Calibrating Various Methods of Setting Par Using Scores from the 2015 PDGA Pro Disc Golf World Championships

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This paper describes how the various methods of setting par can be calibrated so they all produce pars that are consistent with the definition and provide the most useful information to players.

The test bed is the first five rounds of the 2015 PDGA Pro Disc Golf World Championships.

Why Calibrate? Par as a Standard of Comparison for Evaluating Performance

One of the functions of par is to give players a standard of comparison for how well they are doing during a tournament (Or from tournament to tournament, or course to course.)

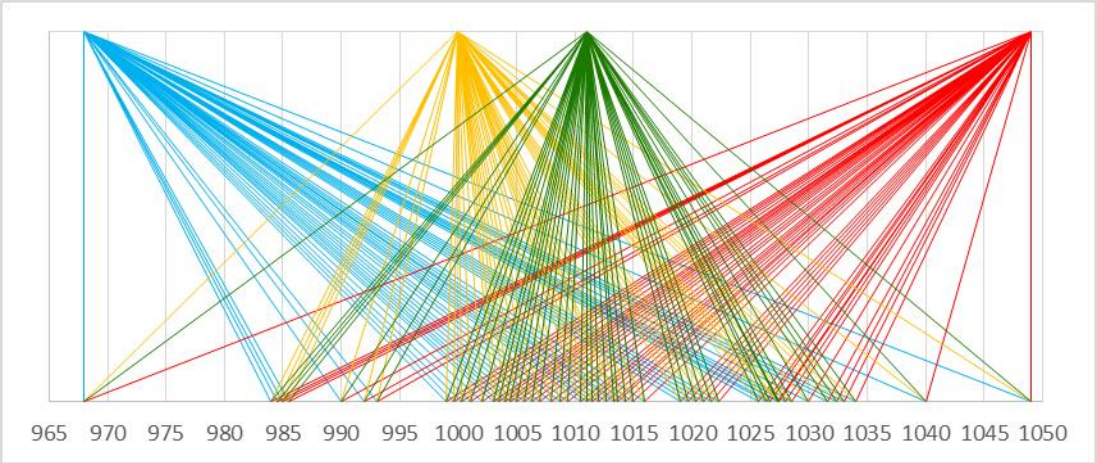
The most important players – and those who are the most concerned about their relative performance - are those who are in contention for prizes. Therefore, any standard for comparison (whether par or other) should be most relevant to these players.

If there were no such thing as par, players could compare their performance to the parallel performance of a prototypical player. The question becomes: which player would be the most useful standard for the largest number of contending players?

If the best player in the tournament were the standard, it would be easy for players to see whether they are winning. However, that would be most useful only to the players who might win.

For players wondering whether they will cash, the most useful standard would be the player who gets last cash. However, that would not be very helpful to those who might win.

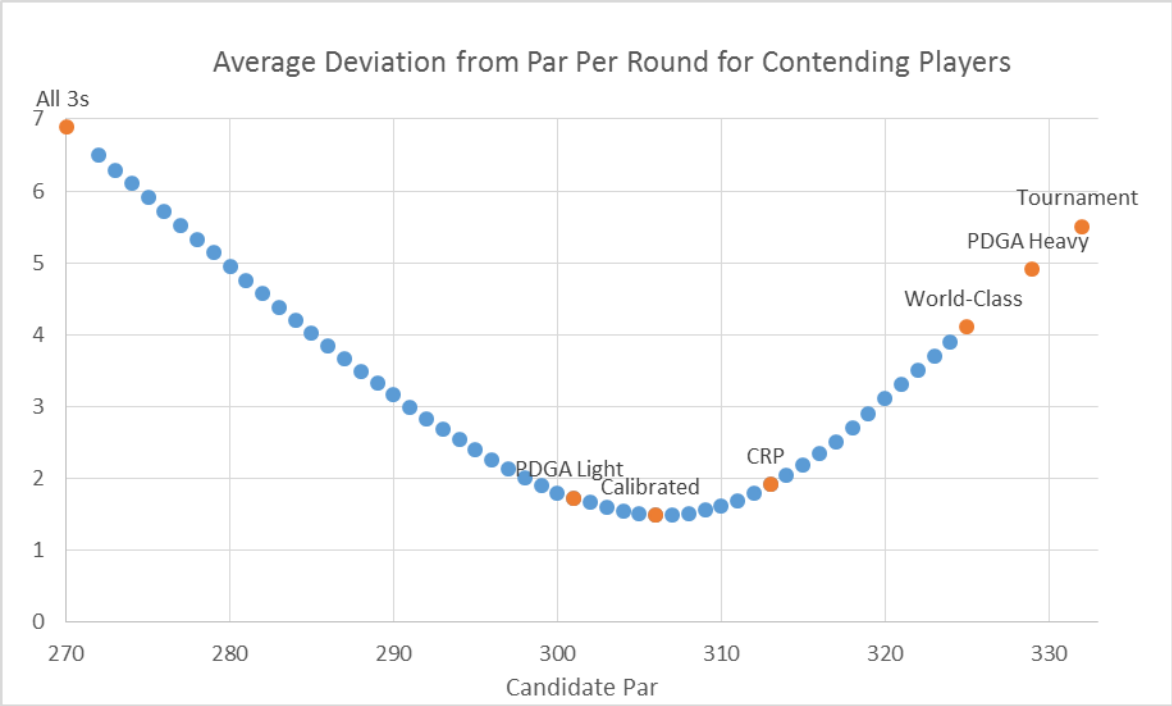
We can plot the distance between various prototypical players and the ratings of all the players who cashed. For Pro Worlds, it looks like this:



