MEASURING DRAW SHOT BOWLING ACCURACY

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Limitations of Game Scores as Performance Indicators

Post-Game Analysis of Score Cards

Competitive bowls performances are not quantifiable by measuring, weighing or timing like they are in sports like jumping, weight lifting or swimming. Thus, improvements in bowling accuracy over time or comparisons between individuals are difficult to quantify where event scorecards are the main yardsticks. Winning performances in bowls are relative. The winner has the greater accumulation of points awarded after intermediate passages of play (ends) according to the number of bowls closer to the jack than any bowls of the opponent. Form of bowlers changes over time, so results of games (even against the same opponent) are inconclusive indicators of improvement.

Club selectors have a need for data on individual performances in trial and pennant fixture games. Coaches also could make effective use of such data. One of the problems in collecting it, especially considering that the performance of a side is the aggregate of several separate games, is that it is so time and labour-intensive.

Forms of feedback that provide data are the official scorecards of each game. Scorecards do not indicate who played well, but at least they indicate whether a team got away to a good start, and whether they faded, or sustained their effort to the end. Another form of feedback that selectors can seek is the subjective opinion of managers and players as to who played well and who did not. This form of feedback gives also some indication of team motivation and cohesion. Selectors should crosscheck subjective opinions to minimise mistaken observations or personal bias. They should collect this type of feedback as soon after the completion of a game as possible while details are fresh in the minds of the observers.

Consistency Singles

'Consistency' singles is a popular game in many clubs. Typically, it requires bowlers to draw to a jack to earn 4 points for the closest bowl. The second closest bowl earns 3 points. The third closest bowl earns 2 points. The fourth closest bowl earns 1 point. Other bowls do not score. Why the game has the name 'consistency' is a mystery. Accuracy is far more decisive than consistency in determining the outcome of a game.

As a performance indicator, consistency has most of the disadvantages of normal game scoring. Close bowls may not score if other bowls are closer to the jack, and wayward bowls can score if there are no close bowls to beat.

'Lead's Scorecard'

A form of feedback occasionally worth considering is a lead's scorecard (see below), so-called because the lead is the only player in a fours team with enough time to maintain it without detriment to other playing responsibilities. In the example below, the focus of interest is the "We" team comprising White (lead), Large (2nd), Driver (3rd), and Jack (skip). If the game were an intra-club pennant trial, interest would also focus on the individuals in the "They" team.

End	We				They			
	Lead	2nd	3rd	Skip	Lead	2nd	3rd	Skip
1	-	-	-	-	1	1	1	2
2	2	3	4	4	-	-	-	-
3	-	-	-	-	2	2	3	1
4	-	1	1	2	1	-	-	-
5	1	2	1	1	-	-	-	-
6	-	-	-	1	1	1	2	–
7	2	-	1	2	-	1	-	-
8	-	-	-	-	2	1	2	3
9	-	-	-	-	2	3	4	5
10	2	4	2	3	-	-	-	-
11	2	2	2	-	-	-	-	1
12	1	1	1	-	-	-	-	1
13	2	2	1	1	-	-	-	-
14	2	2	-	-	-	-	1	1
15	2	3	3	4	-	-	-	-
16	2	3	4	2	-	-	-	-
17	-	1	-	1	2	-	3	–
18	-	-	-	-	2	4	4	3

19	-	-	-	-	2	4	4	3
20	1	-	-	-	-	1	1	1
21	2	4	6	6	-	-	-	-
22	-	-	-	1	2	2	3	–
23	-	2	2	3	1	-	-	-
24	-	1	-	1	2	-	2	-
25	-	-	1	1	2	2	-	-
Adds	21	31	29	33	22	22	30	21
Lead	S.White				V.Black			
2nd	V. Large				A.Small			
3rd	A. Driver				A.Bowler			
Skip	K.Jack				B.Pegg			

On the first end, the "We" team was down a shot after leads had played. It remained one shot down after both second and third players had played. It was down two shots after skips had played and the result of the end determined accordingly. White recorded all this on line 1 of the card. On the second end, The "We" team was up two shots after White had played. It was three shots up after Large had played. It was four shots up after Driver had played. It was still four shots up after the skips had played, and the result of the second end determined accordingly. White recorded all this on line 2 of the card, and used the same routine to record subsequent ends. Where the measured result of an end disclosed an error in recorded interim scores, White correspondingly altered them. The skip (Jack) helped White's task by signalling the interim score after each player in turn had played both bowls.

Analysis For "WE" Team

Line		**Lead**	**Second**	**Third**	**Skip**
1	Scores for, after turn	21	31	29	33
2	Scores against, after turn	22	22	30	21
3	Net scores, after turn	-1	+9	-1	+12
4	Less net score before turn	n/a	-1	+9	–1
5	Contribution to team score	-1	+10	-10	+13

Leads or selectors insert column totals for the "We" team in Line 1 of the following analysis, and for the "They" team in Line 2. They complete Line 3 by subtracting each total in Line 2 from the corresponding total in Line 1. This produces an unadjusted value for each player's contribution. Line 4 is simply the accumulated surplus or deficiency inherited from the previous player which when added to Line 3 produces in Line 5 the adjusted contribution of each player.

The analysis for the "We" team indicates that the skip and the second scored well, the third player did not, and the leads were evenly matched. However, such conclusions may be somewhat misleading. For example, the second player or skip may have encountered a particularly weak or 'out of form' opponent. The third player may have contributed to the good result of the skip, by playing numerous position bowls that did not directly contribute to the score. Over the course of several games however, aberrations tend to disappear. If Black kept a corresponding card for the "They" team, periodic cross checking should disclose any recording errors.

Such a scorecard is adaptable to triples games. However, like the scorecards of any game, a lead’s scorecard has limited usefulness as an indicator of accuracy or other aspects of performance.

Broad Measures of Bowling Accuracy

Nature of performance in games

Typical objectives in the course of a game include delivering:

- a jack or bowl as nearly as possible a particular distance along the rink,
- a bowl on a particular line to impact with one or more stationary bowls in the head, and
- a bowl so that it comes to rest as nearly as possible to a particular position in the head

Outline of an Accuracy Test of Jack Rolling

Leads should be reliable in delivering the jack to an indicated distance. This is conventional wisdom, but no benchmarks are known to exist. Inaccuracy in jack delivery might be symptomatic of corresponding bowling inaccuracy

This test involves measuring the accuracy achieved in delivering 32 jacks. Task requirements assume use of a typical rink approximately 38 m ditch to ditch. Direction of jack delivery reverses after 8th, 16th and 24th deliveries. After each jack delivered comes to rest, a scorer centres it, then measures and records the distance between the indicated distance and the distance actually achieved. Test completion time is saved if distance indicators such as chalk marks, golf tees etc, are available. Scorers should place an aiming object on the indicator at the required distance from the front ditch, and remove it once each jack is in course.

