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PERFORMANCE INTELLIGENCE
WHITEPAPER SERIES

PAPER SEVEN OF SEVEN · GOLF

The Augmented Golfer

Artificial intelligence across technique, practice, strategy and player development

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About this series

This is the last of seven papers examining how artificial intelligence can be used responsibly in performance sport. Each paper stands alone. Together they set out a single argument, which is that the durable advantage in sport comes from better decisions rather than from more data, and that better decisions require systems designed around the person who is accountable for them.

Golf closes the series because it is the sport with the most measurement and the least continuity, and because its own rules have already answered a question the rest of sport is still arguing about. The flagship paper on governance, *The Responsible Performance System*, supplies the assurance model this paper draws on.

Editorial balance. Roughly seven parts in ten of this document is evidence and sector analysis, two parts in ten is original framework, and one part in ten concerns the Athleet.AI platform itself. Readers who want the argument without the product can stop at Chapter 13.

HOW TO READ THE EVIDENCE TAGS

Every substantive claim in this paper carries a tag stating what kind of evidence supports it. The tags are used consistently across the series.

PEER-REVIEWED A primary study in a peer-reviewed journal.

REVIEW A systematic review or meta-analysis.

CONSENSUS A consensus statement, governing-body position, rule of the game or regulator guidance.

COMMENTARY Methodological criticism, which carries weight without being primary data.

PRACTICE Practitioner opinion, including the author's own.

ATHLEET.AI The author's own framework or analysis, proposed rather than proven.

Where the evidence is thin, the paper says so. In golf it is thin more often than the technology market implies.

Legal, regulatory and rules notice. This paper describes the Rules of Golf, data protection legislation and regulatory guidance, in particular in Chapters 11 and 12. Nothing in this document constitutes legal advice or a ruling on the Rules of Golf. The provision of legal advice sits outside the terms of any engagement with the author or with Athleet.AI, and any question of a player's compliance in competition is a matter for the relevant Committee and for qualified advisers.

Statements about what a source says are attributed to that source. Where the author draws a practical implication the source does not itself state, the text says so. The position described is the position the author was able to verify in April 2026.

ILLUSTRATIVE MATERIAL

Every player, coach, academy and scenario in this paper is invented, and none describes a real player, professional or organisation. Cases are marked **illustrative scenario** wherever they appear. Published research is cited and numbered, and invented material is never presented as evidence.

CITATION

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Comments and corrections are welcome and will be acknowledged in later versions.

ALSO IN THIS SERIES

- **Paper one.** *The Responsible Performance System.* Governance and trust in sports AI.
- **Paper two.** *The Intelligent Track.* AI and event-specific expertise in elite athletics.
- **Paper three.** *Closing the Coaching Gap.* Responsible AI in grassroots athletics.
- **Paper four.** *Casting the Net Wider.* AI as a force multiplier in football pathways.
- **Paper five.** *The Connected Endurance Athlete.* Integrated preparation in triathlon.
- **Paper six.** *The Augmented Touchline.* Responsible AI in elite football.

Contents

A NOTE FROM THE AUTHOR

Twelve numbers and no memory

Stand behind a launch monitor for an hour and you will watch something strange. A player hits 60 shots. Each one produces a dozen numbers, displayed instantly, to two decimal places. At the end of the hour the screen is cleared. The numbers are gone, or they are in a session file nobody will open, and what survives is whatever the player and the professional remember about how it felt.

Golf has more measurement per shot than almost any sport and less continuity than most. That is the gap this paper is about, and it is not closed by adding a thirteenth number.

I came to this paper expecting to write about swing analysis and computer vision, which is where the market's attention is. The evidence sent me somewhere else. There is no systematic review of artificial intelligence in golf coaching. There is no peer-reviewed validation of the launch monitors most amateurs own. There is no published trial showing that the strategy systems sold to golfers lower scores. There is no peer-reviewed literature on any green-reading method, despite one being taught worldwide. And there is no rigorous age-performance curve from more than 20 years of shot-by-shot tour data.

That is an unusual amount of absence for a sport this instrumented, and it changed what I think the useful contribution of software actually is. It is not another model of the swing. It is memory, intention and honest error bars, which are three things golf technology has largely declined to provide.

One further finding surprised me more than any of the science. Golf has already decided, in its own rules, what artificial intelligence may and may not do during a round, and the line it drew is a good one. Chapter 11 sets it out. Every other sport in this series is still arguing about a question golf answered in a rulebook.

Test the citations rather than the author. Every one of them is listed, and every one has been checked twice.

TWO PAGES THAT CIRCULATE ON THEIR OWN

Executive summary

Golf's problem is not a shortage of data. It is that almost none of it accumulates into a picture of a player. Sessions are measured densely and then discarded, devices disagree with one another, and the numbers most confidently displayed are the ones with the weakest published support.

This paper argues that the useful contribution of artificial intelligence in golf is continuity rather than diagnosis. A system earns its place by remembering what a player was working on and why, by comparing them against their own history rather than a model swing, by stating the error on the numbers it reports, and by respecting a line the Rules of Golf have already drawn. It argues equally firmly against several product categories that are currently easy to sell.

1

The Rules already govern this. Data may be recorded during a round for use afterwards. Processing or interpreting information from the current round is not allowed, and using physiological data recorded during the round is prohibited outright.

2

Spin rate is not a basis for a decision. Between-session reliability for spin ranged from 0.02 to 0.60 with a standard error of 241 to 455 revolutions per minute, while clubhead and ball speed were highly reliable.

3

Devices are not interchangeable. Against a reference monitor, a consumer device showed a mean spin bias of up to 1,238 revolutions per minute with an interval from minus 2,628 to plus 5,103.

4

Flexibility and balance show no association with clubhead speed. In meta-analysis, jump impulse was the strongest correlate at 0.82, while flexibility and balance were indistinguishable from zero.

5

Putting is not a stroke problem. Face angle accounts for 80 per cent of stroke direction consistency, and a tour player's stroke variability is good enough to hole about 95 per cent of four-metre putts. In tournaments they hole 17 per cent.

6

There is no systematic review of AI in golf. None exists. Nor is there peer-reviewed validation of any consumer launch monitor, of any green-reading method, or of dispersion-based strategy as a coaching intervention.

What follows for a coach, an academy or a union

Keep the session, not the screen. Every practice session should be recorded with its intention, because a launch monitor number without an intention cannot be interpreted six months later, and most of them are not. Compare a player against their own history. Report error alongside every number that carries one. Measure rounds available, which is countable and which the injury evidence supports.

Refuse four things. No in-round processing or interpretation of data from the round in progress, which the Rules prohibit. No use of physiological data recorded during a round, which they prohibit outright. No model swing presented as a target. And no claim that a swing characteristic causes injury, which no review this paper could verify supports.

Chapter 13 proposes a golf performance intelligence design workshop for an academy, union or technology partner. It begins with what to record and why, which is unglamorous, cheap, and the part everybody has skipped.

PART ONE

Measurement without memory

Three chapters on how good golf's numbers actually are, and on why the sport measures more than any other and remembers less.

CHAPTER ONE

Abundance and discontinuity

Golf produces more measurement per shot than almost any sport and keeps less of it than most. The two facts are connected.

The sport is large and growing. Global participation across the markets a governing body reports on reached 108 million adults and juniors in 2024, an increase of almost three million on the previous year, of whom 43.3 million played on nine and 18-hole courses and 8.4 million were registered golfers. In Great Britain and Ireland the figures were 1,279,010 registered golfers and 5,811,000 playing on nine and 18-hole courses.[1] CONSENSUS This is a sport with scale, money and technology, which makes the discontinuity harder to explain rather than easier.