Blue is using the last cash player as the prototype, orange=1000, green=1011, and red is using the winner as the prototype. It is apparent that a prototypical player with a rating of 1011 (green) is the best standard by being the most balanced and the closest to more players.

Therefore, one of the tests we can use to measure the usefulness of par is to see whether it produces a score with a round rating of around 1011.

To look at the ideal level of par from another perspective, the following chart calculates the average distance from various potential total pars (candidate pars) to the actual scores for contending players.



This shows the usefulness of pars for the range of scores that contending players got at 2015 Pro Worlds (blue dots). Low deviations are better.

This chart shows the ideal total par would have been 306 or 307. Also, that there is some wiggle room around the ideal par. All of the pars within a few throws either way would be nearly as useful.

We can also see the usefulness of various method of setting par.

- At the ideal par (Calibrated on this chart), the average deviation of all contending player's scores would be just 1.5 throws from par each round.
- The official Pro Worlds par was so high that the typical contending player's score was 5.5 throws different from par each round.
- Setting all holes to par 3 would have been the least useful for these tough courses – because it would have been so low that very few players got close to it.
- The PDGA Guidelines for holes with Heavy Foliage would have also set par too high, but the guidelines for holes with light foliage would have been quite useful.

- Close Range par also would have produced a useful par.

Why Calibrate? Balancing the Value of Birdies and Bogies

It is mathematically impossible to set par so that every birdie gains a full throw and every bogie loses a full throw for every player. However, it is possible to set par so that every par keeps the player in pace with the field of contending players, and birdies gain almost as much as bogies cost.

If par had been set at the ideal of 306, then every player would know:

- If he scored par on a hole, he was keeping pace with the field.
- Every bogie he scored, he would be losing 0.833 throws to the field; moving toward not cashing.
- Every birdie he scored, he would be gaining 0.633 throws against the field; moving toward winning.
- Each bogie would have needed just 1.37 birdies to offset it.

Using the official Pro Worlds par:

- For each par the player scored, he actually lost 0.288 throws to the field.
- For every bogie he scored, he lost 1.155 throws to the field.
- For every birdie he scored, he only gained 0.3444 throws against the field.
- Each bogie would have needed 3.35 birdies to offset it.
- More telling, for every 6 holes a player got par, he needed to get 5 birdies just to keep up with the field.

Methods of Setting Par

This section will review some popular methods of setting par, and how they can be calibrated to be most useful.

All Holes Have the Same Par

Just for completeness, we need to mention that setting all holes to par 3.40 would have hit the ideal par. But, that would not be consistent with the definition of par, as no one can score a 3.40.

Similarly, other methods that do not attempt to set par correctly for each hole are not covered here.

Average Score of Highly Rated Players: Set par on each hole to the rounded average score of a set of players with ratings higher than 1000 so that the round rating of the total par is 1011.