A specimen score sheet appears below. Players should position the mat at the specified mark near the rear ditch, and scorers should position the aiming marker at the specified distance near the front ditch as shown on the sheet. The (centred) distance markers for positioning of the mat and indicating run distance objective are as follows:

- 'T' marks. 2 metres from the front and rear ditches.
- 'M' (Middle) marks. 4 metres (5 ordinary paces) in from each 'T'.
- 'C' (Central) marks. 8 metres (10 ordinary paces) in from each 'T'

Delivery Number	Mat Posn.	Objective Posn.	Distance (approx)	Measured Distances						
				1-8	9-16	17-24	25-32			
1, 9,17,25	T	M	29 m							
2,10,18,26	T	T	34 m							
3,11,19,27	M	M	25 m							
4,12,20,28	T	T	34 m							
5,13,21,29	C	M	21 m							
6,14,22,30	M	T	29 m							
7,16,23,31	M	C	21 m							
8,16,24,32	C	T	25 m							
									÷ 32	

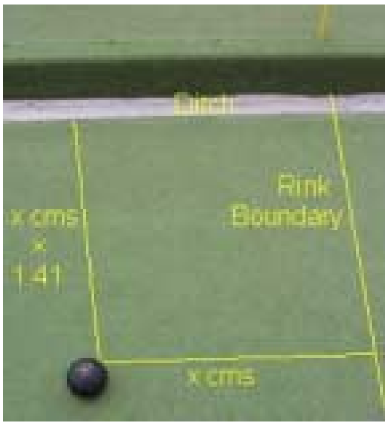
With one or two bowlers per rink, about 30 – 40 minutes per player is the average time to complete the test. Scorers average the results of all 32 deliveries to obtain an average (distance) error. If desired, a scorer may also identify errors short and errors long to determine the net error. (However, the net error is not the average error. For example, if errors long total 12 metres and errors short total 20 metres, the net error is 8m (difference) ÷ 32 (deliveries)= 25 cm short, but the average error is 32m (sum) ÷ 32 = 1.0 metre.)

Tasks for testing bowl delivery accuracy

Draw shots aimed at finishing as close to the jack as possible typically constitute at least 80% of all deliveries in competitive play. Therefore, most testing involves measuring the accuracy of both length and line as represented in draw shot placements. Routines that exercise accuracy of both line and length involve delivering bowls that will come to rest either in a designated target area, or as nearly as possible to an object position. Averaging the frequency with which bowls come to rest within an area of standardised dimensions is a broad measure of accuracy of bowling into a target. The area of the target affects the degree of difficulty of the test task. The section below headed '40-bowl accuracy test' discusses testing that involves measurement of the distances between a jack and the positions reached by bowls.

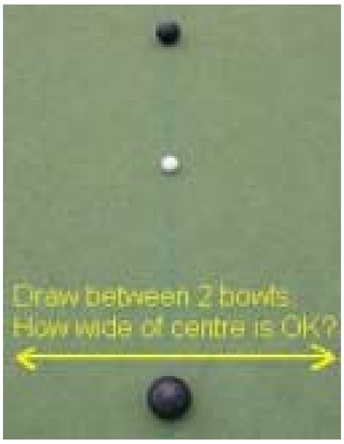
Interpretation of test results

A sample of measurements of how nearly a bowler achieves delivery tasks under test conditions allows reasonably reliable inferences to be drawn about the accuracy of performances and current level of skill. Periodic measurements of bowlers' draw shot accuracy enable the setting of individual benchmarks. Such benchmarks are useful for evaluating individual improvement over time.



Typical distribution of results

In games of bowls, heads are typically longer than they are wide. Bowls delivered towards a jack or other destination near the opposite end of the rink tend to come to rest in an elliptical zone, the longitudinal axis of which is about 40% (i.e. $\sqrt{2} - 1$) greater than



its crosswise axis. This is the statistical outcome of delivery speed errors combined with delivery line errors. A method of constructing an elliptical target zone appears on page 14.

A target zone that is about 40% longer than it is wide effectively gives equal weight to line errors and delivery speed errors. Any sideways error (eg missed wresting attempt) is directly proportional to the delivery line error. However, a lengthwise error (eg error in jack roll distance) is proportional to the square of the delivery speed error. Thus, length errors tend to be greater than sideways errors.

The layout on the left is an example of a target zone. Its length is 40% greater than its width, so it tests delivery speed and line accuracy fairly equally. The ditch and the boundary alignment define its limits on two sides. A single bowl indicates the alignment of the remaining sides.

Target zones that are separated from the boundary require additional markers for designating their limits. Pegged tapes or marked lines sometimes make better markers than jacks or bowls. Bowlers are at a distinct disadvantage if target zone boundaries are indistinct or ill-defined like the task in the image on the right.

'Scoring Zone' as a Target

The scoring zone is the area, typically of about one square metre, around the jack that normally encloses most, if not all, of the bowls lying at rest in scoring positions. During competition, players can visualise a scoring zone of a size appropriate to their level of skill. A pattern for construction of a practice scoring zone is appended at page 13. Bowlers of novice or intermediate standard should contemplate a larger size of scoring zone related to their current level of skill. The following image shows a chalked scoring zone formed by outlining a template. The base is nearest the ditch, and the 'apex' points toward the mat.

Target Zone Choices

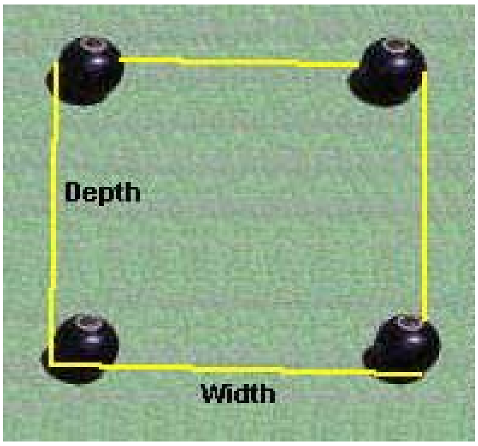
Performing tasks that are more 'line' than 'length' practices include: drawing through an isolated bowl or jack, drawing to the centre line, drawing to a side boundary line, or drawing to between markers or bowls aligned lengthwise. Ways of increasing the degree of difficulty of the exercise include leaving the delivered jack uncentred, changing the hand of play more frequently, narrowing the defined scoring zone, or practicing in a variable cross wind. Averaging of sideways error distances is a measure of accuracy. Any penalties applicable (eg for missed impacts, bowls finishing out of bounds, etc) can significantly change the object of an exercise, and need clarifying at the outset. The fluctuations in recorded measurements are indicators of technical consistency

Routines that are more 'length' than 'line' practices include: delivering jacks to indicated lengths; drawing bowls to an imaginary crosswise 'line' (e.g. 2 m from ditch), or to a crosswise alignment indicated by bowls or other markers; or drawing bowls to the plinth (edge of the ditch). Ways of increasing the degree of difficulty of the exercise include: requiring successive deliveries to incrementing or decrementing lengths, changing objective distance substantially and frequently, increasing average 'end' length, setting the objective near the front ditch, shortening the defined scoring zone, or practicing in a variable head or tail wind. Averaging of lengthwise error distances is a measure of accuracy. Any penalties applicable (eg for distance errors that exceed imposed limits, loss of bowl in the ditch, etc) can significantly change the object of an exercise, and need clarifying at the outset. The fluctuations in recorded measurements are indicators of technical consistency.