THE GOLF PERFORMANCE INTELLIGENCE WHEEL

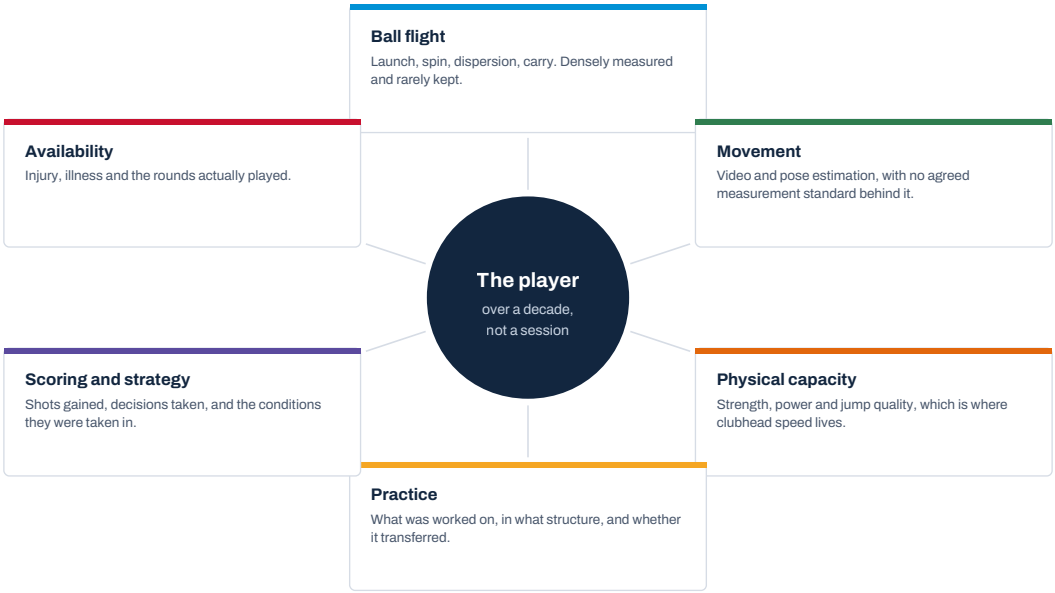

FIGURE 1 Six domains that describe a golfer. Each is measured somewhere. None of them is connected to the others in the systems most players and coaches actually use.

Athleet.AI framework. ATHLEET.AI

1.1 What is actually lost

Three things disappear at the end of a session, and all three are the ones that would matter later. The intention disappears first. A session working on a lower ball flight and a session working on strike quality produce the same 12 numbers, and without the intention neither can be interpreted six months later. The conditions disappear second, which matters more than most players think, because a range session indoors on a mat is not comparable with the same numbers hit outdoors into wind. And the decision disappears third. What the professional and the player agreed to do next is the single most valuable thing produced in that hour, and it is almost never in the same place as the data.

My own view, offered as practice rather than evidence, is that this is a recording problem rather than an analytical one, and that the industry has spent 15 years

solving the wrong half. A launch monitor is an excellent instrument. It is not a memory, and nothing in the market has volunteered to be one.

THE ARGUMENT IN ONE PARAGRAPH

Golf has measurement abundance and continuity scarcity. The useful contribution of artificial intelligence is therefore memory rather than diagnosis, which means recording intention alongside outcome, comparing a player against their own history rather than a model, stating error honestly, and keeping the decision with the record that prompted it. Everything in this paper is either evidence about how good the numbers are, or an argument about what a system should refuse to do with them.

CHAPTER TWO

How good are the numbers

Some of golf's measurements are excellent. One of the most discussed is close to unusable between sessions, and almost nobody is told which is which.

A golfer looking at a launch monitor sees a dozen values presented with identical confidence. The published reliability of those values differs by an order of magnitude, and the differences are not intuitive.

HOW REPEATABLE ARE THE NUMBERS ON THE SCREEN

METRIC	BETWEEN-SESSION RELIABILITY	STANDARD ERROR OF MEASUREMENT	WHAT THAT SUPPORTS
Clubhead speed	0.99	1.6 to 1.7 mph	Trustworthy between sessions
Ball speed	0.97 to 0.99	2.5 to 4.4 mph	Trustworthy between sessions
Carry distance	0.91 to 0.97	7.8 to 14.2 yards	Directional, not decisive
Spin rate	0.02 to 0.60	241 to 455 rpm	Not a basis for a decision

Devices are not interchangeable

Comparing a consumer monitor against a reference device, spin rate showed a mean bias of up to 1,238 revolutions per minute with an interval from minus 2,628 to plus 5,103.

The devices most amateurs own are the least tested

No peer-reviewed validation of any consumer launch monitor was located, and there is no systematic review of launch monitor validity at all.

FIGURE 2 Reliability and measurement error for four commonly used metrics, from indoor testing in high-level golfers across two sessions.

Reference 2. The carry distance error is printed in the source with an evident unit typography error and is reported here in yards. PEER-REVIEWED

2.1 What holds and what does not

Two indoor sessions of ten driver shots in high-level golfers produced excellent between-session reliability for clubhead speed, with an intraclass correlation of 0.99 and a standard error of measurement of 1.6 to 1.7 miles per hour, and for ball speed at 0.97 to 0.99 with an error of 2.5 to 4.4. Carry distance was good at 0.91 to 0.97. Spin rate was the outlier, with reliability from 0.02 to 0.60 and a standard

error of 241 to 455 revolutions per minute, and a significant difference between sessions.[2] PEER-REVIEWED

That last figure deserves a sentence of its own. A player told that their spin has changed by 300 revolutions per minute has been told something within the measurement error of the instrument, presented as a finding. This is the most common false signal in golf coaching and it is entirely avoidable by reporting the error.

Comparing devices makes it worse. A consumer monitor compared against a reference device across 29 youth golfers showed correlations from 0.25 to 0.99, strongest for clubhead and ball speed and worst for spin rate, where the mean bias reached 1,238 revolutions per minute with an interval from minus 2,628 to plus 5,103.[3] PEER-REVIEWED Later work found a consumer device consistent with a reference device while producing systematically different absolute values, with poor absolute agreement for angle of attack, dynamic loft and swing plane.[4] PEER-REVIEWED Consistency and agreement are different properties, and a player moving between a club fitting and a home simulator is relying on the second.

2.2 The gap in the evidence

Two absences should shape how a buyer reads any accuracy claim. There is no systematic review or meta-analysis of launch monitor validity, so all available evidence is individual comparative studies with small samples. And there is no peer-reviewed validation of any consumer launch monitor. Every accuracy assessment of the devices amateurs actually own is vendor material or trade press. The instruments most widely used are the least examined, which is the reverse of what a reader would assume.

NOT THE SAME NUMBER

Two devices can track a player's improvement identically and disagree about what the value is. A number is only comparable to itself on the same device.

SPECIFICATION

What a system should display alongside a number

- Which device produced it, because values are not comparable across devices.
- The measurement error for that metric on that device, where a published figure exists, and a statement that none exists where it does not.
- Whether the change since last time is larger than that error. Most of the time it is not.
- What the player was trying to do, without which none of the above can be interpreted.

CHAPTER THREE

The limits of the perfect swing

The literature does not agree on whether variability helps or hurts, and it does agree that it has no shared way of measuring the swing.

Every swing-analysis product implies a model swing. Some are explicit about it and some hide it in a comparison against a professional. Both rest on an assumption the biomechanics literature does not support as strongly as the market believes.

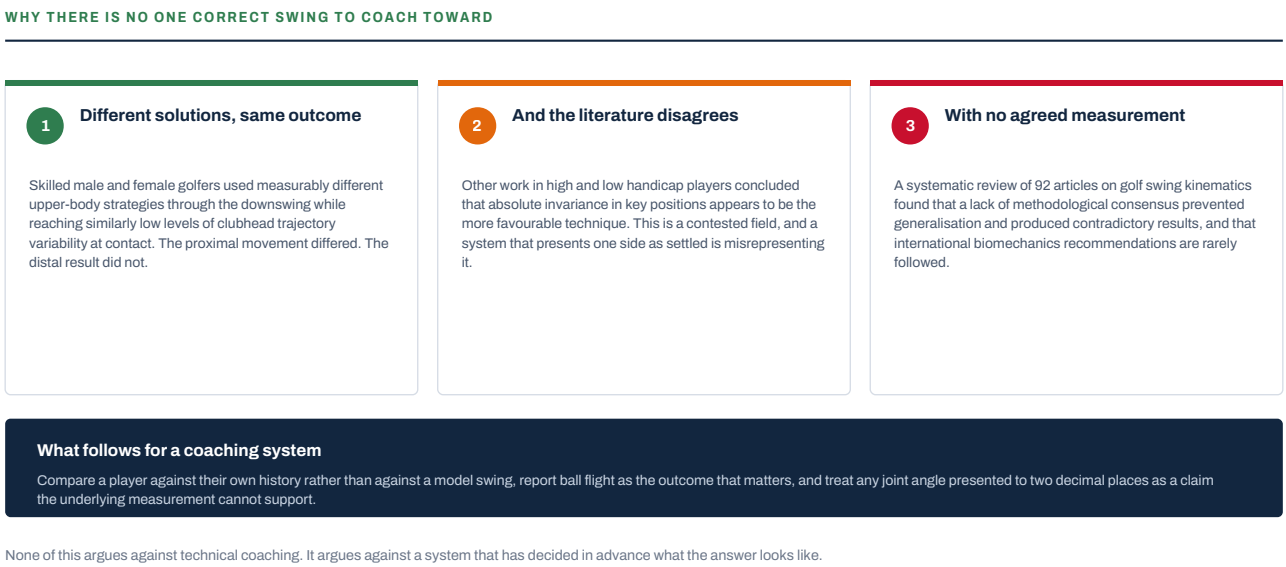

FIGURE 3 Three findings that together argue against a model swing as a coaching target, including the one that argues in the other direction. References 5, 6 and 7. PEER-REVIEWED

3.1 Different solutions, similar outcomes

Three-dimensional data from 19 male and 19 female skilled golfers found that women showed higher thorax and pelvis axial-rotation variability and higher coupling variability at mid-downswing and at contact, while hand and clubhead trajectory variability decreased through the downswing in both groups and reached similarly low levels at ball contact. The authors concluded that the two groups used different upper-body movement strategies while achieving similar clubhead trajectory consistency.[5] PEER-REVIEWED Different proximal solutions, converging on the same distal outcome, is the pattern that undermines a single model.