Note that because most average scores round up, you can't just use the average scores of players with an average rating of 1011. So a bit of trial and error is needed to find the precise higher rating that would produce rounded hole pars that add up to the desired total. It should usually be around 1025.

In this case, using the rounded average scores of players with ratings from 1016 to 1031 (for an average rating of 1024) produced the desired rounded total par of 306 which would have been rated 1011.

This method is also fairly consistent with the definition, using the widely accepted "Expert" of a 1000-rated player. The reason is because the average play of a 1025 rated *super expert* is about the same as the errorless play of a 1000-rated *expert*.

This method might depart from the definition of par for weird holes, like an island hole with throw-and-distance penalties.

Lowest Score that Enough 1000-rated Payers Get (4/9ths par).

This method is a more direct application of the definition. Again, taking the 1000-rated player as the expert, when a high enough percentage of experts get a certain score (or lower), we can say that particular score is expected with errorless play, and is therefore par.

For the Pro Worlds players, it turns out that any percentage between 42.5% and 45% produces the desired total par of 306 over 5 rounds. To apply the method, we simply look at the scoring distribution for each hole for 1000-rated players and pick the lowest score where at least 44% of the players got that score. Set that as par for that hole.

Lowest Score that Indicates a Series of Errorless Throws

This method uses a different cutoff percentage for each level of par, based on the theory that a par score is the result of a series of errorless throws. The only parameter is the probability of an errorless throw on the toughest hole. Par is the score where more players got that score than the cumulative probability of that many errorless throws in a row.

For the scores from Pro Worlds, setting the probability of an errorless throw to 72.25% results in total par of 306. This translates into

- Set par as 2 when more than 52.20% of 1000-rated players score a 2, (52.20% = 72.25% *72.25%, because two errorless throws)
- Par 3 when more than 37.72% get 3,
- 27.25% for 4,
- 19.69% for 5, and
- 14.23% for 6.

For the higher pars, the percentages don't matter much – it becomes more of test of whether enough players failed to get a lower score.

Straight Integer-ized Average Scores of 1000-Rated Players

With this method, the average hole scores of 1000-rated players are converted into integers in a way that produces the ideal par.

The average scores can be found by using tournament data, or the DGCDg's Hole Forecaster.

It would not be right to simply round the average scores to the nearest integer, for two reasons.

- First, average scores include errors. Par is defined as errorless play. So, averages are larger than par. For Pro Worlds, about two throws per round higher.
- Second, more disc golf hole scores round up than down, which can also inflate the resulting par above ideal. For Pro Worlds, this effect added another 1.74 throws per round.

So, the method to convert average scores into integer par is to add .305 to the average score and truncate to use just the integer part.

Range-based Integer-ized Average Scores.

It would seem that there should be more scores above par for higher par holes. The more throws, the more chance to make an error or two. So, the difference between average score and par should be greater for higher par holes.

To account for this, each par can have its own range of average scores for 1000-rated players. For Pro Worlds, the best set of ranges is:

- A hole with an average score of less than 2.55 is a par 2,
- Below 3.75 = par 3,
- Below 4.95 = par 4.,
- Below 6.05 = par 5.

Calibrated Par by Length of Hole, derived from PDGA Par Guidelines

The PDGA has a chart of pars by effective length (length + 3* change in elevation), with different pars for holes with light foliage and heavy foliage.

Light Foliage gives a total par of 301, lower than ideal, but quite useful.

Heavy Foliage gives a total par of 329. Higher than ideal, but still better than what was actually used.

Interpolating between Light and Heavy, we get the following ranges which produce the ideal total par:

- Par 2 = up to 247 feet.
- Par 3 = up to 569 feet.
- Par 4 = up to 861 feet.
- Par 5 = up to 1072 feet.

Even better would be to use the light foliage factors for most holes, and the heavy foliage factors for only the 4 tightest holes out of each 18.

Close Range Par

Close Range Par is a refinement of just using the effective hole lengths. It also takes into account doglegs and other throws where the maximum possible distance is constrained. Par is the total of the tee throws, fairways throws and close range throws it should take to complete the hole.

The original parameters are 400 feet for a tee throw, 330 feet for a fairway throw, and 100 for Close Range. Those parameters work fairly well, producing a total par of 313, just 7 over idea and quite useful.