Simultaneous practice of accurate delivery line and speed is the most common mode of practice. Practice procedures that produce measured results tend to be of greater benefit. Routines that challenge both line and length accuracy include: drawing to a visible, hidden or ditched jack, to a receiving or covering position, or to a blocking position - although effective blocking often challenges the accuracy of line more than length. Reducing the area of the scoring zone, and varying the hand of play, end length, etc frequently can increase the degree of difficulty. The nature of the scoring system, or practicing while fatigued, or in the presence of actual or simulated distractions can likewise increase difficulty. Practising in adverse environmental conditions (e.g. slow green, strong wind, etc) likely during a forthcoming competition also increases difficulty.

Measures of Bowling Consistency

Margin for Error Test



Some Australian clubs have used a 'margin for error' test for several years. To begin the process, candidates complete their usual 'warm up'. The test does not require use of a jack. The tester specifies the forehand and backhand aiming references. Candidates deliver all of their four bowls in a specified direction and at a speed sufficient to enable them to run a medium distance. The object is to minimise the separations of the finishing points of the bowls by optimising the consistency of the delivery movement. Candidates should not attempt correction of delivery line or release speed.

After four bowls delivered to the forehand side come to rest, measurement of the width and depth of a rectangle that would enclose them follows. The same procedure repeats for four backhand deliveries. The average of the two widths and two depths is the 'margin for error' for the eight deliveries. Inconsistent results produce large values that warrant checking for inconsistent or faulty technique.

Possible Adaptations of the Test

The merit of combining forehand and backhand consistencies is not obvious. Some bowlers vary their delivery action according to their hand of play, and separated 'margins for error' may have greater value.

Four deliveries on each hand is rather a small sample for drawing reliable conclusions. However, bowls may be rolled back towards the delivery zone by helpers after marking the finishing position of each bowl. That procedure would enable a greater number of deliveries, and thus more reliable averaging.

Turns in the margin for error test do not alternate as in the tempo of a normal game. Consequently, the challenge to short term memory of the 'feel' of the delivery movement is appreciably less in the test compared with normal game play. Margin for error testing may be organised so that it follows normal game tempo, but recorded results should indicate the testing method used, and be evaluated accordingly.

Consistency is a factor of accuracy. Bowlers typically improve accuracy through practice over time. Improvement in consistency normally accompanies improvements in accuracy. Practice routines primarily for improvement of consistency are not in general use. In any case, accuracy routines adequately yield improvements in consistency also, and are of wider general value.

40-Bowl Accuracy Test

Recommended Method

The method of measuring draw shot accuracy advocated here is not new. As practice bowls come to rest, the method simply involves measuring the distance of each to the jack. Measured draw shot errors during practice (preferably under conditions that simulate competition) when compared with individual benchmarks indicate improvement in draw shot accuracy. That comparison also allows some inferences about likely competency at faster deliveries. Even novices are occasionally able to position a bowl against the jack. Even a champion is unlikely to be able to better such bowls. However, bowling accuracy depends on low average error for all shots, not on an average error that omits the results of wayward shots. The main inconvenience of this method is that measuring and recording the result of each bowl takes 10-20 seconds. Then, totalling and averaging at the end of the test takes another minute or two.

Procedure

Group Organization. Bowlers work in pairs, a pair to each rink. That arrangement enables completion of the test within about 60 minutes.

Order of Play. After a few warm up ends, each bowler proceeds by delivering all four bowls. On ends 1 to 5, the first two bowls are forehands and the last two bowls are backhands. On ends 6 to 10 the first two bowls are backhands and the last two bowls are forehands. This sequence enables valid comparison between forehand and backhand accuracy.

While one bowler is at the mat delivering four bowls, the other bowler measures, records results and kicks measured bowls clear.

Number of Ends. The test involves playing of 40 draw shots: 20 forehands and 20 backhands in 10 ends. Each bracket of ends (1 to 5 and 6 to 10) comprises three ends of medium length, one end of maximum length, and one end of minimum length. There is no need to deliver the jack at any stage. For ease of setting up the rink, bowlers simply centralise the jack at the specified point. For a minimum length end the mat is on the 2-metre mark and the jack is at the 23-metre alignment, or vice versa. For a maximum length end, the mat and jack are at opposite two metre marks. For a medium length end the mat is on the inner end of the chalk line and the jack is at the centre of the opposite chalk line, or vice versa.

Special Occurrences If the jack moves, the measurer replaces it before measuring. Measurers record no result for any bowl delivered on the wrong bias. They return the bowl for re-delivery. If a bowl on the correct bias comes to rest out of bounds, the measurer records the actual distance between it and the jack. If a bowl comes to rest in the ditch, the measurer adds 0.5 metres to the distance to the point where it entered the ditch. That extra distance is an arbitrary value of the overrun.

Recording. A calibrated rod or a flexible tape measure is suitable for measuring.

A suitable form for recording of measurements for each bowler is appended at page 15, and is as follows:

Player Name:

	End →	1	2	3	4	5	
	Length→	M	S	M	L	M	
	Mat→	C	I	E	T	C	Row
Hand ↓	Jack→	E	T	C	T	E	Totals
Fore→	Bowl 1→						F_1
Fore→	Bowl 2→						F_2
Back→	Bowl 3→						B_1
Back→	Bowl 4→						B_2
	Totals						1-5

	6	7	8	9	10	
	M	S	M	L	M	
	C	T	E	T	C	Row
Hand ↓	E	I	C	T	E	Totals
Back→						B_3
Back→						B_4
Fore→						F_3
Fore→						F_4
						6-10

C=Centred, 4 m from ditch, E=Centred, 6 m from ditch, I=Centred opp. 23 m mark, L=Long, M=Medium, S=Short, T=2m mark

Rating of Overall Accuracy

The mean overall error is the aggregate of the 10 column totals divided by 40 (the total number of deliveries measured). Since the early-1990s, hundreds of Queensland bowlers representing all levels of bowling skill have undertaken the test. The median results they have achieved are as follows:

Group Description	Average Error
Novice, pre-pennant	1.5 - 3 m
Pennant - 5th division	~1.5m
Pennant - 4th division	~1.4m
Pennant - 3rd division	~1.3m
Pennant - 2nd division	~1.2m

Pennant - 1st division	~1.1m
Junior State Squad	~1.1m
State Development Squad	~0.95m
Junior State Singles Rep	~0.9m
State Squad	~0.75m
State Singles Representative	~0.55m

Variable winds or slick greens may adversely affect test results. Deferment of testing if the wind is gusting and continually changing direction should be an option. However, results on the day tend to be affected more by the form, focus and feelings of the participating bowlers than by environmental variables.

Particularly for the initial ends, the individual results of the first test ever undertaken by bowlers are often affected by the distraction of coming to terms with an alien procedure. Some candidates seek to undertake a second test as soon as possible so that they obtain starting benchmarks in which they have confidence. Bowlers that subsequently undertake training programs are able to repeat the testing procedure from time to time and obtain measures of their improvement. Intervals between tests might typically be 6 to 8 weeks. Such intervals are long enough for sustainable improvements to have occurred. They are short enough to provide regular progress indicators, to identify any pauses in improvement, and to enable detection of any aberrations in test results.

