With Motorized Assistance (2019)

Force–velocity profiling of sprinting athletes: single-run vs. multiple-run methods. European Journal of Applied Physiology (2019)

Training at maximal power in resisted sprinting: Optimal load determination methodology and pilot results in team sport athletes. PLOS ONE (2018)

Validation of force-, velocity-, and acceleration-time curves and temporal characteristics as output data from the 1080 Sprint. Masters' thesis, Norwegian School of Sport Sciences
(2018)

A Resisted Sprint Improves Rate Of Force Development During A 20-Meter Sprint In Athletes. Journal of Strength and Conditioning Research (2018)

The Potentiating Effect of Resisted Sprint Training in Varsity Level Sprinters. Journal of Strength & Conditioning Research (2018)

The effect of individualized sprint training in elite female team sport athletes. Journal of Sports Sciences (2018)

Effects of a 4 Week Very Heavy Resisted Sprinting Intervention on Acceleration Sprint and Jump Performance in Youth Soccer Players. Masters' thesis, The Swedish School of Sport and Health Sciences (2018)

A training intervention on acceleration sprint and jump performance in late pubertal adolescent athletes. Masters' thesis, The Swedish School of Sport and Health Sciences (2018)