Setting the Close Range parameter to 215 feet produces the ideal par.

Conclusions

1. There is a correct size for par. The correct size will do all of the following well:

- Be consistent with the definition.
- Reflect a consistent level of difficulty (or required skill) from course to course.
- Balance the value of a birdie to a bogie to help players choose tactics on each hole.
- Directly track player performance during a tournament.

2. For most big Open divisions, players rated 1000 and up are usually the players who are in contention for prizes. Therefore, the correct level of par would result in a round rating of in the range of 1005 to 1020.

3. There is no perfect way to set par. Any method will either be based on player scores or hole characteristics.

Methods that use player scores are subject to statistical fluctuation and the vicissitude of various calculation methods.

Methods that depend on hole characteristics are subject to errors in measuring, or differences in judgement about the effect of features.

4. All methods of setting par can be calibrated to approach the ideal level of par and therefore be almost optimally useful. The ideal level is a moving target which can only be determined with hindsight, but anything close to ideal is almost as useful to players as the theoretical ideal.

5. Because the parameters used in this paper were calibrated using the biggest gathering of Open players, they should be useful in setting par for the Open division of any tournament.

Here are the hole lengths, 1000-rated average scores, and the results of non-calibrated methods that have formerly been used to set par.

(Totals include two rounds each at MO-G and SR-G.)

Hole	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Tot
Hole Lengths																			45508
DL-B	438	246	831	351	243	471	423	315	903	597	342	378	486	756	336	534	372	630	8652
MO-G	372	453	288	468	276	1026	345	582	414	570	381	678	282	516	843	663	315	552	9024
SR-G	326	394	343	459	503	779	783	400	297	239	991	830	566	312	773	233	675	501	9404
Tournament Par																			332
DL-B	4	3	5	3	3	4	3	3	5	4	3	3	4	5	3	4	3	4	66
MO-G	3	4	3	4	3	5	3	4	3	4	3	4	3	4	4	5	3	4	66
SR-G	3	3	3	4	4	4	5	3	3	3	5	4	4	3	5	3	4	4	67
Average Score of 1000-rated Players																			316.3
DL-B	3.7	2.4	4.8	2.8	2.7	4.0	2.5	2.9	4.8	4.0	2.9	2.7	3.9	4.7	2.8	4.3	2.7	4.0	62.5
MO-G	2.8	3.6	2.6	3.7	2.5	5.5	2.7	4.0	3.3	3.8	3.0	4.5	2.9	3.9	3.8	4.9	2.8	3.9	64.0
SR-G	3.2	3.0	2.7	3.9	3.5	4.1	4.7	2.8	2.6	2.7	4.8	3.8	3.3	2.9	4.6	2.5	4.1	3.8	62.8
Rounded Average Scores of 1000-rated Players (World-Class Par)																			325
DL-B	4	2	5	3	3	4	3	3	5	4	3	3	4	5	3	4	3	4	65
MO-G	3	4	3	4	3	5	3	4	3	4	3	4	3	4	4	5	3	4	66
SR-G	3	3	3	4	3	4	5	3	3	3	5	4	3	3	5	2	4	4	64
PDGA Par Guidelines Light Foliage																			301
DL-B	3	2	4	3	2	3	3	3	5	3	3	3	3	4	3	3	3	4	57
MO-G	3	3	3	3	3	5	3	3	3	4	3	4	3	3	4	4	3	3	60
SR-G	3	3	3	3	3	4	5	3	3	3	5	4	4	3	4	2	4	3	62
PDGA Par Guidelines Heavy Foliage																			329
DL-B	3	3	5	3	3	4	3	3	5	4	3	3	4	5	3	4	3	4	65
MO-G	3	4	3	4	3	5	3	4	3	4	3	4	3	4	4	5	3	4	66
SR-G	3	3	3	3	4	5	5	3	3	3	5	4	4	3	5	2	4	4	66
Original Close Range Par																			313
DL-B	4	3	4	3	3	4	3	3	4	4	3	3	4	4	3	4	3	4	63
MO-G	3	4	3	4	3	4	3	4	3	4	3	4	3	4	4	4	3	3	63
SR-G	3	3	3	4	3	4	4	3	3	3	4	4	4	3	4	3	4	3	62

Here are the hole-by-hole results of the calibrated methods.