Honesty requires reporting the other side. Work in high and low handicap players concluded that absolute invariance in the key technical positions appears to be the more favourable technique for skilled performance.[6] PEER-REVIEWED A narrative review of movement variability in the golf swing distinguishes strategic variation from trial-to-trial variability and states plainly that very little is known about the impact of variability on this skill and that the functional and detrimental trade-off has yet to be fully researched.[8] COMMENTARY This is a live argument, not a settled one, and a system presenting either side as established is misrepresenting the field.

3.2 The measurement problem underneath

A systematic review of 92 articles on golf swing kinematics, covering the X-factor, the crunch factor, swing plane and clubhead trajectory, the kinematic sequence and joint angular kinematics, found that a lack of methodological consensus prevented generalisation of the results and led to contradictory findings, and that international biomechanics recommendations are rarely followed.[7] REVIEW That is a serious statement about a field, made by people inside it, and it should be read before any joint angle is accepted as a coaching target.

Markerless capture is where most golf vision products now sit, and the best available evidence on its accuracy in rapid rotation comes from an adjacent sport. Comparing markerless and marker-based capture of baseball pitching across 275 pitches, waveform similarity was high at 0.88 to 0.97, while discrete measurement

biases ranged from zero to 16 degrees, standard deviations of the between-system differences ranged from zero to 14 degrees, and reliability ranged from 0.64 to 0.92. The authors recommended that normative ranges be established separately for each system.[9] PEER-REVIEWED A bias of up to 16 degrees is decisive against treating a markerless joint angle as a coaching target, and golf's rotation is at least as fast.

Golf-specific vision work exists and is instructive rather than conclusive. Single-camera markerless analysis of 27 golfers found that forward tilt angle stability discriminated proficiency, while club trajectory did not and instead separated players into two groups, behaving as an individual characteristic rather than a skill marker.[10] PEER-REVIEWED That is a small study and a useful one, because it found a variable everybody coaches to be a matter of individual style.

WHAT THIS RULES OUT

No comparison against a model swing presented as a target. No joint angle reported to a precision the underlying method cannot support. No cross-system comparison of angles without stating that the systems produce different values. A system may legitimately compare a player against their own earlier swing on the same equipment, which is the only comparison the measurement evidence supports.

CHAPTER FOUR

From range session to development plan

The practice principles that sound most scientific are the ones whose evidence is weakest in the field. That is a reason for humility rather than for ignoring them.

Golf coaching has absorbed a set of motor learning principles, chiefly that varied practice beats blocked practice for retention, and it now sees them delivered by software as prescribed ratios. The underlying evidence is more modest than the confidence.

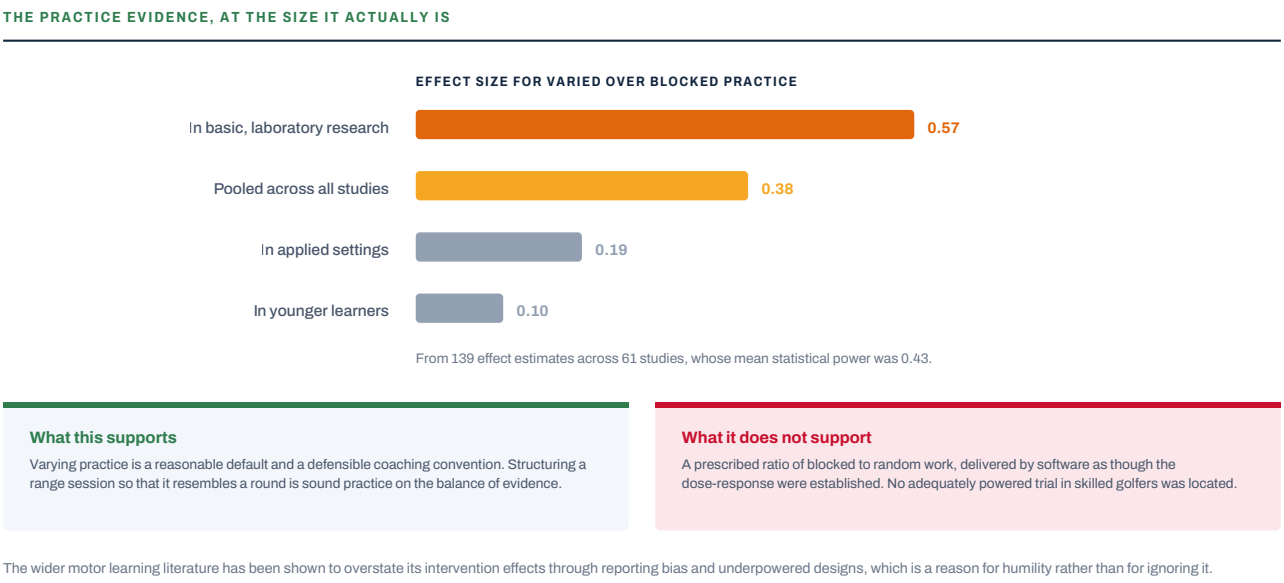

FIGURE 4 Effect sizes for varied over blocked practice, by setting. The applied effect is a third of the laboratory effect.

Reference 11. REVIEW

4.1 What the meta-analysis found

A meta-analysis of 139 effect estimates from 61 studies found an average effect of 0.38 for contextual interference. Basic, laboratory-based research produced 0.57 and applied research 0.19, a significant difference. Adults produced 0.50 and younger learners 0.10, also significant. The mean statistical power of the reviewed studies was 0.43.[11] REVIEW An effect that shrinks by two thirds when it leaves the laboratory, derived from studies with less than half the power they needed, is a reasonable working assumption and not a dose-response model.

The golf-specific evidence is thinner still. Novice golfers practising putting under blocked, random or progressively increasing schedules showed superior retention in the increasing-interference group, which is a genuinely useful finding about progression.[12] PEER-REVIEWED They were novices. I searched for an adequately powered trial of contextual interference in skilled golfers and found none.

The wider methodological picture argues for caution rather than dismissal. A meta-analysis has shown that reporting bias combined with underpowered designs substantially exaggerated the motor learning benefits claimed for self-controlled practice and enhanced expectancies.[13] COMMENTARY The same literature that gave golf coaching its practice principles has been shown to overstate its own effects. That is worth knowing before a product prescribes a ratio.

4.2 The feedback question

A closely related argument concerns how often a player should see a number. The guidance hypothesis holds that frequent augmented feedback improves performance during practice while degrading retention, because learners become dependent on it and neglect their own error detection.[14] COMMENTARY It is a 42-year-old idea, it is theoretically well motivated, and the argument against constant metric feedback in golf rests on it.

I have to report that the direct test does not support it. A golf putting study of 56 participants comparing full and reduced feedback frequency found effects that were not statistically significant and trivially small, and stated that the results

were inconsistent with the guidance hypothesis.[15] PEER-REVIEWED A study in a different task found that more feedback produced better retention than less.[16] PEER-REVIEWED I could not locate a meta-analysis of feedback frequency or a systematic review of video feedback in sport.

My own position, offered as practice and not as a finding, is that a system should still be capable of showing less. The reason is not that the guidance effect is proven. It is that a player who can only tell whether a shot was good by looking at a screen has lost something a coach spent years building, and the cost of being cautious here is low.

