The benefits of DANU Gait Analysis for remote professional athletes

Case Study:

Load Monitoring in Elite Sport

The importance of athlete load management has all consumed the field of sports medicine and performance today. Combining adequate training volume with athlete recovery from a disrupted homeostasis brought about by training is essential to produce optimal athlete adaptations (Windt and Gabbett, 2016). Knowing this, means that with every training comes a risk of overtraining, and injury. Isolating injuries into load and trauma based has been a game changing evolution in sports medicine with the explosion of Sports Technology being a driving factor. DANU is one of the available technologies that can be used to monitor an athlete's load in a remote environment as it measures bilateral gait, plyometric, and balance assessments to generate a movement profile of an athlete while flagging any deviations from normative movement patterns.

"So, where physio is moving now is that there is a bigger expectation that we should be able to control the load related injuries more." *(Bebhinn Flaherty)*

Sports Tech Increases the realm of possibility in monitoring athletes' load using quantifiable markers for both internal and external assessment tools, both in person and remote cases. Across the globe, plyometric and gait-based screening has been used in sports to monitor performance as well as rehab and injury risk parameters. However, practitioners and athletes often find it frustrating that these screening devices can be time-consuming, restrictive, and detached from the athlete's usual sporting environment. DANU provides the capability to integrate precise screening through sensor-equipped Smart Socks that mould seamlessly into any footwear, ensuring they are unobtrusive to the athlete and do not hinder movement.

“If things like hamstring injuries, calf injuries are coming up in a space, previously you'd have just said, oh, that's unlucky, that's unfortunate. But actually, now you have to start asking questions and auditing every injury and going, is this isolated to this person or is this across the squad? Do we have to investigate this thing further? Because the idea would be that you should be able to manage and mitigate the load related injuries pretty well” (Bebhinn Flaherty- Hockey Ireland Physio)

Availability of accurate data for athletes, teams and leagues allows for more individualised analysis and programs to be created. Utilising data effectively empowers practitioners to recognise trends and patterns that are normal for specific sports, positions, all the way down to the individual themselves to keep them on their field of play for longer. Even if we gather extensive data on an athlete, it is useless unless it conveys meaningful insights or paints a comprehensive picture of that athlete. For example, GPS data in hockey informs sports scientists on variances of how much time, distances, and speed everyone expends on the pitch informing their training expectations (McGuinness et al., 2017). Aggregation of injury data indicates the high biomechanical strain induced by hockey players' trunks flexed forwards for long periods risks increasing stiffness and common injuries to the lower back, hips and thigh area in comparison to other sports (Wilmes et al., 2023), and being a drag flicker in hockey which is a specialist skill leaves them even more vulnerable to injury in this area as they have to rapidly generate a large force while in this hinged position (Ng et al., 2016).

(Drag Flicking technique)

Such data allows coaches and physios to make informed decisions around training to maximise workloads. However, where a tool could provide quantifiable information on how the response to training demands such as pain / stiffness alters normal movement patterns replicable to their specific sport could prove vital for early injury identification, injury risk, as well as athlete development and rehab. This is where DANU's potential is realised as it detects alterations in movement strategy to the individual for both performance progressions and injury risk as evident in this case study.

DANU

The DANU System was used as a remote load monitoring tool to complement GPS and internal load data analysis for three Irish international hockey players competing in the nine-week Hockey One league in Australia.
By utilising DANU to monitor player movement profiles during the intense nine-week period and deliver meaningful biomechanical analysis, a comprehensive understanding of each athlete's response to training loads was gained. Immediate feedback was also available to coaches monitoring the athletes back in Ireland on how their players were moving at regular intervals, to provide an extensive picture of their training adaptations remotely. The three athletes covered three different positions on the pitch with a forward (KM), midfield (SH), and defender (RU) represented. RU also engaged in drag flicking sessions throughout the block, which meant that she had extra sessions involving little running load, but heavy biomechanical strain exerted on her, which has no current quantifiable load monitoring tool.

Danu integrated into their training program in two ways:

1) **Daily Training Readiness Screening** was conducted using ten Repeated Hops combined with three vertical Countermovement Jumps (CMJ), often used in elite sports as one of the most frequently employed tools for neuromuscular fatigue assessment due to its simplicity and sensitivity (Alba-Jiménez et al., 2022). The metrics assessed here were reactive strength index (RSI) and jump height. These activities and metrics were used previously in Hockey Ireland centralised camp as weekly readiness to train determinants, however, often were regarded as highly time consuming as one athlete completes the protocol at a time. DANU allows all athletes to complete the assessment simultaneously, reducing the time spend on important screening sessions.

2) **DANU Performance Progression Protocol** baseline, followed by repeated testing every three weeks. In this protocol, two sprint tests over 25 and 50 yards, a 5-minute steady state pitch run, and a battery of single and double leg jumps including Drop Jumps, CMJ, and Repeated Hops all were examined for both neuromuscular response and performance response feedback (Alba-Jiménez et al., 2022). In the gait assessments, both temporal, spatial and foot strike mechanics were analysed, and for jumps, asymmetries in RSI, jump heights and flight times were recorded. This protocol is