Forehand and Backhand Error

The total of forehand rows F1 + F2 + F3 + F4 is the aggregate error of the 20 forehand deliveries. Therefore, average forehand error is the total divided by 20. Similarly the mean backhand error is B1 + B2 + B3 + B4 divided by 20.

Random mean error differences from test to test between the 20 forehands and 20 backhands are unlikely to be of concern. However, superiority in the accuracy of one hand of play could limit shot selection options. Any necessary technique refinements and subsequent practice should focus on the less accurate bowl delivery hand of play.

Starting Slowly or 'Fading'

A useful comparison is the mean error of the first twenty deliveries (totals of columns 1 to 5, divided by 20), with the error for the last twenty deliveries (totals of columns 6 to 10, divided by 20). The test should be preceded by a couple of trial ends to enable candidates to warm up and assess the environmental conditions. A bowler's first attempt at the 40-bowl test typically results in a greater error for the first five ends than for the last five ends. Subsequent tests typically produce a much smaller improvement in accuracy the last 5 ends. Initial unfamiliarity with the process is then no longer a factor, and only the task of assimilating the conditions of the playing surface remains.

A large difference in error for the first five ends compared with the second five ends warrants attention. A bowler might fail to warm up properly, take some time to focus undistractedly on the task or to establish appropriate delivery line and length. For whatever reason, the results suggest a 'slow starter'. Conversely, a bowler might tire, sustain injury or discomfort, lose concentration, develop anxiety, or fail to notice changes in playing conditions. For whatever reason, the results suggest a 'tapering off' or a 'bolter'.

Excessive Reliance on Corrections

In each of the ten ends, the hand of play changes before the third delivery. Therefore, just as delivery 2 is an opportunity for bowlers to improve on the result of delivery 1; on the opposite hand, delivery 4 is an opportunity for bowlers to improve on the result of delivery 3.

Some bowlers take insufficient care with the first of each pair of deliveries. They tend to use the first delivery as a 'sighter' and the second delivery as a 'correction'. They place excessive reliance on the correcting capability of their second delivery. Elite-level bowlers take care to achieve the tactical objective with every delivery. When they achieve it with their first delivery, their second delivery becomes a bonus.

Thus, another useful comparison is the mean error of deliveries 1 and 3 (total 10 ends x 2 = 20 deliveries) with that of deliveries 2 and 4 (also 20 deliveries). The total of rows F1 + B1 + B3 + F3 is the aggregate error of the 20 "first" deliveries. Therefore average "first" delivery error is that total divided by 20. Similarly the mean "second" delivery error is the total of rows F2 + B2 + B4 + B4 divided by 20.

Typically, there is marginal improvement in the mean error of "second" deliveries. However, there may be excessive reliance on "second" deliveries if their mean accuracy is disproportionately better than that of "first" deliveries. Where the mean accuracy of "first" deliveries is significantly better than that of "second" deliveries, there is a possibility that each carefully executed and reasonably successful first attempt is followed by feelings of release of pressure and a more relaxed but less disciplined second delivery.

Consistency

Consistency' is the opposite of inconsistency. Inconsistency is a measure of bowl 'scatter' around the jack. The larger the scatter, the less consistent is the performance. For example, consider a case of bowlers A and B, in which the first half dozen measured errors of Bowler A might be 1.0M, 0.1M, 1.5M, 0.0M, 2.2M, and 0.6M. Those of Bowler B might be 1.0M, 0.9M, 0.8M, 1.1M, 0.7M, and 0.9M. A and B each has an average error of 0.9M, i.e. 90 cm. A brief examination of the results shows that Bowler B's results are fairly consistent, whereas Bowler A's results are highly variable, even though A got three bowls (2nd, 4th and 6th) closer to the jack than B managed to get with any attempts.

Appended at page 16 is a method for determining consistency from measured errors in accuracy.

Automatic calculation of consistency, in addition to all the averages defined above, occurs by keying the recorded test measurements into the table at 'http://home.austarnet.com.au/coaching/result40.html'. Offline, a prepared spreadsheet is useful for calculating averages, standard deviations and consistency factors. The only task then remaining on each occasion is keying in the measured error for each test delivery. The computer calculates test results, virtually instantaneously. If a computer is not available and the tested group is not large, a pocket calculator may be an acceptable alternative.

The method involves use of a work sheet for entering error distances, calculating their standard deviation, and deriving consistency expressed as a percentage. The standard deviation is a measure of inconsistency of a bowler's errors. In the previous case, A's calculated standard deviation (or probable error) is 77 cm, and B's is only 13 cm. A's consistency factor is 37%, which is fair to poor and warrants diagnosis. By reducing bad deliveries (e.g. #5 = 2.2 m), A would not only become more consistent, but also reduce average error, thereby becoming more accurate than bowler B. B's consistency factor is 93%, which would be exceptional - anything over 70% is extremely good.

Inconsistency at the 'head' is commonly caused by inconsistency in a bowler's delivery action on the mat. When bowlers produce consistency results less than 40%, they and their mentors (possibly aided by a camcorder and a VCR with slow-speed replay) should analyse every phase of the delivery movement in an effort to spot occasional departures from grooved technique. Elimination of those variations could yield not only greater consistency, but also reduced mean error, i.e. improved bowling accuracy. A checklist for identifying variations in technique might include the following:

- Is the delivery process rushed?
- Does the bowler follow a routine for getting set on the mat?
- Does the aiming method appear to vary from shot to shot?
- Does the bowler wobble during the delivery process?
- Does the delivery action or follow-through vary from shot to shot?
- Does the bowler seem distracted by the testing process?
- Does the bowler seem fit and healthy with good eyesight and a competent judge of line and length?
- Does the bowler recall any poor deliveries and their likely causes?
- Does the bowler remember feeling any variations in balance or movements?

Target Bowling

Limitations of Draw Shot Accuracy Test

The various results calculated in the draw shot accuracy test constitute average finishing distances of bowls from the jack. That test takes no account of direction from the jack of bowl finishing positions. For example, a bowl that is a metre long is recorded no differently from a bowl that is a metre short. The usual task of bowlers is to draw their bowls as closely as possible to specific positions in the head, and distances alone suffice for many purposes. However, any persistent delivery faults often produce consistent error patterns in results achieved. For example, some bowlers might be consistently short: other bowlers consistently narrow, etc.

Bowls Target Protractor

Archers and shooters obtain knowledge of their results from their used targets. Bowlers can derive similar results by adopting an equivalent marking method. First, they require some form of bowls target protractor equivalent to the device in the following image:

This protractor was made of 3 mm Masonite. White enamel makes it damp proof, and provides good contrast for markings. The darker, zero line points up the centre of the rink towards the mat. Protuberances marked 0, 1, 2 and 3 readily identify 360/0°, 100°, 200° and 300° lines, respectively. Intermediate lines appear every 10°. The bowl in the image is at about 070°.

The protractor's inside diameter is large enough to slip over a jack readily. It is small enough for ease of centring and for providing adequate area for scalar markings. In this case, the inside diameter is 7.5 cm. The protractor's outside diameter is large enough to give it strength, to provide sufficient width for reasonably length of sighting lines, and provide sufficient space for numbers that are readily legible while standing. It is small enough to avoid interfering with close bowls and provide ease of handling. In this case, the outside diameter is 19 cm.