ILLUSTRATIVE SCENARIO

The session that could not be reviewed

An invented elite amateur has 40 launch monitor sessions saved across a winter. In March her coach tries to work out whether the technical change they made in November has held. The files contain every number and no intentions. Of the 40, 11 were on a mat indoors and nine were outdoors, and nothing records which. Four were played after a gym session, which she remembers and the record does not. The coach can see that the average spin has fallen by 280 revolutions per minute, which is inside the measurement error, and can see nothing that would let them tell whether the change worked. The data is complete and the season is unreviewable.

CHAPTER FIVE

Course strategy and decision quality

Expected-value strategy is the most intellectually satisfying idea in modern golf and the one with the thinnest published support.

Strokes gained changed how golf thinks about performance, and it did so on a peer-reviewed foundation. Applying the method to shot-level tour data established that long-game shots explain about two thirds of the scoring variability among tour professionals.[17] PEER-REVIEWED That is a real finding from a real dataset, and it is the baseline every expected-value argument in golf depends on.

What follows from it in practice is where the evidence stops. The amateur baselines that make strokes gained usable for a club player exist in a trade book and in commercial products rather than in the literature.[18] COMMENTARY The strategy systems sold to golfers on the basis of dispersion and expected value have no peer-reviewed literature at all. And no published trial shows that teaching dispersion-based target selection lowers scores.

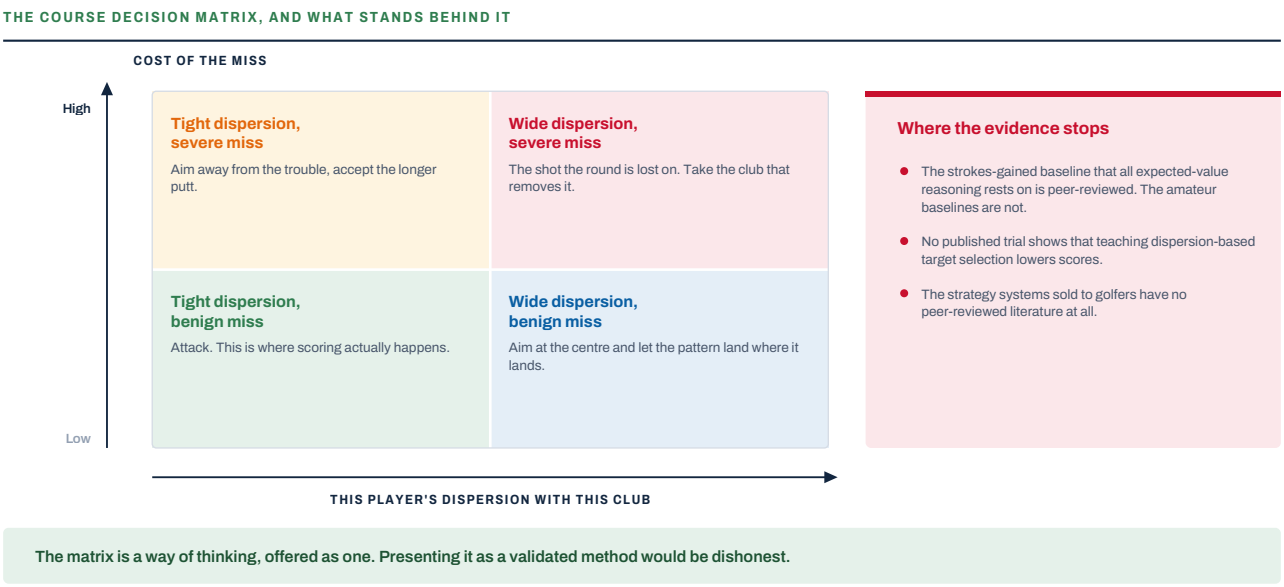

FIGURE 5 A way of thinking about target selection, offered as a framework rather than a validated method, with the evidence limits stated alongside it.

Athleet.AI framework, resting on reference 17 for the expected-strokes baseline. ATHLEET.AI

5.1 What is defensible and what is not

Three claims can be made honestly. Shots are distributed rather than aimed, so a target is a distribution rather than a point. The cost of a miss varies enormously across a course, and that variation is knowable in advance. And most golfers do not know their own dispersion with any club, which is a measurement problem software is genuinely well suited to solving.

Two claims cannot. That a particular aggressiveness rule lowers scores, which has not been tested. And that a system can compute the optimal target for a shot, which requires an amateur baseline the literature does not contain and conditions the system does not know. Note also that computing a club recommendation from shots hit in the round in progress is prohibited by the Rules, which Chapter 11 sets out.

There is a further reason for humility. Analysis of tour scoring found that a substantial share of round-to-round variation is noise rather than skill.[19] PEER-REVIEWED A strategy system evaluated over a handful of rounds is being judged mostly on chance, and so is the player evaluating it.

THE HONEST PRODUCT

Measure this player's actual dispersion, which almost nobody knows. That is a real contribution. Prescribing what to do about it is not yet supported.

CHAPTER SIX

What actually moves clubhead speed

This is the best-evidenced chapter in the paper, and its central finding contradicts what most golfers spend their preparation time on.

Physical preparation in golf has moved from novelty to normal in 20 years, and the evidence base has moved with it. This is the one area where a golfer can be given a clear, meta-analysed answer.

FIGURE 6 Pooled associations between physical characteristics and clubhead speed, with confidence intervals, from 20 studies.

Reference 20. Values are pooled transformed correlations. REVIEW

6.1 The findings

A systematic review with meta-analysis screening 3,039 records and including 20 studies found clubhead speed most strongly associated with jump impulse at 0.82, upper-body explosive strength at 0.67, jumping peak power at 0.66 and jump displacement at 0.53, with upper and lower-body strength at 0.48 and 0.47 and anthropometry at 0.43. Flexibility, at minus 0.04, and balance, at minus 0.06, were not significant.[20] REVIEW An earlier meta-analysis found the same shape, with upper-body power at 0.51 and flexibility at 0.03 and trivially small.[21] REVIEW

Two meta-analyses agreeing that flexibility and balance have no detectable association with clubhead speed is about as clear as this literature gets, and it is the opposite of how most golfers allocate their preparation time. I should be careful here. Flexibility may matter for other reasons, including comfort, injury and the ability to achieve a position a coach is asking for. What it does not appear to do is produce speed.

The intervention evidence agrees. A systematic review of 25 studies found average increases in clubhead speed, ball speed and distance measures of 4 to 6.4 per cent where findings were significant.[22] REVIEW A separate review of 20 studies

found combined non-specific and golf-specific training produced a mean 4.1 per cent increase in clubhead speed and 5.2 per cent in hitting distance, with non-specific strength training alone producing 1.6 and 4.8 per cent, and eight-week programmes with golf-specific movements at high velocity being most effective.[23] REVIEW

6.2 What a system should do with this

Very little, and that is the point. This is settled enough to be a recommendation rather than a model. A system that holds jump testing alongside launch monitor data, and shows a player the relationship in their own record, is doing something useful. A system that predicts a clubhead speed gain from a training block is doing something the evidence does not support at individual level, since these are pooled associations rather than individual predictions.

Sex-specific claims deserve their own source rather than an assumption, and a systematic review with meta-analysis of physical training and performance in female players exists for that purpose.[24] REVIEW The series' flagship paper sets out why subgroup performance should be reported or declared unknown, and golf is better placed than most sports to do it.

CHAPTER SEVEN

Putting, and the misallocation of effort

One study from 2008 explains most of what putting technology gets wrong, and it has been available the whole time.

Putting is the most heavily instrumented part of golf relative to its difficulty, and the instruments overwhelmingly measure the stroke. The evidence says the stroke is not the problem.