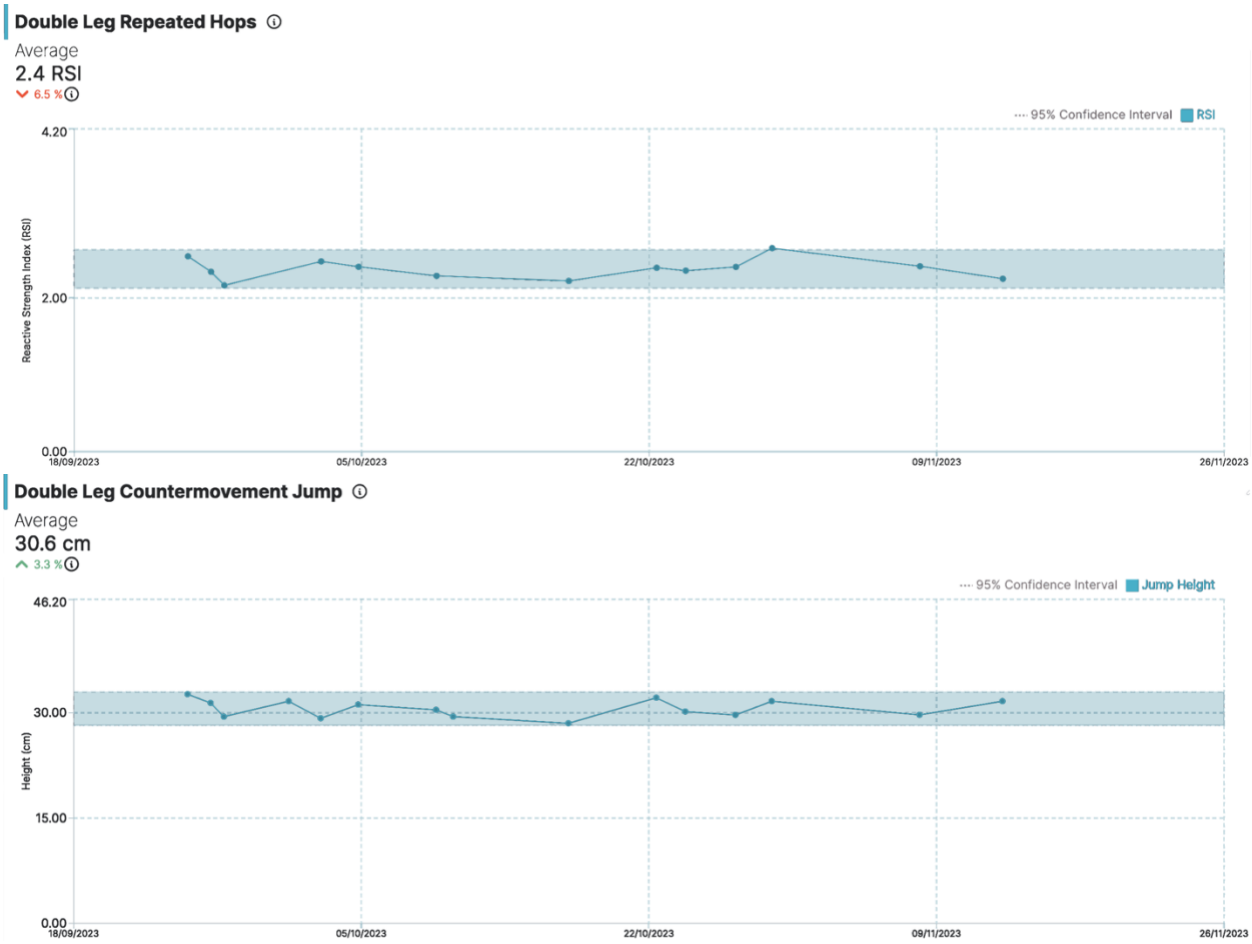
designed to provide an exhaustive athlete report which demonstrates limb dominances and normative movement patterns over different speeds in both gait and plyometrics.

Daily Training Readiness Screening

The daily neuromuscular fatigue screening test demonstrated little change throughout the block which highlighted the athletes' capabilities to tolerate the chronic load and recover effectively. Danu provides longitudinal athlete progression data, and alerts if any athlete deviates outside one standard deviation from their norm which none did for these tests as visible in the graphs below.

DANU Longitudinal Analysis of Training Day Screening:

RU:



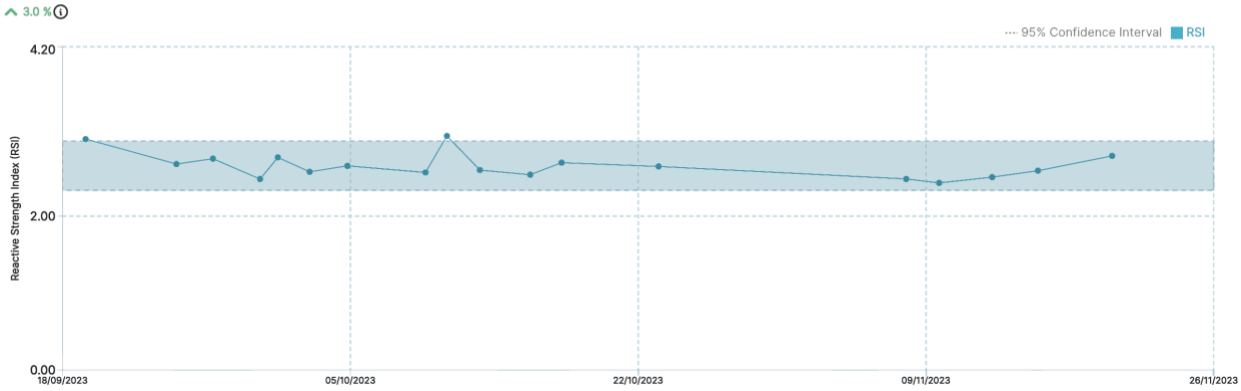
SH:

Double Leg Repeated Hops

Average

2.7 RSI

3.0 %

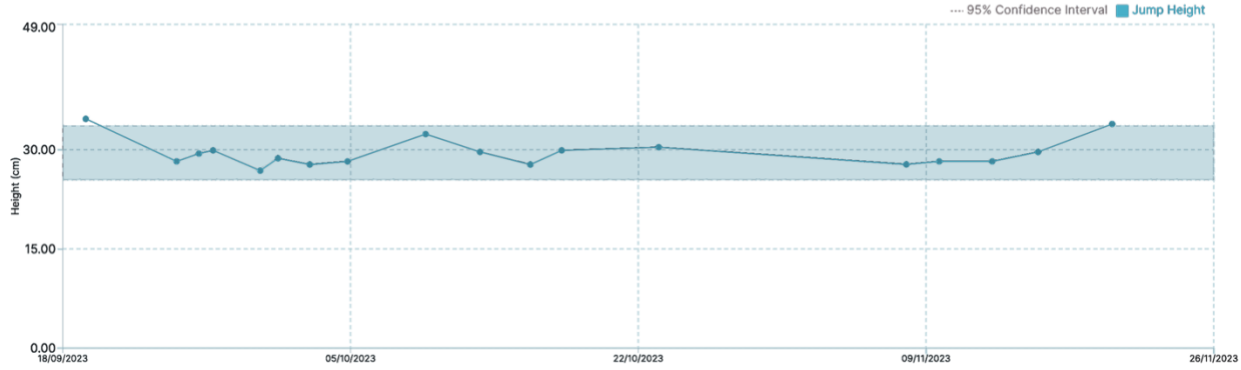


Double Leg Countermovement Jump

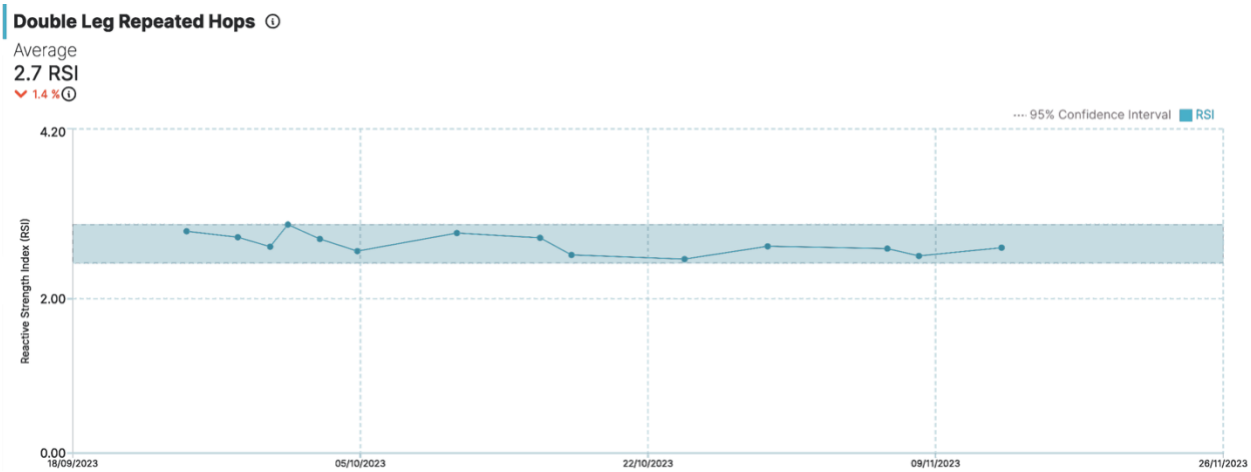
Average

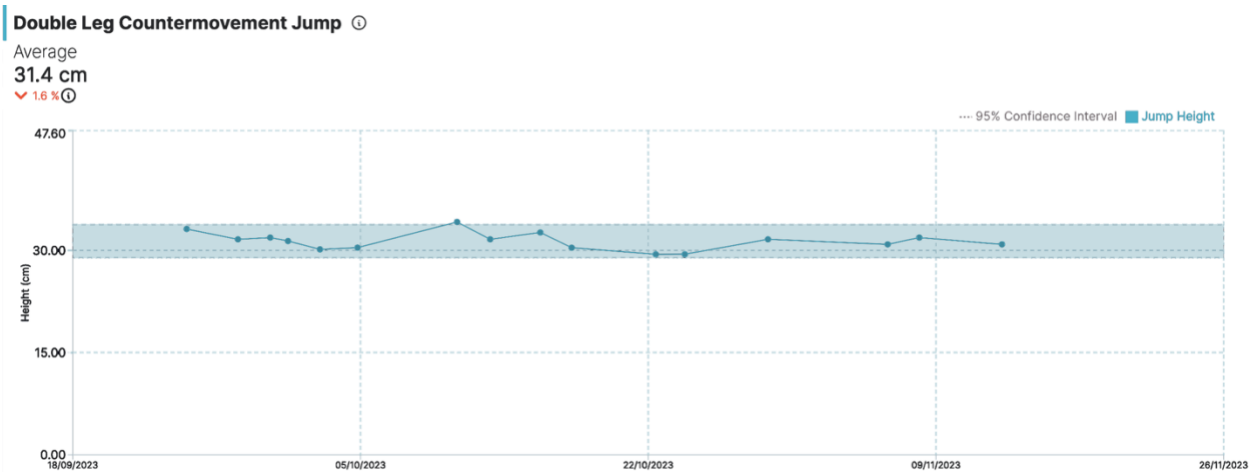
29.6 cm

13.6 %



KM:





DANU Performance Progression Protocol:

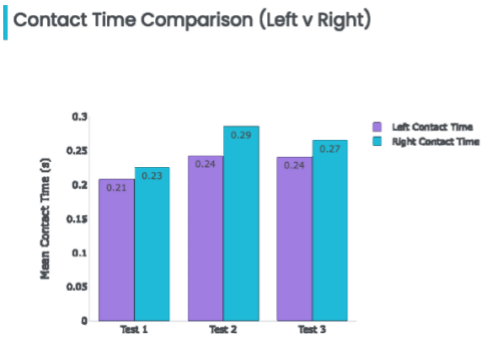
All plyometric assessments in the protocol for the athletes remained relatively consistent with only minor drops in scores, and the dominant limb remaining dominant throughout.
Like other field-based sports, jumping alone does not capture the normative patterns in hockey and that is why a combined gait screening, which is a bonus of DANU, was performed. So, what is pivotal to a hockey player's performance on the pitch? Running effectiveness, asymmetries, change of direction and speed. It was therefore decided to take a closer look into the DANU gait testing in relation to the athletes' response to load.

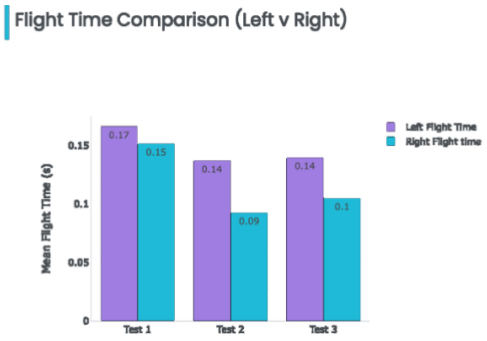
Gait Response to Load:

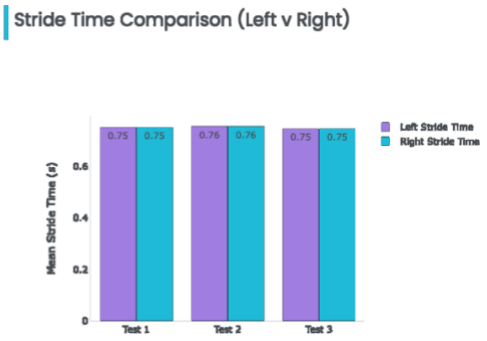
DANU was utilised as a periodic assessment tool to visualise how the athletes were running both at low and high speeds, and combined this with bilateral jump tests to identify dominant limbs and any deviations throughout the block during periods of high training volume that may indicate injury risk. What was found was that the bilateral analysis provided much more meaningful and actionable information than unilateral feedback alone, especially for injury and load management parameters.

DANU delivered meaningful feedback that reinforced how the athletes' gait was responding during periods of heavy training, indicated by GPS reports where high-speed running peaked, by using the 5-minute steady state assessment. Each athlete had varied responses:
Where stride time remained consistent for all athletes, what was occurring within those strides was changing as the weeks progressed. Both KM and SH showed a slight increase in average contact times, but these times remained relatively stable overall. At the same time, flight times decreased steadily, which may be attributed to fatigue as the load increased. Both athletes missed one steady state jog assessment within the block.
DANU identified an interesting change in gait in RU's bilateral analysis. In between Test 2 and Test 3, she had a significant alteration in flight times and a shift in dominant limb contact times. This corresponded with minor discomfort identified by the athlete in her upper right hamstring area.

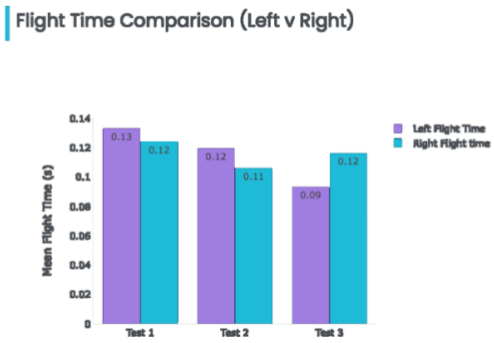
5 mins Steady State temporal metrics bilateral DANU report:
KM:

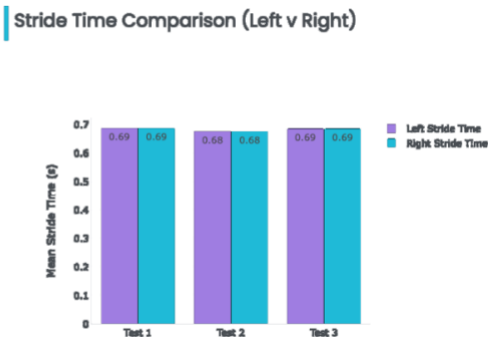






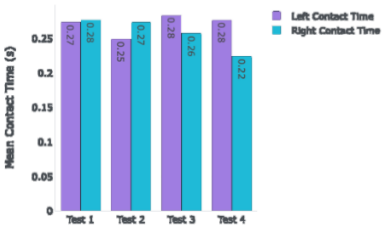
SH:



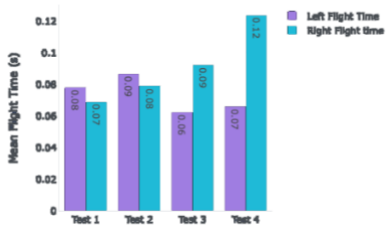


RU:

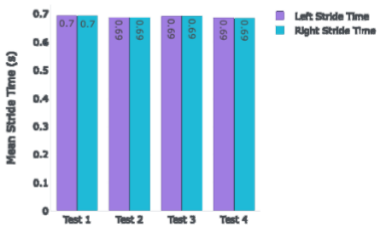
Contact Time Comparison (Left v Right)



Flight Time Comparison (Left v Right)



Stride Time Comparison (Left v Right)



DANU Injury Management:

Two of the three athletes successfully completed the block, however RU suffered from an injury that was initially identified as hamstring discomfort causing a significant change in jogging strategy as highlighted in the DANU. In combining DANU with GPS, one could see how she sustained high levels of high-speed running as well as drag flicking sessions between Test 2 and 3. Taking the individualised approach, it is known that defenders, and drag flickers can be more susceptible to load based injuries (Ng et al., 2016). DANU demonstrated a shift in gait patterns which coincided with pain in her right upper hamstring, where contact times and flight times altered and an asymmetry different from her earlier norms presented. What progressed was a diagnosis of osteitis pubis by the team medical group which is inflammation in the joint between the pubic bones. DANU flagged a pain management strategy early in this injury that the athlete was compensating by loading her left leg to avoid discomfort on the injured side, which shifted her asymmetries from earlier gait assessments. How an athlete adapts their movement patterns to deal with discomfort is important to recognise as it could help identify not only if an issue is present, but also pose a second injury risk to the loaded side. DANU allowed data collection to be longitudinal, providing more data points throughout the nine-week period which not only helped to identify when the injury developed but could also be used throughout rehab empowering the athlete to take an active approach to her rehabilitation using quantitative data. A final Test 4 steady state jog was completed by RU which ascertained further asymmetry indicating how she was still offsetting to take load off her right side.

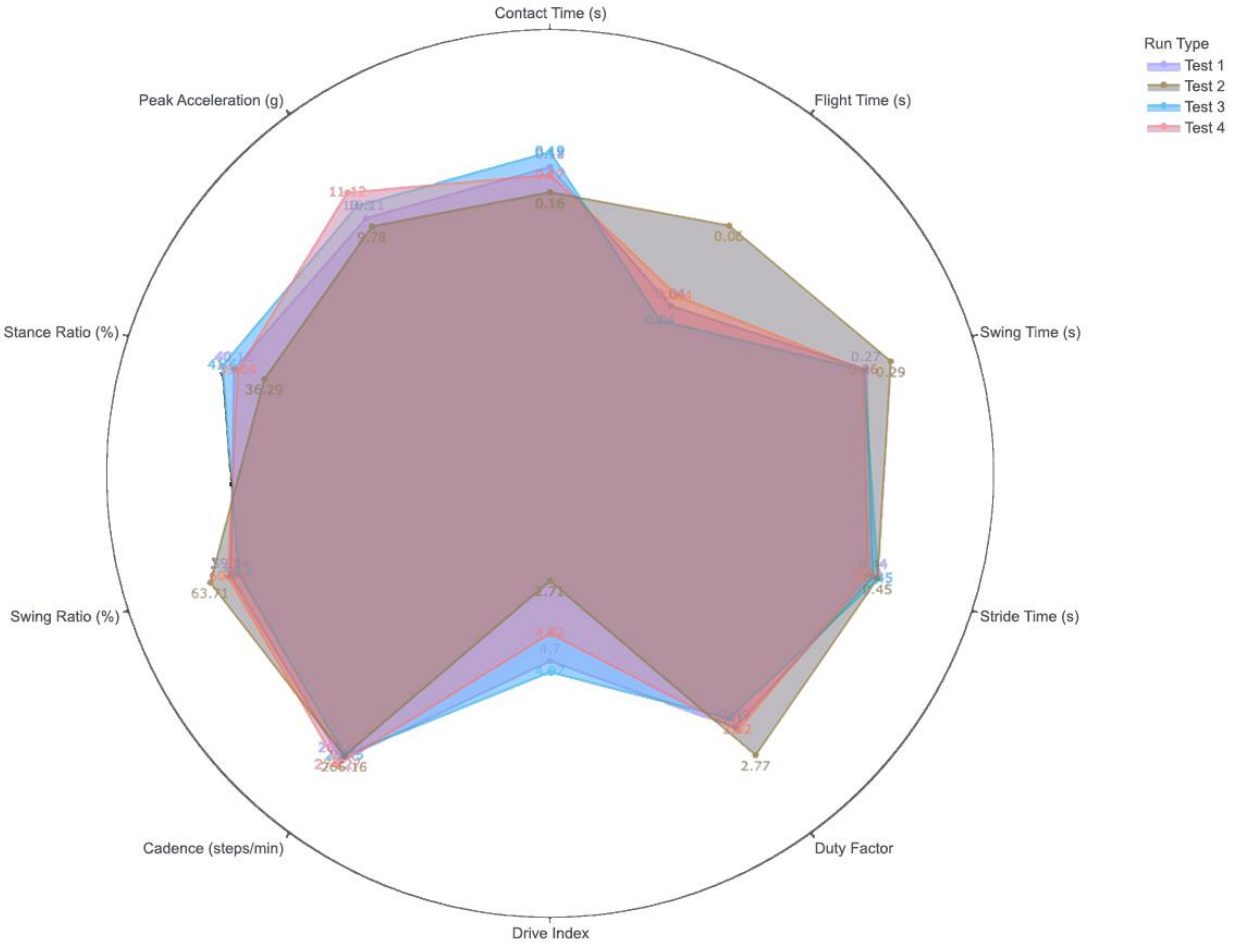
Danu Performance Monitoring:

DANU reflected performance related outcomes in the sprinting mechanics of all the athletes. While outcome measures of time for both the 25- and 50-yard sprints were not recorded by the system, sprinting strategy was. Two of the athletes in particular experienced decreased contact times, and stride times combined with increased flight times, peak tibial acceleration, and cadence over both sprint distances. Combining this with a maintained or progressive RSI from jump assessments might suggest a capacity to maintain and improve the max velocity phase in the 50-yard sprint where leg stiffness is increased (Haugen et al., 2019). Danu provided a