In use, it is a good idea to mark the green under the jack. If an approaching bowl is likely to have its course obstructed by the protractor, the marker can lift both jack and protractor, and exactly replace and align them after the bowl has passed.

Measuring Procedure

Many suitable procedural steps: e.g. working in pairs, playing warm up ends, measuring and recording duties, removal of measured bowls, etc are similar to those suggested for the Draw Shot Accuracy Test. The number of bowls allowable depends on the amount of available time. Bowlers should deliver a similar number of bowls as their partners, and should deliver similar numbers of forehands and backhands. Recording may be less prone to error if bowlers deliver all their forehands before any of their backhands, or vice versa. Forehands and backhands really require separate marking sheets and target charts. Bowlers should similarly separate results for shorter and for longer end lengths.

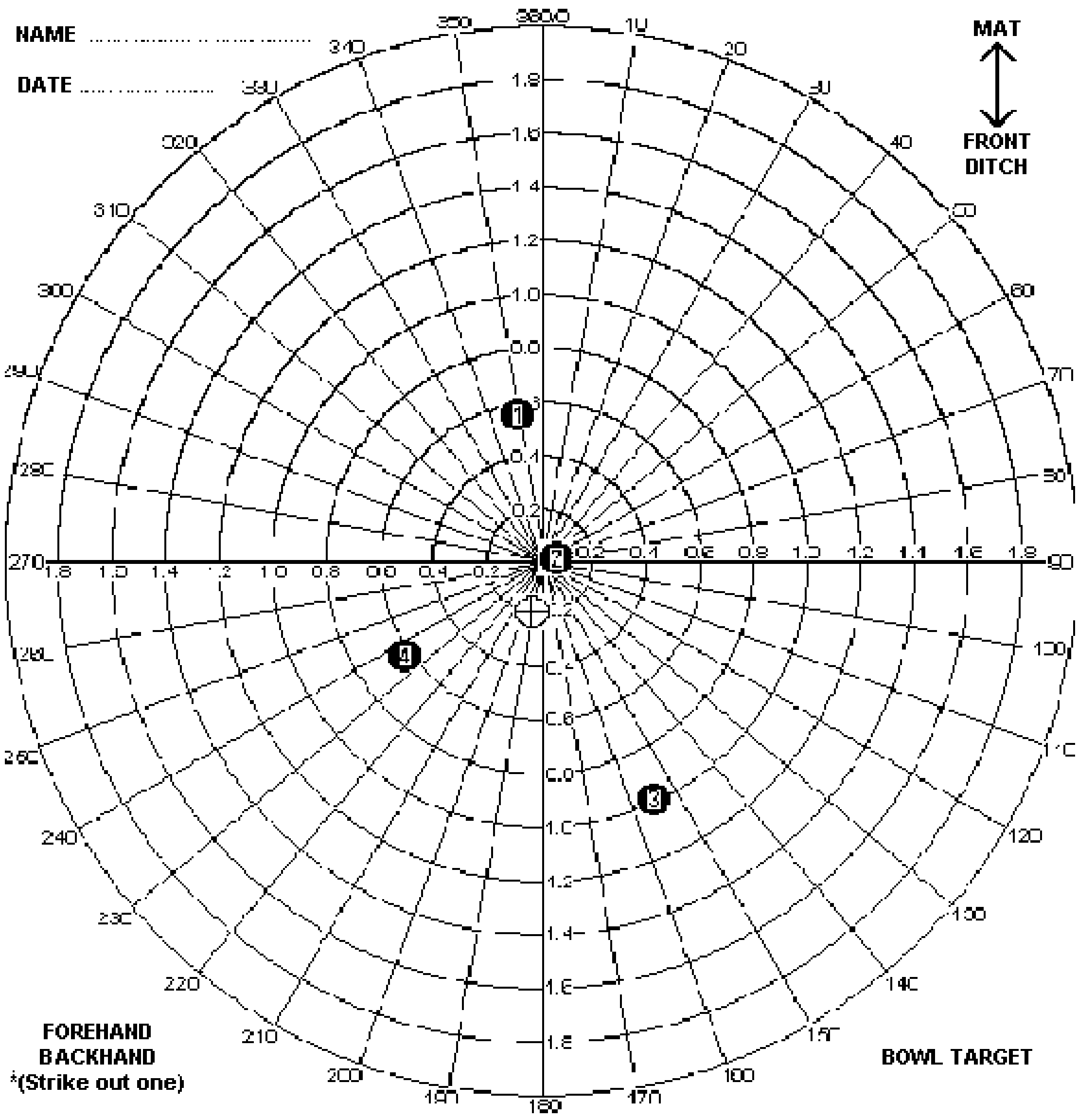
The procedure requires the measuring and recording of each bowl's finishing direction and distance from the jack. (A direction centrally between 150° and 160° would be 155°). A suitable sheet with four specimen entries is as follows:

Name……………………………… Date..…/……/……. End Length……m Fore/Back Hand

No	Direction°	m/cms	No	Direction°	m/cms	No	Direction°	m/cms	No	Direction°	m/cms
1	349°	0.55m	9			17			25		
2	070°	0.07m	10			18			26		
3	155°	0.99m	11			19			27		
4	235°	0.62m	12			20			28		
5			13			21			29		
6			14			22			30		
7			15			23			31		
8			16			24			32		

Had the marker not removed each bowl after measuring and recording, those bowls would be located as follows:

However when bowlers plot the values of each bowl on to a bowling target, a similar picture emerges, as follows:



The target then shows the result of the same four deliveries (marked 1,2,3 & 4). The spread of these finishing positions indicates accuracy, and the possible presence of any consistent error tendency. The target also shows a spot about 0.2 m from the jack in the direction 190°. That spot could be considered the 'epicentre' of the pattern. Bowlers can estimate the position of the centre with satisfactory accuracy in many cases. A blank target plotting sheet is appended at page 17.

Calculating The Resultant Of All Test Deliveries For Plotting On A Target

A step-by-step procedure for precisely calculating the ‘epicentre’ of the pattern of test bowl finishing positions is appended at page 18

Interpreting Results

From the centre of the target, the resultant of the finishing positions of all test deliveries has a distance and a direction. The distance to the resultant position from the jack (variable R in step 6 of the calculating procedure) is typically much smaller than the average of the (error) distances to the finishing positions of each test delivery from the jack. The reason is that opposing errors offset one another in target bowl calculations. For example if a test delivery is 2 m past jack high, and another is 3 m short of jack high, offsetting produces a result (for those two deliveries) of 1 m short. However, the average of the error distances is really the average of 2 m and 3 m, which is 2.5 m.

The direction of the resultant of the finishing positions of all test deliveries is relative to the viewpoint of an observer behind the head. Irrespective of the actual direction of the line of play on the rink, a direction of the resultant around 000° (i.e. 350°, 360/000°, 010°, etc) indicates a tendency for bowls to finish in positions farthest from the observer. From the viewpoint of the player on the mat, they indicate a tendency for bowls to finish before reaching the jack. In other words, the player’s short deliveries tended to be shorter than the long deliveries were long.