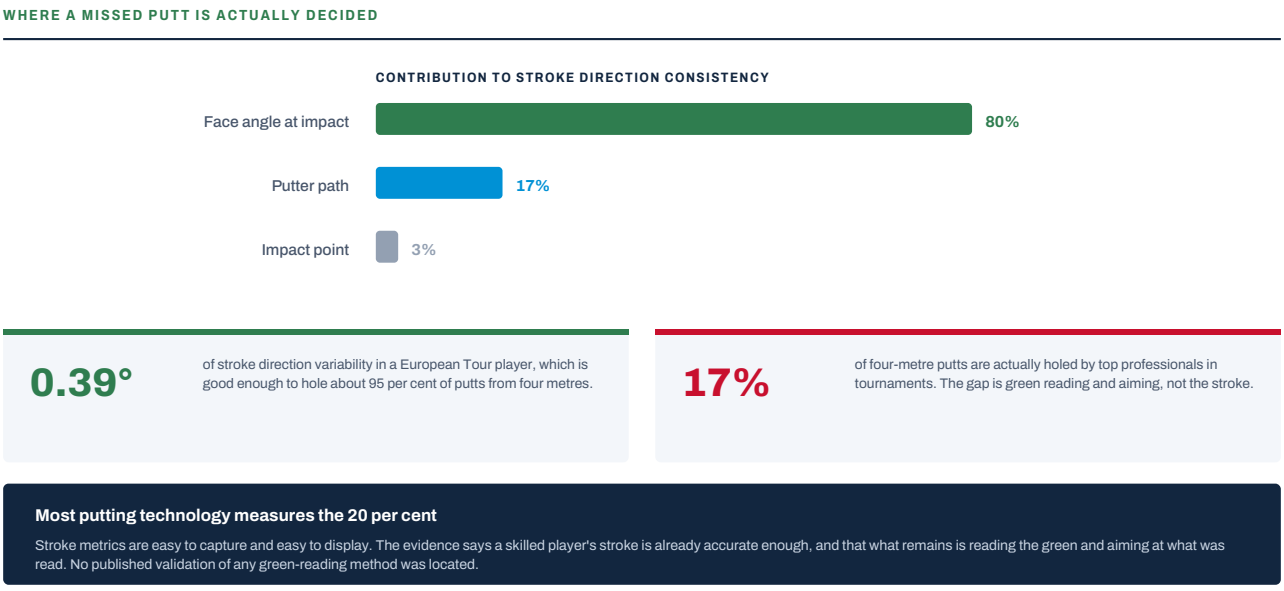

FIGURE 7 Contributions to stroke direction consistency, and the gap between what a tour stroke could hole and what tour players actually hole. Reference 25. PEER-REVIEWED

7.1 The finding

Kinematic stroke parameters from 71 elite golfers across 1,301 putts from about four metres established that of the factors determining stroke direction consistency, face angle accounted for 80 per cent, putter path 17 per cent and impact point 3 per cent. Mean stroke direction variability for a European Tour player was 0.39 degrees, which is good enough to hole about 95 per cent of all four-metre putts. In tournaments, top professionals hole about 17 per cent of putts from that distance.[25] PEER-REVIEWED

Read those two numbers together. A tour player's stroke is accurate enough to hole nearly every four-metre putt, and they hole one in six. The difference is not the stroke. It is reading the green and aiming the face at what was read, and almost none of the technology sold into putting addresses either.

The associated work on distance control points the same way, examining the role of green reading in distance variability among highly skilled players.[26] PEER-REVIEWED Work on expert gaze behaviour during green reading shows there is more to it than looking at the line.[27] PEER-REVIEWED

7.2 What is missing

Two absences are worth stating. There is no peer-reviewed publication of make-percentage curves by distance. The tables in general circulation come from tour statistics and from a trade book, which are legitimate commercial sources and not literature, and a system quoting them should say so. And there is no peer-reviewed literature on any green-reading method, including the method taught most widely to amateurs. A technique taught worldwide, for the part of putting that the evidence says actually matters, has no published validation at all.

My own view is that this is the clearest example in golf of technology following what is easy to measure rather than what determines the outcome. A device that tells a player their path was two degrees out has measured something real and largely irrelevant. What the player needed was to know that they read the putt with half a cup too little break, and nothing on the market reliably tells them that.

80%

FACE ANGLE

The share of stroke direction consistency attributable to face angle at impact. Putter path accounts for 17 per cent and impact point for three.

CHAPTER EIGHT

Injury, availability and career durability

Golf agreed how to count injuries in 2020. Almost everything published before that counted differently, and it shows.

The injury evidence in golf improved sharply once the sport agreed a method. An international consensus statement on recording and reporting epidemiological data on injuries and illnesses in golf was published in 2020.[28] CONSENSUS Reading the literature before and after that date is reading two different fields.

FIGURE 8 What the recent evidence reports, and the boundary between what it supports and what it does not.

References 29, 30, 31 and 32. REVIEW

8.1 The numbers

A systematic review and meta-analysis of 20 studies covering 9,221 golfers found lifetime injury prevalence of 73.5 per cent in professionals against 56.6 per cent in amateurs, a relative risk of 1.50. Professionals had a significantly greater lifetime prevalence of hand and wrist injury at a relative risk of 3.33 and of lower back injury at 3.05. Injury frequency was not associated with age or sex.[29] REVIEW

A season-long prospective study of 910 amateur golfers, with weekly monitoring across five months, found injury prevalence of 11.3 per cent and an incidence of 3.79 injuries per golfer per year. The highest burden by site was the lumbosacral spine at 5.93 time-loss days per player per year, followed by the shoulder at 3.47 and the knee at 2.08. Risk was higher with increasing age, osteoarthritis and previous injury.[30] PEER-REVIEWED A United Kingdom sample of 303 golfers reported an overall incidence of 41.26 injuries per 1,000 hours, with the lower back most frequent at 9.94 and a mean time loss of 54 days.[31] PEER-REVIEWED A separate meta-analysis of exposure-based incidence found 2.5 injuries per 1,000 rounds overall.[32] REVIEW

8.2 What is not supported

The claim that a particular swing characteristic causes lumbar injury is repeated constantly in golf coaching and is not supported by any review this paper was able to verify. The systematic review of golf kinematics treats the relevant measure as one of five domains across 92 papers and concludes that methodological heterogeneity prevents generalisation.[7] REVIEW A system that flags a swing characteristic as an injury risk is making a causal claim the literature does not carry.

Career durability is thinner still. Work on age and winning in professional golf found peak winning ages of 35 on one leading tour and 30 on another, from a five-year window and using wins rather than performance.[33] PEER-REVIEWED That is a narrow basis for a claim about careers. Shot-level tour data has been collected since 2003 and no rigorous longitudinal age-performance curve derived from it appears in the peer-reviewed literature, which is a striking gap in a sport that prides itself on analytics.

WHAT THIS RULES OUT

No individual injury prediction, for the reasons the flagship paper sets out. No attribution of injury risk to a swing characteristic. No health inference from a wearable during a round, which the Rules prohibit in any case. What a system may legitimately do is count rounds played, record where discomfort appears, and notice when volume rises faster than it has before, presenting each as a prompt rather than a diagnosis.

CHAPTER NINE

The coach and player relationship

The professional's most valuable asset is a decade of judgement about one player, and it is stored in the least reliable medium available.

A golf professional working with the same player over ten years accumulates something no launch monitor holds. They know which technical changes this player can absorb in season and which cannot be attempted before November. They know that the miss goes right under pressure and left when tired. They know what the player says when a change has actually landed, as opposed to when they are being polite. None of that is written down, and when the relationship ends it is gone.

This is the application of artificial intelligence in golf that I would build first, and it is the least demonstrable. A system that captures why a decision was made, in the professional's own words, at the time it was made, produces the institutional memory that no swing model ever will. It requires no computer vision, no prediction and no model of anything. It requires a habit and a place to put the record.

9.1 Asynchronous coaching, which is where the volume is

Most coaching contact in golf now happens between lessons rather than during them, through video sent from a phone. That is a genuine expansion of access and a genuine risk. A professional reviewing a swing video on a Tuesday evening has less context than they would on the range, and the temptation for software to supply the missing context with an automatic analysis is considerable.

My own view, offered as practice, is that the correct role for a system in asynchronous coaching is preparation rather than opinion. It should assemble what the professional would otherwise have to remember, being the last three sessions, what was agreed, what the player reported and what the numbers did, and then stop. The judgement is the professional's, and a system that offers one has replaced the part of the relationship the player is paying for.

SPECIFICATION

Four requirements for a coaching system in golf

- **Intention is captured with every session.** One line, in the coach's or player's words, at the time.
- **Comparison is against this player's own history.** Not a model, and not another player.
- **Error is stated.** A change smaller than the measurement error is reported as no change.

- **The decision is recorded separately from the analysis.** What was agreed, by whom, on what date.

CHAPTER TEN

The developing golfer

Golf has no pathway research of its own, and it has a general consensus it is largely ignoring.

The general position on youth athletic development is well established. An international consensus statement sets it out, and a systematic review of specialisation in young athletes concludes that for most sports there is no evidence that intense training and specialisation before puberty are necessary to achieve elite status, while identifying higher injury rates, increased psychological stress and early dropout among the risks. Its recommendation is that intense single-sport training to the exclusion of others be delayed until late adolescence.[34,35] CONSENSUS

Golf has no evidence of its own to set against that. I searched for golf-specific early specialisation or talent pathway research meeting review standard and found none. A sport with academies, national squads and a well-funded junior structure is operating on general consensus alone, which is worth stating plainly to the people running those structures.