(Totals include two rounds each at MO-G and SR-G.)

Hole	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Tot
Average of 1024 rated players																			306
DL-B	3	2	4	3	3	4	2	3	5	4	3	2	4	5	2	4	3	4	60
MO-G	3	4	2	4	2	5	2	4	3	4	3	4	3	4	4	5	3	3	62
SR-G	3	3	3	4	3	4	5	3	2	2	5	3	3	3	4	3	4	4	61
Lowest Score that Enough 1000-rated Payers Get																			306
DL-B	4	2	5	3	3	4	2	3	5	4	3	3	4	4	2	4	3	4	62
MO-G	3	3	2	4	2	5	3	4	3	4	3	4	3	4	4	5	3	4	63
SR-G	3	3	3	4	3	4	4	3	2	3	4	4	3	3	4	2	4	3	59
Lowest Score that Indicates a Series of Errorless Throws																			306
DL-B	4	2	4	3	3	4	3	3	4	4	3	3	4	4	3	4	3	4	62
MO-G	3	3	3	3	3	5	3	4	3	4	3	4	3	4	4	4	3	3	62
SR-G	3	3	3	4	3	4	4	3	3	3	4	4	3	3	4	2	4	3	60
Straight Integerized Average of 1000-rated																			306
DL-B	4	2	5	3	3	4	2	3	5	4	3	3	4	4	3	4	2	4	62
MO-G	3	3	2	4	2	5	2	4	3	4	3	4	3	4	4	5	3	4	62
SR-G	3	3	2	4	3	4	5	3	2	2	5	4	3	3	4	2	4	4	60
Range-based Integer-ized Average Scores																			306
DL-B	4	2	4	3	3	4	3	3	4	4	3	3	4	4	3	4	3	4	62
MO-G	3	3	3	3	3	5	3	4	3	4	3	4	3	4	4	4	3	3	62
SR-G	3	3	3	4	3	4	4	3	3	3	4	4	3	3	4	2	4	3	60
Par by Length of Hole																			306
DL-B	3	2	4	3	2	4	3	3	4	4	3	3	4	4	3	4	3	4	60
MO-G	3	3	3	3	3	4	3	4	3	4	3	4	3	4	4	4	3	4	62
SR-G	3	3	3	3	4	4	4	3	3	2	4	4	4	3	4	2	4	4	61
Calibrated Close Range Par																			306
DL-B	4	3	4	3	3	3	3	3	4	4	3	3	4	4	3	4	3	4	62
MO-G	3	3	3	3	3	4	3	4	3	4	3	4	3	4	4	4	3	3	61
SR-G	3	3	3	3	3	4	4	3	3	3	4	4	4	3	4	3	4	3	61

All of the calibrated methods either come up with the same par for a hole, or differ by only one.

(Totals include two rounds each at MO-G and SR-G.)

Hole	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Tot
Highest of All Calibrated Methods																			330
DL-B	4	3	5	3	3	4	3	3	5	4	3	3	4	5	3	4	3	4	66
MO-G	3	4	3	4	3	5	3	4	3	4	3	4	3	4	4	5	3	4	66
SR-G	3	3	3	4	4	4	5	3	3	3	5	4	4	3	4	3	4	4	66
Lowest of All Calibrated Methods																			281
DL-B	3	2	4	3	2	3	2	3	4	4	3	2	4	4	2	4	2	4	55
MO-G	3	3	2	3	2	4	2	4	3	4	3	4	3	4	4	4	3	3	58
SR-G	3	3	2	3	3	4	4	3	2	2	4	3	3	3	4	2	4	3	55
Consensus Holes																			143
DL-B				3				3		4	3		4			4		4	25
MO-G	3							4	3	4	3	4	3	4	4		3		35
SR-G	3	3				4		3						3	4		4		24
Contentious Holes: Average																			164.3
DL-B	3.7	2.2	4.3		2.8	3.8	2.5		4.5			2.8		4.2	2.7		2.8		36.3
MO-G		3.2	2.5	3.5	2.5	4.7	2.7									4.5		3.5	27.0
SR-G			3.1	3.5	3.1		3.8		2.9	3.1	3.8	3.7	3.5			3.0		3.5	37.0