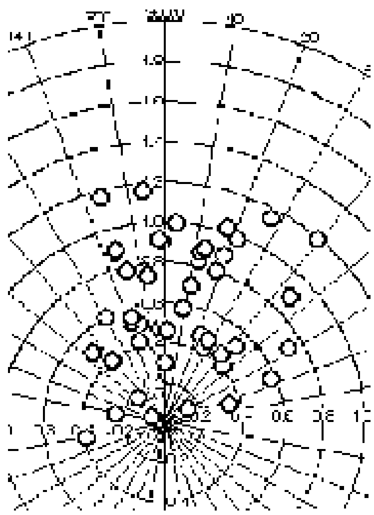
A direction of the resultant around 180° (i.e. 170°, 180°, 190°, etc) indicates a tendency for bowls to finish in positions nearest the observer. From the viewpoint of the player on the mat, they indicate finishing positions behind the jack. In other words, the player tended to bowl long.

Angles near 090° (i.e. 080°, 090°, 100°, etc) are to the left of the jack from the viewpoint of the player on the mat. Differences in interpreting such a result arise from right or left-handedness, and from whether the delivery direction is forehand or backhand. For a right-handed player, such angles indicate narrow bowling for forehand deliveries but wide bowling for backhands. For a left-handed player, angles near 090° indicate wide bowling for forehand deliveries but narrow bowling for backhands.

Angles near 270° (i.e. 260°, 270°, 280°, etc) are to the right of the jack from a player's viewpoint. For a right-handed player, they indicate wide bowling for forehand deliveries but narrow bowling for backhands. For a left-handed player, angles near 270° indicate narrow bowling for forehand deliveries but wide bowling for backhands.

The use of two sheets for each player tested enables separation of forehand and backhand delivery results. Such separation avoids much complexity in interpreting results.

The adjacent diagram shows the resultant of bowl finishing points for each player in a trial squad of experienced bowlers. There are two points for each player: one for result of 20 forehand deliveries and one for the result of 20 backhands. The sectors trimmed off the target contained no data. The bottom of the image is the direction of the front ditch, and the top is the direction to the mat. The finishing points are distributed rather evenly about the vertical mid-line. This indicates that the distances ‘narrow’ largely offset the distances ‘wide’



Except in one instance, the resultant finishing points are all ‘above’ a horizontal line through the centre of the grid. In other words, all but one of them is between the mat and the jack. The mean distance error of the 40-bowls delivered by each bowler (determined as a step in target bowling calculations) was 1.51 m. For every bowl that averaged 1.2 m long, another bowl averaged 1.8 m short. The mean, or average, of 1.2 m and 1.8 m corresponds with the 1.5 m mean. The result of offsetting 1.2 m long against 1.8 m short is 0.6 m short, which corresponds with the median bowl finishing point apparent on the target. In other words, short bowls averaged about 0.6 m shorter than long bowls were long. Had the players aimed at a position 0.6 m (2 ft) behind the jack, the circles on the target might very well have all ‘moved down’ the diagram so that they clustered around the bullseye.

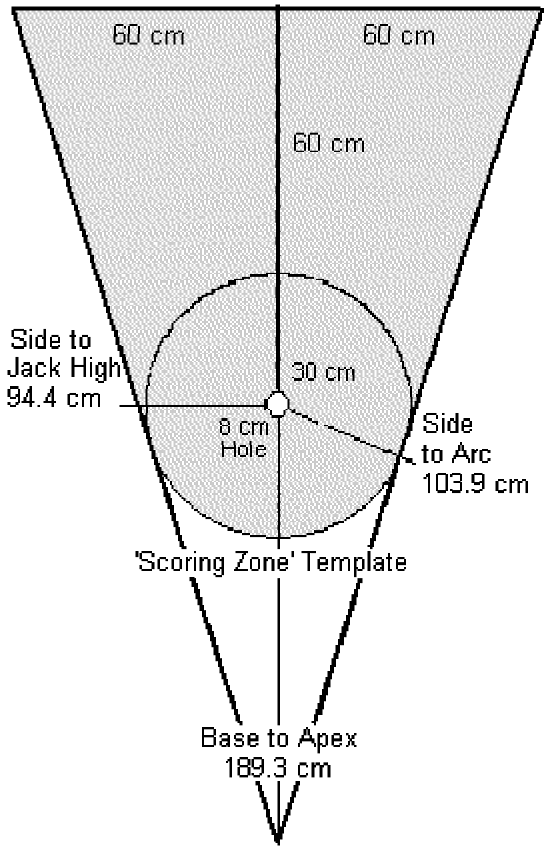
APPENDICES

Scoring Zone

The 'scoring zone' is a concept that Bowls Australia's present-day coaching director, Bob Middleton, used often when he played as leader for national World Bowls (1976 & 1984) teams, the Trans Tasman team (1984).), and at other times in his career. It was the outcome of his long experience. He has been Bowls Australia's National Coaching Director since mid 1980s. Bob contributed the scoring zone concept as an article on Team Play (The Leader), published in *Bowls in Victoria* – February/March 1994.

The shaded area in the following diagram gives dimensions for a scoring zone for practice. The 1.2 m 'base' is the edge nearest the ditch, and the 'apex' points toward the mat. Some of the dimensions shown have the purpose of simplifying marking and cutting out of scoring zones for accuracy practice.

Tensioned thread anchored with small nails is a possible form for a scoring zone for practice. The chalked outline of a cardboard template (possibly hinged with packaging tape along the centre-line to allow folding for storage) is another satisfactory form. A template made of thin sponge rubber sheet would be a possibility.



Marking Out Ellipses

The following method envisages use of chalk as the marking medium. Where use of chalk is not acceptable, the method also serves to make an elliptical template, useful for marking or defining the scoring zone in some other way.

Method:

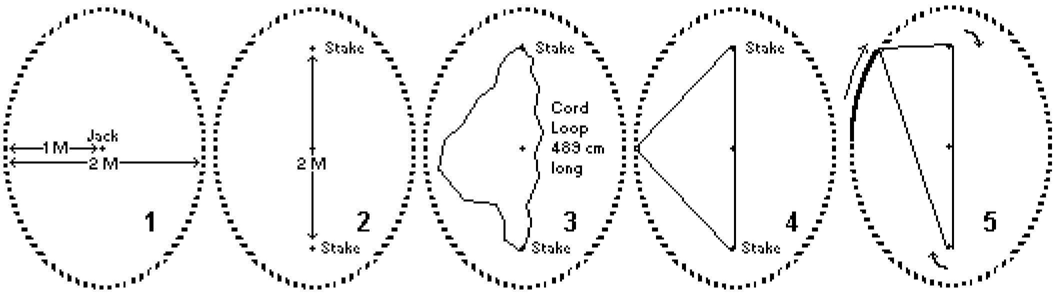
Decide a suitable size for the ellipse. Subtract about 20% from the average error of the bowler. Suppose the average error of the bowler is about 1.3 metres. 80% of 1.3 metres is 1.04 metres. The smallest (crosswise) radius of the ellipse should not normally exceed this length. Accordingly, the minimum diameter should not normally exceed double this distance, i.e. 2.08 metres. Suppose the chosen distances are 2 metres and 1 metre (minimum diameter and radius, respectively)

Fix the position of the proposed ellipse. Mark the alignment of the ellipse by inserting 2 spikes on the longest (lengthwise) axis, separated by a distance equal to the crosswise axis (i.e. 2 metres)

Make a loop. Make a cord loop of total length equal to twice the crosswise axis plus 20.7%. Twice the crosswise distance (2 m) is 400 cms, which when increased by 20.7% is 483 cms. (20.7% is $((\sqrt{2} - 1) \div 2)$.