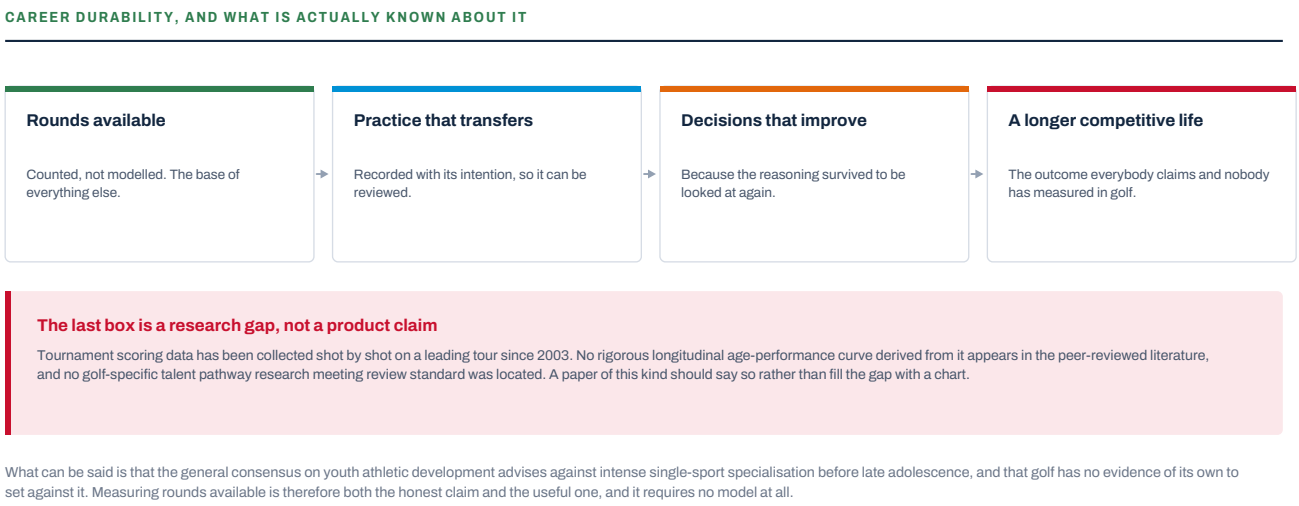

FIGURE 9 The chain a golf programme can audit, and the point at which the published evidence runs out.

Athleet.AI framework. References 33, 34 and 35 support the statements about age and specialisation. ATHLEET.AI

10.1 What follows for a junior system

The flagship paper in this series sets out the four lines that apply to any system touching young people, and they apply here without modification. No score attached to a child. No ranking of children by predicted adult potential. No system communicating with a child without an adult in the loop. No profiling

without a completed impact assessment that considers the child's interests specifically.

The legal position has moved recently and a junior programme should know it. Section 81 of the Data (Use and Access) Act 2025 inserted children's higher protection matters into the data protection by design provisions of the UK General Data Protection Regulation, and came into force on 5 February 2026 alongside section 80 on automated decision-making.[36] CONSENSUS The Children's Code itself remained the 2020 text, with its 15 standards including the best interests of the child, impact assessments, data minimisation and restrictions on profiling.[37] CONSENSUS A club or academy taking video of juniors and holding launch monitor records against their names is processing children's data whether or not it thinks of itself that way.

ILLUSTRATIVE SCENARIO

The junior ranking nobody meant to build

An invented county academy adopts a launch monitor and a video platform for its under-16 squad. Nobody decides to rank the children. The platform, quite reasonably, sorts the squad by clubhead speed on its default screen. Within a season the list has acquired authority. Parents ask where their child sits on it. A selection conversation in March refers to it. Nobody has made a decision to rank children by a physical characteristic that is substantially determined by maturation, and the academy is doing it anyway, on a default sort order that a supplier chose.

CHAPTER ELEVEN

What the Rules already decide

Golf has answered the question the rest of sport is arguing about, and it answered it in a rulebook rather than a policy document.

This is the shortest chapter in the paper and the one I would most like technology companies to read. The Rules of Golf contain a provision on the use of equipment during a round, and it draws a line that maps almost exactly onto the argument this series has been making across six previous papers.

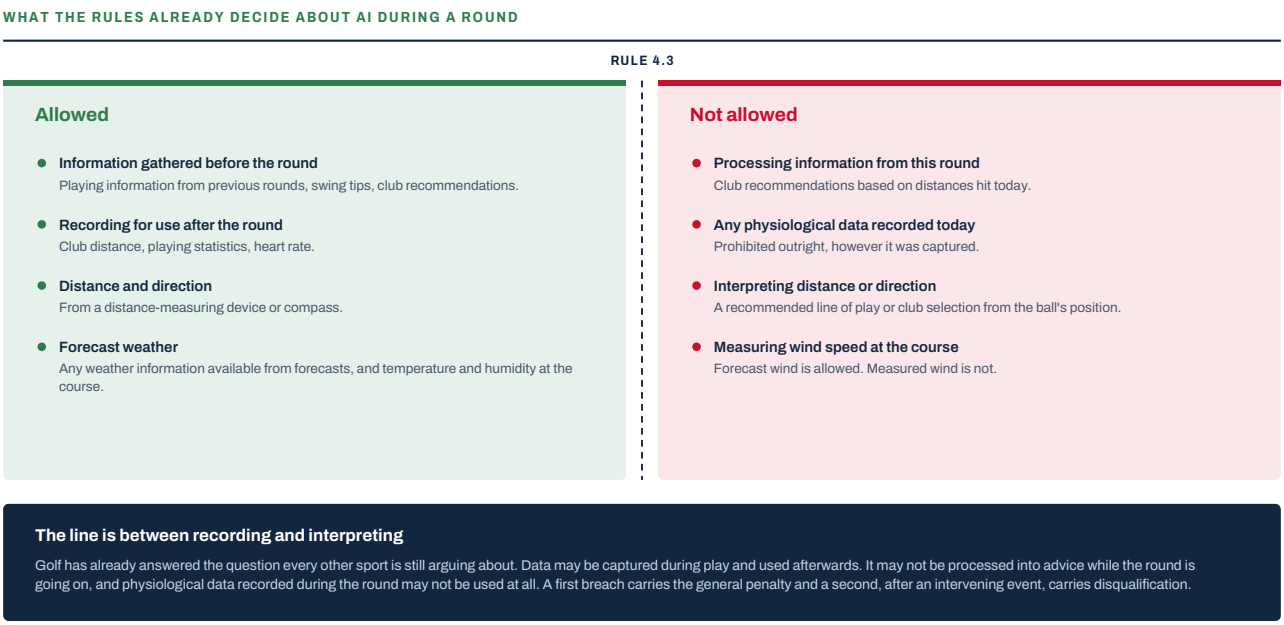

FIGURE 10 The line the Rules draw between recording and interpreting, as set out in Rule 4.3.

Reference 38. Wording condensed from the published Rule; the Rule itself is the authority and any question of compliance is a matter for the Committee. CONSENSUS

11.1 The provision

The general test in Rule 4.3a is that a player may use equipment to help their play, except that they must not create a potential advantage by using equipment that artificially eliminates or reduces the need for a skill or judgement essential to the challenge of the game, or by using equipment in an abnormal way in making a stroke.[38] CONSENSUS

The provision that governs artificial intelligence is Rule 4.3a(3), on information gathered before or during the round. It allows using information gathered before the round, including playing information from previous rounds, swing tips and club recommendations, and it allows recording playing or physiological information from the round for use after it. It does not allow processing or interpreting playing information from the round, giving the example of club recommendations based on distances hit in the current round, and it does not allow using any physiological information recorded during the round.[38] CONSENSUS A first breach of Rule 4.3 carries the general penalty. A second carries disqualification, provided an intervening event has occurred since the first.

Related provisions matter for anyone building a product. Getting distance or direction from a device is allowed, while interpreting it into a recommended line of play or club selection is not. Forecast weather including wind speed is allowed, while measuring wind speed at the course is not. Audio and video on matters unrelated to the competition are allowed, while audio to help with swing tempo is not.[38] CONSENSUS

11.2 Why this is a good line

I found no published guidance from either governing body specifically addressing artificial intelligence during play, and the position therefore rests entirely on Rule 4.3a(3). That is worth saying because it means the rule was not written with these products in mind and covers them anyway, which is a sign that the distinction it draws is a durable one.