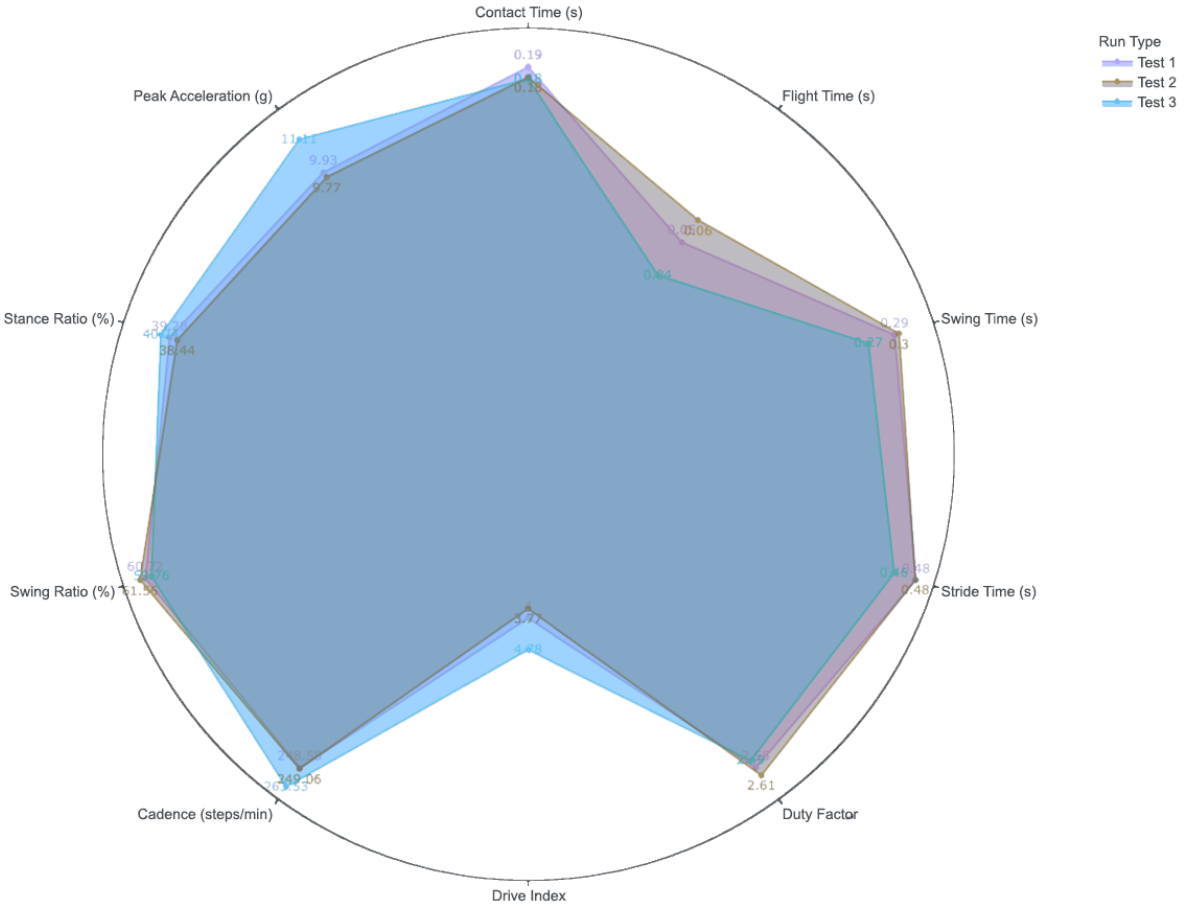
quantifiable measure of how each athlete completed a sprint which can be as valuable as the outcome time itself while remaining in their sport specific environment.

25 yard sprint tests DANU Radar Graphs:
KM:

SH:

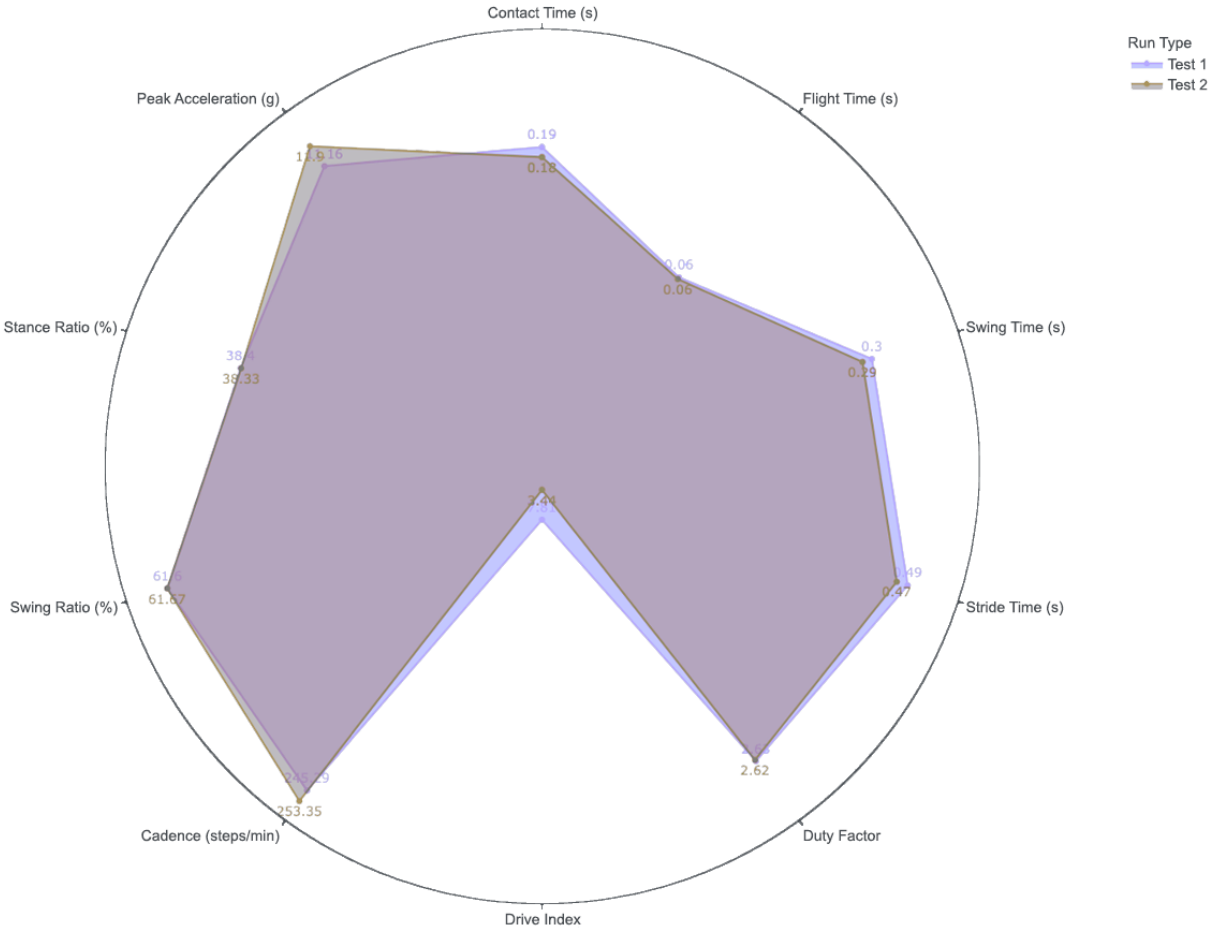

Contact Time (s)
Flight Time (s)
Swing Time (s)
Stride Time (s)
Duty Factor
Drive Index
Cadence (steps/min)
Swing Ratio (%)
Stance Ratio (%)
Peak Acceleration (g)
Run Type
Test 1
Test 2
Test 3
Test 4

RU:

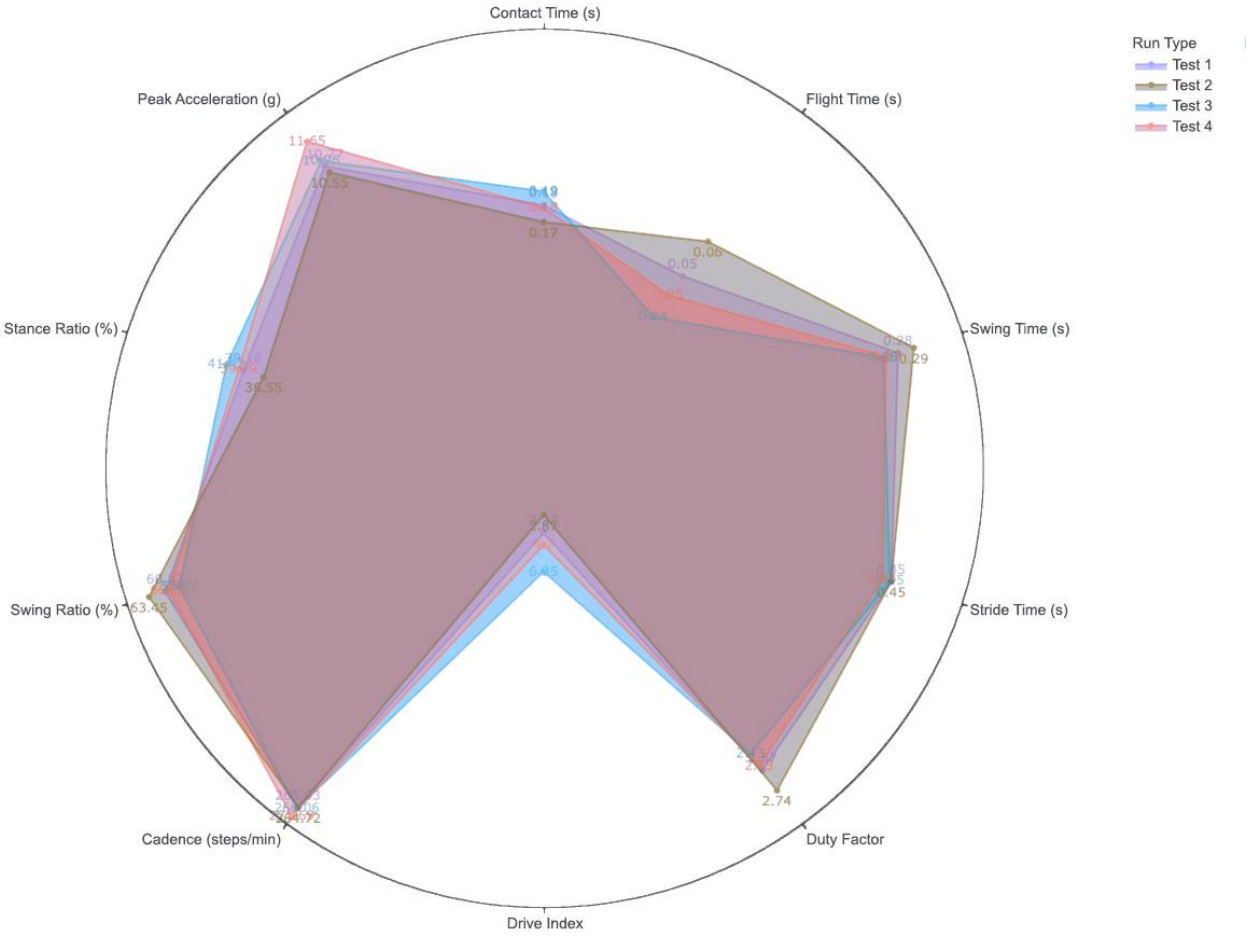


50 yard sprint tests:

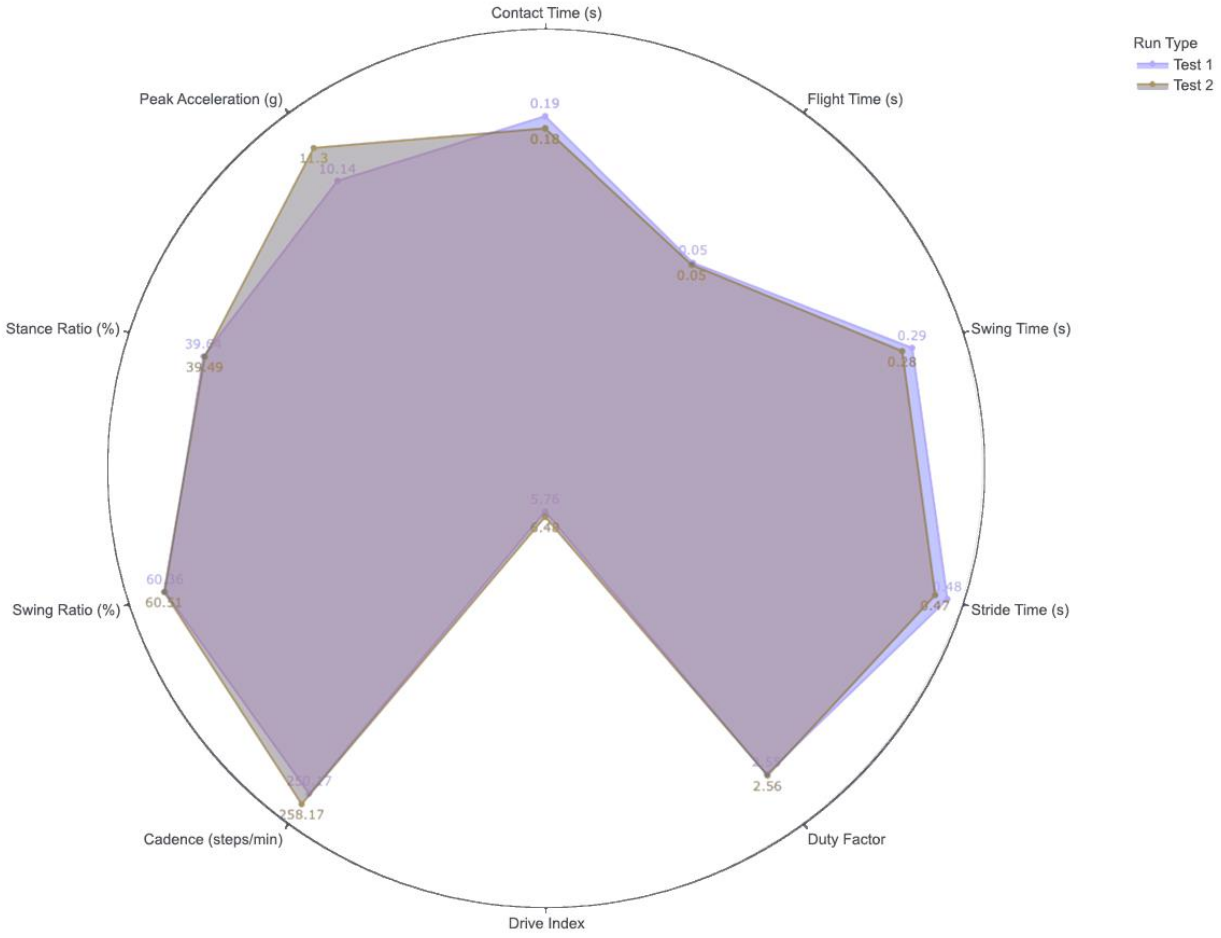
KM:


Contact Time (s)
Flight Time (s)
Swing Time (s)
Stride Time (s)
Duty Factor
Drive Index
Cadence (steps/min)
Swing Ratio (%)
Stance Ratio (%)
Peak Acceleration (g)
Run Type
Test 1
Test 2
0.19
0.18
0.06
0.06
0.3
0.29
0.49
0.47
2.62
2.44
253.35
61.67
38.33
0.16

SH:


Contact Time (s)
Flight Time (s)
Swing Time (s)
Stride Time (s)
Duty Factor
Drive Index
Cadence (steps/min)
Swing Ratio (%)
Stance Ratio (%)
Peak Acceleration (g)
Run Type
Test 1
Test 2
Test 3
Test 4

RU:



While sports technology is integrated throughout performance related outputs today, an individualised approach to early identification of athlete movement strategy, and how it changes on the field of play could be a game changer. Here, DANU helped three athletes, and their practitioners understand their own responses to a high workload by individual limb load, as well as provide meaningful feedback on an injury profile for one of the athletes in a remote environment. The learnings obtained were related to how one assesses field-based athletes who often must sustain chronic load in their season schedules, while not always feeling 100%. If they are a sport that places a heavy demand on running, perhaps an analysis tool that can assess bilateral gait seamlessly could help bridge the gap between injury and adaptations in their sport.

Works Cited

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