Prepare for marking. Drop the loop around the spikes and a marking device (eg. stick of chalk) and tension the loop by moving the marker outwards.

Draw the ellipse. Outline the ellipse by moving the marker around the circumference, allowing the tensioned loop to glide around the restraining spikes and the marking device.



40-Bowl Test Recording Sheet

Player Name:

	End →	**1**	**2**	**3**	**4**	**5**			**6**	**7**	**8**	**9**	**10**	
	Length→	**M**	**S**	**M**	**L**	**M**			**M**	**S**	**M**	**L**	**M**	
	Mat→	**C**	**I**	**E**	**T**	**C**	**Row**		**C**	**T**	**E**	**T**	**C**	**Row**
Hand ↓	**Jack→**	**E**	**T**	**C**	**T**	**E**	**Totals**	**Hand ↓**	**E**	**I**	**C**	**T**	**E**	**Totals**
Fore→	**Bowl 1→**						F_1	**Back→**						B_3
Fore→	**Bowl 2→**						F_2	**Back→**						B_4
Back→	**Bowl 3→**						B_1	**Fore→**						F_3
Back→	**Bowl 4→**						B_2	**Fore→**						F_4
	Totals						1-5							6-10

C=Centred, 4 m from ditch, E=Centred, 6 m from ditch, I=Centred opp. 23 m mark,
L=Long, M=Medium, S=Short, T=2m mark

Player Name:

	End →	**1**	**2**	**3**	**4**	**5**			**6**	**7**	**8**	**9**	**10**	
	Length→	**M**	**S**	**M**	**L**	**M**			**M**	**S**	**M**	**L**	**M**	
	Mat→	**C**	**I**	**E**	**T**	**C**	**Row**		**C**	**T**	**E**	**T**	**C**	**Row**
Hand ↓	**Jack→**	**E**	**T**	**C**	**T**	**E**	**Totals**	**Hand ↓**	**E**	**I**	**C**	**T**	**E**	**Totals**
Fore→	**Bowl 1→**						F_1	**Back→**						B_3
Fore→	**Bowl 2→**						F_2	**Back→**						B_4
Back→	**Bowl 3→**						B_1	**Fore→**						F_3
Back→	**Bowl 4→**						B_2	**Fore→**						F_4
	Totals						1-5							6-10

C=Centred, 4 m from ditch, E=Centred, 6 m from ditch, I=Centred opp 23 m mark,
L=Long, M=Medium, S=Short, T=2m mark

Player Name:

	End →	**1**	**2**	**3**	**4**	**5**			**6**	**7**	**8**	**9**	**10**	
	Length→	**M**	**S**	**M**	**L**	**M**			**M**	**S**	**M**	**L**	**M**	
	Mat→	**C**	**I**	**E**	**T**	**C**	**Row**		**C**	**T**	**E**	**T**	**C**	**Row**
Hand ↓	**Jack→**	**E**	**T**	**C**	**T**	**E**	**Totals**	**Hand ↓**	**E**	**I**	**C**	**T**	**E**	**Totals**
Fore→	**Bowl 1→**						F_1	**Back→**						B_3
Fore→	**Bowl 2→**						F_2	**Back→**						B_4
Back→	**Bowl 3→**						B_1	**Fore→**						F_3
Back→	**Bowl 4→**						B_2	**Fore→**						F_4
	Totals						1-5							6-10

C=Centred, 4 m from ditch, E=Centred, 6 m from ditch, I=Centred opp23 m mark,
L=Long, M=Medium, S=Short, T=2m mark

Calculating Consistency

A measure of inconsistency is the calculated 'standard deviation' of measured errors. Bowlers with access to a calculator or a computer spreadsheet can readily calculate not only mean errors, but also standard deviations and relative consistency. Calculated standard deviation is normally expressed in the same units (eg centimetres) as the error measurements. A concept of consistency is based on the difference between the mean error and the standard deviation, expressed as a percentage of the mean error.

Note: The following example of the method of calculating consistency is illustrative and contains only 8 terms. A worksheet for calculating consistency of a different number of test deliveries (as in the 40-bowl test) would have a corresponding number of terms.

Example of method:

- Deliver 8 bowls towards a marked target position
- Measure the distance between the target and the actual stopping position of each bowl (column 1)
- Calculate average error. Deduct average error from each actual error (column 3)
- Square each error difference (column 4) and calculate the square root of the sum of the squares.
- Calculate consistency by completing the step that follows the table.

Measured distance between target and actual stopping position (m)	Average error	Actual error minus average error	Squares of variations
0.4	0.7	-0.3	0.09
1.1	0.7	0.4	0.16
0.8	0.7	0.1	0.01
0.0	0.7	-0.7	0.49
0.5	0.7	-0.2	0.04
1.3	0.7	0.6	0.36
0.6	0.7	-0.1	0.01
0.9	0.7	0.2	0.04
5.6			1.20

Average error
= 5.6 ÷ 8 = 0.7 m
= 70 cms

Average square
= 1.2 ÷ 8 = 0.15

Square root of average square ('Standard Deviation')
=√0.15 = 0.39 m = 39 cms

Thus, the bowler has an average error of 70 cms, with a standard deviation, or dispersion zone 39 cms in width. This value (39 cms) reflects the extent of scatter, or *inconsistency*. Subtraction of this value (39 cms) from the average error (70 cms) produces a value (31 cms) that reflects the extent of *consistency*. A more meaningful expression of consistency is the square root of the consistency factor, thus:

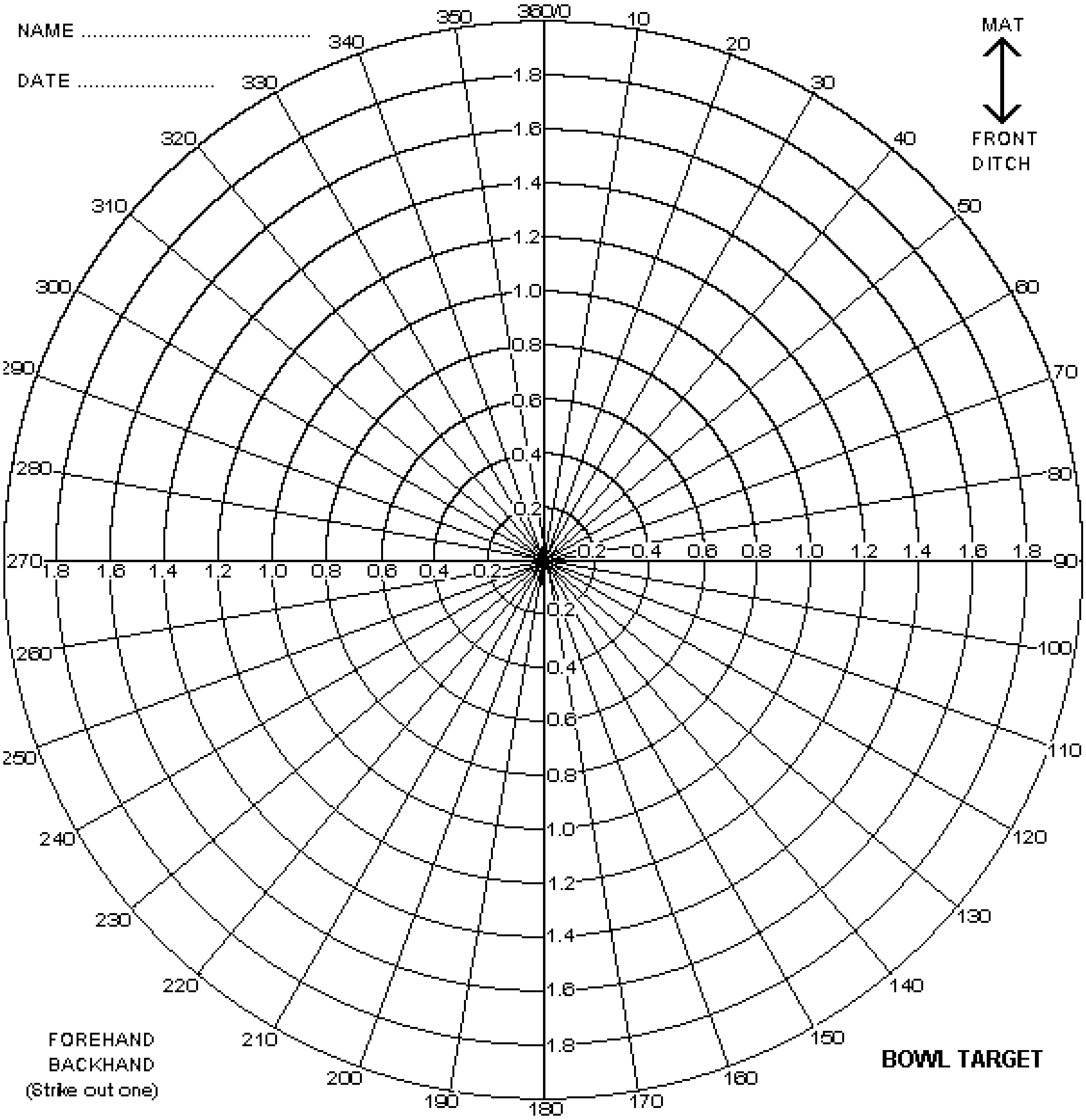
$\sqrt{(31 \div 70)} = \sqrt{0.443} = 0.66 = 66\%$.

Consistency tends to improve with accuracy over time. Therefore, the following suggested scale for assessing consistency is reasonably valid whatever the standard of the player being assessed:

Under 40%	some bad deliveries spoiling consistency?
40-60%	fair to good
61-70%	good to very good
Over 70%	Exceptionally good

As bowlers improve and reduce their mean errors, the standard deviation of their errors tends to reduce in similar proportion. Therefore, as mean error reduces (i.e. accuracy improves), the consistency percentage might not vary materially.

Target Bowling Marking Sheet Blank



Scores To Be Plotted

No	Direction°	m/cms	No	Direction°	m/cms	No	Direction°	m/cms	No	Direction°	m/cms
1			9			17			25		
2			10			18			26		
3			11			19			27		
4			12			20			28		
5			13			21			29		
6			14			22			30		
7			15			23			31		
8			16			24			32		

(Use separate sheets for forehands and for backhands)

Target Bowling Example - Resolution Of Vectors

1. List the magnitude and direction of each vector

Direction	Magnitude
349°	0.55 metres
70°	0.07 metres
155°	0.99 metres
235°	0.62 metres

2. Calculate the magnitude of the vertical and horizontal component of each vector as follows:
   a. Magnitude of vertical (N/S) component (y) = vector magnitude × cos(vector direction)
   b. Magnitude of horizontal (E/W) component (x) = vector magnitude × sin(vector direction)

Direction	Magnitude	Vertical (y)	Horizontal (x)
349°	0.55 metres	0.5399	-0.1049
70°	0.07 metres	0.0239	0.0658
155°	0.99 metres	-0.8972	0.4184
235°	0.62 metres	-0.3556	-0.5079

3. To assist later analysis (see 6), calculate the mean distance error

	Magnitude	
	0.55 metres	
	0.07 metres	
	0.99 metres	
	0.62 metres	
Total	2.23 metres	
Average	**0.56 metres**	**… (1)**

4. Obtain totals of both x components (T_1) and y components (T_2) (deducting any minus values).

	Vertical (y)	Horizontal (x)
	0.5399	-0.1049
	0.0239	0.0658
	-0.8972	0.4184
	-0.3556	-0.5079
T_2 & T_1 (resp)	-0.6890	-0.1286

5. T_1 and T_2 are the y and x components of the resultant vector (R).

6. The magnitude (or length) of R is simply the square root of the sum of the squares of T_1 and T_2 (squaring a negative x or y results in a positive)

$R = \sqrt{((-0.6890)^2 + (-0.1286)^2)} = \sqrt{(0.47472 + 0.016538)} = \sqrt{0.491258} = 0.7009$ metres.

The mean distance of the resultant vector error is R divided by the number of vectors (4) so, in this case:

0.7009 ÷ 4 **= 0.175 metres … (2)**

7. If a computer with Works, Excel, 123, etc is available; the direction of resultant R is the value of a cell containing the following formula:

"=mod(450-atan2(x,y)*180/pi(),360)" *(where x and y are the values of the cells containing T_1 and T_2)*

If a spreadsheet is not available, the direction of R may be derived by calculation as follow:

a. Determine the quadrant in which R lies

If both T_1 and T_2 are positive, R is between 0 and 90 degrees.
If only T_1 is positive, R is between 90 and 180 degrees
If neither T_1 nor T_2 is positive, R is between 180 and 270 degrees
If only T_2 is positive, R is between 270 and 360 degrees

Both T1 and T2 are negative in this example, so **R must lie between 180° and 270°.**

b. Calculate R's angle relative to the x or y axis:

Relative to Vertical Axis (y) (Option A)

R's angle corresponds with the tangent (of absolute values) of T_1 divided by T_2. (=atan(abs(T_1)/abs(T_2)).

abs(-0.1286) ÷ abs(-0.6890) = 0.1286 ÷ 0.6890 = 0.1866, which is the tangent of an **angle of 10.57°**

Therefore, **the direction of R is 180 + 10.57 = 190.57° … (3)**

Relative to Horizontal axis (x) (Option B)

R's angle corresponds with the tangent (of absolute values) of T_2 divided by T_1. (=atan(abs(T_2)/abs(T_1)).

abs(-0.6890) ÷ abs(-0.1286) = 0.6890 ÷ 0.1286 = 5.3577, which is the tangent of an **angle of 79.43°**

Therefore, **the direction of R is 270 – 79.43 = 190.57° … (3)**

8. Thus, **the mean magnitude of the resultant of the four deliveries is 0.175 metres** (0.7009 metres total**) in distance, and 190.57° in direction.**