The line is between recording and interpreting. Capture what happened, and use it afterwards to get better. Do not have a machine make the judgement while the judgement is the point of the exercise. Every other paper in this series argues for that distinction from evidence about model performance and human accountability. Golf arrived at it from the nature of the game, which is a different route to the same place, and the coincidence is worth pausing on.

WHAT THIS RULES OUT

An artificial intelligence caddie that computes a club recommendation from shots hit in the round in progress. Any use of heart rate or other physiological data captured during the round. An application that interprets a rangefinder reading into a suggested line. These are not risky product decisions. They are prohibited by the Rules for competition play, and a supplier who has not checked should do so before building, rather than after a player is disqualified.

CHAPTER TWELVE

Data ownership and reference architecture

A golfer typically owns the devices, pays the subscriptions and cannot take the record anywhere.

Golf's data ownership question has a feature that distinguishes it from team sport. The player usually bought the equipment. An elite amateur has typically paid for the launch monitor time, the video subscription, the wearable and the lessons, and it surprises most of them to learn how little of the resulting record they can take with them when they change professional or platform.

12.1 What exists elsewhere and not here

Professional football has a charter of player data rights setting out eight rights over performance and personal data, covering information, access, revocation, restriction, portability, rectification, complaint and erasure.[39] CONSENSUS It has no binding force, and on my reading it largely restates rights that data protection law already provides, but it exists and golf has no equivalent. The academic literature is thinner still. The best available anchor identifies five areas of concern in biometric monitoring in professional sport, being the validity and interpretation of data, surveillance and privacy, confidentiality and security, conflicts of interest and coercion, and notes the technologies remain largely unregulated and unexamined.[40] PEER-REVIEWED I found no published academic work specifically on golfers' launch monitor or wearable data rights.

The four positions the flagship paper asks any organisation to write down apply here. Who is the controller and who is the processor. Whether a supplier may train models on player data. What a player receives on request and in what format. And what happens to a decade of records when the relationship ends. None of the four requires new law, and none of the four is standard practice in golf technology.

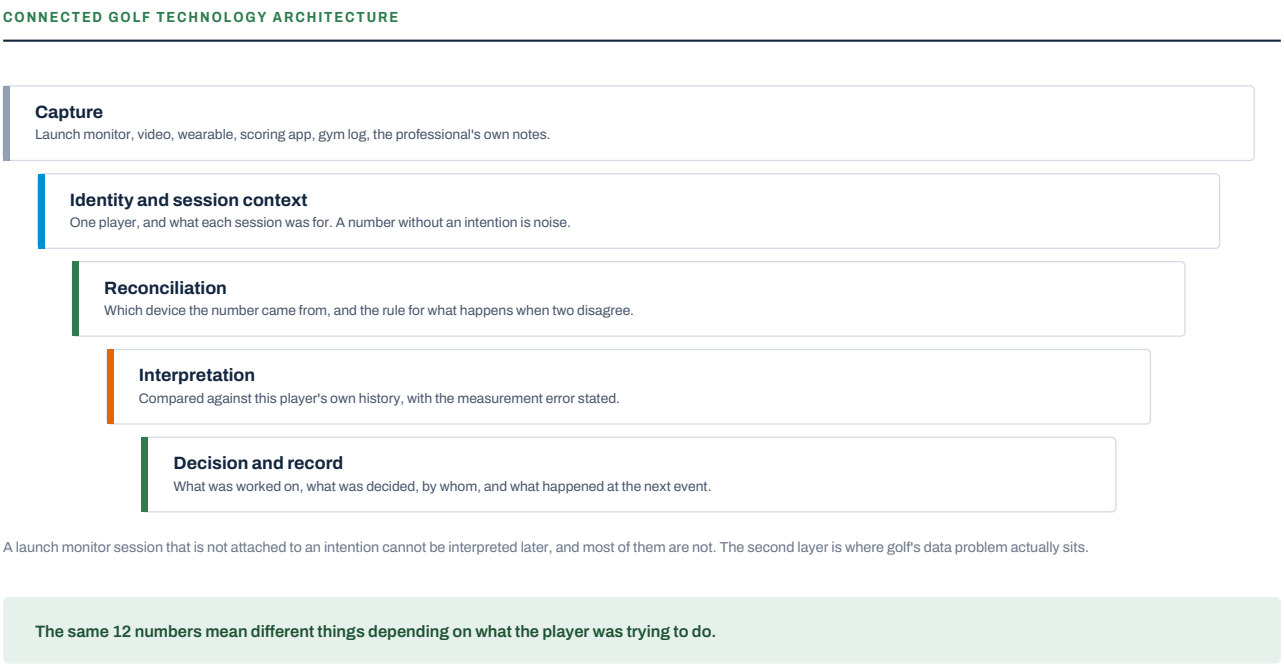

FIGURE 11 Five layers, of which the second is where golf's particular problem sits. A number without an intention cannot be interpreted later. Athleet.AI framework. ATHLEET.AI

12.2 The layer golf gets wrong

Every sport in this series has a reconciliation problem. Golf has that and a second one that is more specific, which is session context. A launch monitor file records what happened and not what the player was trying to do, and the same 12 numbers mean different things depending on the intention behind them. Chapter 4 gives the example of a winter's sessions that could not be reviewed, and the cause was not missing data. It was missing intention.

Fixing it costs one line of text per session and no technology at all. That is the least impressive recommendation in this paper and, on my own experience, the one most likely to change what a coach can do in March.

12.3 The regulatory position, briefly

For completeness, and because a technology partner will ask. Sections 80 and 81 of the Data (Use and Access) Act 2025 came into force on 5 February 2026, replacing Article 22 of the UK General Data Protection Regulation with new provisions on automated decision-making and inserting children's higher protection matters into the data protection by design provisions.[36] CONSENSUS The European Union's Artificial Intelligence Act entered into force in August 2024 and applies in stages, with general application from 2 August 2026 and product-embedded high-risk systems a year later. A simplification package proposed by the Commission in November 2025 had not been adopted when this paper was written and remained a legislative proposal, so the original timetable stood.[41] CONSENSUS A club or academy relying on a particular date should verify it against the current official position rather than against this paper.

CHAPTER THIRTEEN

The intelligent player-development environment

What to adopt, in what order, and what to measure. The first step costs nothing and is the one everybody skips.

The adoption sequence that follows from this paper is deliberately unimpressive, which is the point. Golf has spent 20 years buying instruments and has not yet built a memory.

13.1 The sequence

First, record intention with every session. One line, at the time, in the player's or professional's own words. Nothing else in this list works without it. Second, record the conditions, because indoor mat numbers and outdoor numbers are not the same numbers. Third, attach measurement error to every metric that has a published one, and say plainly where none exists. Fourth, compare the player only against their own history on the same equipment. Fifth, record the decision separately from the analysis, with a name and a date. Sixth, and only sixth, consider anything predictive, and expect to conclude that the first five have already delivered most of the value.

13.2 What to measure

Rounds available is the headline, for the reasons Chapter 8 sets out and for the reasons the flagship paper argues across every sport in this series. Alongside it, two process measures that tell an academy whether the system is being used rather than owned. The proportion of sessions carrying a recorded intention, which should approach all of them within a season. And the proportion of technical changes that can be traced from decision to outcome six months later, which starts near zero everywhere and is the clearest single indicator of whether a programme has acquired a memory.

13.3 What good looks like in three years

A player who can see why they were asked to do something in November and what happened as a result. A professional who inherits a player with a record rather than a folder of video files. An academy that can say what it changed and whether it worked, rather than what it bought. And a set of numbers on a screen that are markedly less confident than they used to be, because each one now carries an honest statement of what it can and cannot tell you.

That is a modest description of progress in a sport that has been sold something far more exciting for two decades. It is also, on the evidence assembled here, most of what is actually available.

A launch monitor is an excellent instrument. It is not a memory, and nothing in the market has volunteered to be one.

CHAPTER ONE

END MATTER

Coach and academy checklist

Eighteen items. The first four cost nothing and deliver most of the value.

- [ ] **Every session carries an intention**
  One line, recorded at the time, in the player's or professional's words.
- [ ] **Conditions are recorded**
  Indoor or outdoor, mat or turf, wind. Otherwise the numbers are not comparable.
- [ ] **The device is recorded with the number**
  Values are not comparable across launch monitors.
- [ ] **Decisions are recorded separately from analysis**
  What was agreed, by whom, on what date.
- [ ] **Measurement error is displayed**
  Where a published figure exists, and stated as absent where it does not.
- [ ] **Spin rate changes are treated with suspicion**
  Between-session error can exceed 400 revolutions per minute.
- [ ] **No model swing is presented as a target**
  Comparison is against this player's own history.
- [ ] **Joint angles carry the method's uncertainty**
  Markerless bias in rapid rotation has been reported up to 16 degrees.
- [ ] **Physical testing includes jump measures**
  Jump impulse is the strongest published correlate of clubhead speed.
- [ ] **Flexibility work is justified on its own terms**
  It shows no association with clubhead speed in two meta-analyses.
- [ ] **Putting practice addresses reading and aiming**
  Face angle accounts for 80 per cent of direction consistency.
- [ ] **Dispersion is measured before strategy is prescribed**
  Most players do not know their own, and the prescriptions are untested.
- [ ] **No injury risk is attributed to a swing characteristic**
  No review this paper could verify supports the claim.
- [ ] **Rounds available is counted and reported**
  Ahead of any predictive output.
- [ ] **In-round features are checked against Rule 4.3**
  Processing information from the round in progress is not allowed.
- [ ] **No physiological data recorded during a round is used**
  Prohibited outright, however it was captured.
- [ ] **No child is scored or ranked**
  And no default sort order is allowed to become one.
- [ ] **A player can take their record with them**
  In a usable format, including the derived record.

END MATTER

Glossary

Angle of attack
The vertical direction of clubhead travel at impact. One of the metrics with the poorest absolute agreement between devices.

Contextual interference
The effect by which varied practice produces worse performance during practice and better retention afterwards. Laboratory-strong and field-weak.

Crunch factor

A combined measure of lateral bending and axial rotation of the trunk, widely linked to lumbar injury without a review this paper could verify.

Dispersion

The distribution of outcomes for a given club and player, rather than the intended target. The quantity most golfers do not know about themselves.

Guidance hypothesis

The proposal that frequent augmented feedback aids performance and harms retention. Long-standing, plausible, and not supported by the one golf test located.

Intraclass correlation

A measure of consistency between repeated measurements. Reported here for between-session reliability of launch monitor metrics.

Kinematic sequence

The order and timing of segment accelerations through the swing. Measured without an agreed methodological standard across the literature.

Markerless motion capture

Estimating body position from video without physical markers. Similar in pattern to marker-based systems and not interchangeable in absolute values.

Standard error of measurement

The typical error attached to a single measurement. The figure that determines whether a change is real.

Strokes gained

The difference between a shot's outcome and the expected number of strokes from where it started, against a baseline. Peer-reviewed at tour level.

X-factor

The separation between thorax and pelvis rotation. One of five kinematic domains a systematic review found could not be generalised across studies.

END MATTER

Method and evidence grading

How the sources in this paper were selected, checked and graded, and what the reader should distrust.

Sources were gathered from the peer-reviewed literature, consensus statements, the Rules of Golf, primary legislation and governing-body statistical publications, with priority given to systematic reviews, meta-analyses and methodological criticism over single primary studies. Every reference in the list that follows was checked against the publishing journal, publisher or issuing body, and then checked a second time by an independent process against the same sources.

What could not be verified

Nine things were searched for and not found, and the pattern of absence shapes this paper more than any single finding. No systematic, scoping or critical review of artificial intelligence or machine learning in golf coaching. No peer-reviewed validation of any consumer launch monitor, and no systematic review of launch monitor validity at all. No peer-reviewed test of whether tour-derived strokes-gained baselines transfer to amateur play. No published trial showing that dispersion-based target selection lowers scores. No peer-reviewed literature on any green-reading method. No peer-reviewed publication of make-percentage curves by distance. No golf-specific early specialisation or pathway research meeting review standard. No rigorous longitudinal age-performance curve from more than two decades of shot-level tour data. And no published guidance from either governing body specifically addressing artificial intelligence during play, so the position in Chapter 11 rests entirely on the Rule itself.

Several sources are cited with limitations recorded here. The launch monitor metrology study is cited for its conclusions rather than for per-parameter error mag-

nitudes, which its abstract does not publish. The variability review is cited for its conceptual distinction rather than for numbers, which it does not contain. The meta-analysis of reporting bias in motor learning is cited for its conclusion rather than for its corrected effect sizes. And the participation figures are governing-body statistics rather than peer-reviewed data, and are labelled as such.

What to distrust in this paper

Three things. The performance intelligence wheel in Chapter 1, the course decision matrix in Chapter 5 and the architecture in Chapter 12 are the author's own frameworks, proposed rather than validated. The decision matrix in particular is a way of thinking rather than a tested method, and the figure says so on its face. The condensation of Rule 4.3 in Chapter 11 is the author's summary and not a ruling; the Rule itself is the authority and any question of compliance is for the relevant Committee. And the argument against constant metric feedback in Chapter 4 is a precautionary position, offered as such, against a direct golf test that found no effect.

Conflict of interest

The author is the founder of Athleet.AI, which builds software in the area this paper examines. The paper recommends against several product categories that would be commercially straightforward to build for golf, including two that are already on sale. Readers should weigh the argument accordingly. Test the citations rather than the author.

One conflict in the cited literature is worth repeating. The author group of the clubhead speed meta-analysis includes affiliations with several golf governing bodies and tours, which is declared in the paper and does not appear to have affected its conclusions.

END MATTER

About the author

Paul Forrest is the founder and Chief AI Officer of Athleet.AI. He works with organisations on the deployment of artificial intelligence, having begun in business process reengineering in the 1990s and moved into natural language and machine learning work from 2014, building small, domain-specific models in preference to general-purpose ones.

He is a qualified athletics coach, holding level three qualifications in sprints, hurdles and endurance, and he coaches as a volunteer at club level. That combination of enterprise systems work and time on a track is the reason this series exists, and it is also the reason the papers decline to recommend several things that would be straightforward to sell.

He is the author of *Tales from AI Development Hell* and *AI Made the Decision: Who Answers When Nobody Owns the Outcome?*, and holds an adjunct professorship teaching digital acumen and digital entrepreneurship. This is the final paper in the series.

END MATTER

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Rules, rights and regulation

1. **Data (Use and Access) Act 2025** (c. 18), sections 80 and 81. Section 80 replaces Article 22 of the UK GDPR with new provisions on automated decision-making; section 81 inserts children's higher protection matters into Article 25. Both commenced 5 February 2026 by S.I. 2026/82 (C. 10), made 29 January 2026.

2. **Information Commissioner's Office** (2020). *Age Appropriate Design. A Code of Practice for Online Services.* Wilmslow, ICO. Laid before Parliament 11 June 2020; in force 2 September 2020. The code document remained the 2020 text at the date of this paper.

3. **The R&A and United States Golf Association** (2023). *The Rules of Golf*, Rule 4.3, Use of Equipment. Effective 1 January 2023. Rule 4.3a and its provisions on distance and directional information, weather, information gathered before or during the round, and audio and video.

4. **FIFPRO** (2022). *Charter of Player Data Rights.* Hoofddorp, FIFPRO. Launched 19 September 2022 and developed with FIFA, setting out eight rights over performance and personal data. Cited as an analogue; golf has no equivalent.

5. **Karkazis, K., & Fishman, J. R.** (2017). Tracking U.S. professional athletes. The ethics of biometric technologies. *The American Journal of Bioethics*, 17(1), 45–60. doi:10.1080/15265161.2016.1251633

6. **European Parliament and Council of the European Union** (2024). Regulation (EU) 2024/1689 laying down harmonised rules on artificial intelligence (Artificial Intelligence Act). *Official Journal of the European Union*, OJ L, 2024/1689, 12 July 2024. Article 113 staged application. The Commission's simplification proposal of November 2025 had not been adopted at the date of this paper.

WHERE THIS GOES NEXT

A golf performance intelligence design workshop

The argument in this paper is testable, and the cheapest way to test it is to start recording intention and conditions with every session for one squad, for one winter, and see what becomes reviewable in March that was not reviewable last year. That costs nothing but a habit, and in my experience it changes more than any purchase.

Athleet.AI runs design workshops with academies, unions, coaching businesses and technology partners. The output is a recording standard the organisation owns, an error position for every metric in use, a rules position for anything intended to operate during play, and a measurement baseline. It is not a product demonstration.

What a workshop involves

- Two sessions with the professionals who actually coach, not only with the people who buy the software.
- A recording standard covering intention, conditions and device for every session.
- An error position for every metric in use, including the honest entries where no published figure exists.
- A rules review of any feature intended to operate during a round, against Rule 4.3.
- A baseline for rounds available and for the proportion of sessions carrying a recorded intention.