Who is likely to win matchplay events?

Introduction

Many important archery tournaments are decided on the outcome of one-on-one 12 arrow matchplay. These include the Olympic Games and the FITA World Target Championships.

In these events the archers are ranked using either a FITA 144 arrow round or a FITA 70 Metre round prior to the matchplay. The archers then have a series of elimination one-on-one matches with the loser dropping out. The highest ranked archer plays the lowers ranked archer in the first round match, and so on.

There have been many comments along the lines of 'matchplay specialists', '70 Metre specialists', and so on, as well as a strong dependency on the use of matchplay for team selection. However, the statistics of performances in major events do not support these comments.

What is an archer likely to score?

Given reasonable weather conditions (that is: not extreme wind or rain) an archer can be expected to have his arrows group such that the probability of the distance of the arrows from the centre of the target follows a Normal distribution. That is, there is a given probability that a particular arrow will fall within a particular scoring ring. This Normal distribution can then be described by its mean (which we take to be the centre of the target) and Standard Deviation.

On average, we can expect 68% of the archer's arrows to be within one Standard Deviation of the centre of the target, and 95% to be within two Standard Deviations.

As the consistency, and overall ability of the archer increases the Standard Deviation decreases, so the archer's groups get smaller and the score gets higher. However, even for a very competent archer there is still a finite probability of a particular arrow obtaining only a low score, albeit a low probability. So although while it might not happen very often, a champion still has a possibility of shooting a very poor shot. The archer's group size can then be defined by the Standard Deviation for his competence level.

An archer's group size varies as the distance to the target varies. This is not a linear relationship since several factors degrade accuracy more rapidly than that, with the obvious examples being wind drift and bow cant, which are better described as varying with the square of the distance. Any calculation of likely group sizes needs to allow for this.

The Archery Australia rating table uses a Normal distribution to calculate an archer's likely score as above. This has been rigorously tested against archer performance in many

events over many years. This testing has shown that it is a very good way to predict performances at different distances and in different rounds for an archer.

The Archery Australia rating table allocates an index to a particular capability level. For example, using the FITA 90 Metre round the relationships is as follows:

Index	Score
120	1400
115	1386
110	1368
105	1347
100	1324
95	1295
90	1264
85	1228
80	1185
75	1137

Figure 1: FITA 90 Metre round average

This indicates that an archer of ability '100' can be expected to score on average 1324 for a FITA 90 Metre round. The archer will not get exactly 1324 every time, but his average can be expected to be about 1324, given reasonable conditions. The archer will get both higher and lower scores than that, which does not mean that his ability level is different from '100', just that it is the usual variation about his expected average.

The 12 arrow matchplay event

The usual matchplay round consists of just 12 shots for each archer at 70 Metres at a 122 cm target face. If the archers tie for those 12 shots each archer then shoots an additional arrow and the archer with the highest score for that arrow wins. If they are again equal they shoot a further arrow, and if needed a third.

Just as an archer will not always obtain exactly the same score for a FITA 90 Metre round, neither will the archer do so for a 12 arrow matchplay round. Over many such rounds the archer will have an average score for a 12 arrow matchplay round, according to his ability level.

Index	Score
120	117
115	115
110	114
105	112
100	110
95	108
90	105
85	102

80	98
75	94

Figure 2: FITA 12 arrow 70 Metre matchplay average

Hence, if we have two archers, 'on average' the archer with the higher index could be expected to win the 12 arrow matchplay events as his average score will be higher.

However, as noted a '110 index' archer will not always score 114 for his 12 arrows. Statistically he must have a variation about that average. Sometimes he will score more, sometimes less. When he scores less it is not because he shot poorly, it is exactly as is expected from the statistics.

This is a very common misunderstanding of how statistics works. It is frequently commented that 'the archers must cut down his score variation in matchplay'. This is simply not possible as statistically there must be some variation. In fact what should be said is that 'we want the archer to raise his <u>average</u> score'. Note that in raising his average score he is raising his ability index, and hence his scores for the FITA 90 Metre round should also increase. Raising the archer's index is the only way to create a lower probability of the archer having a low score for a particular matchplay event (or for any event for that matter).

Just as our '110 index' archer will sometimes score lower than his average 114, so will our '110 index' archer score higher than his 110 average. When these happen simultaneously we can get the less capable archer beating the more capable archer. The probability that this will happen is greater than most people think.

The following figure shows the distribution of likely scores for 12 arrow 70 Metre matchplay events for these two archers. This has been calculated using 'Accurate Sights', over 5000 such events. Over the 5000 matches, Archer A (the more capable archer) should win about 83% of the matches in the 12 shots. However, in about 6% of the matches the archer will tie and will need to use the one arrow shoot-off. After allowing for the one arrow shoot-off, the more capable archer should win on average about 87% of the matches. That is, about one match in 7 he will lose.

In this particular case the more capable archer has a very much better average score for the FITA 90 Metre round than does the less capable archer. In fact, it would be quite unusual for the less capable archer to obtain even a single FITA score equal to the average of the more capable archer in this case. Nevertheless, the less capable archer does have a good chance of success in the matchplay event.

Note however, that while the less capable archer has a reasonable chance of winning the first 12 arrow matchplay event, he is quite unlikely to win two in a row (we multiply the probabilities for successive matches, so his probability of winning two in a row is about 1.5%).

Therefore our less capable archer is a <u>very</u> dangerous opponent for our champion in any particular match, but we are <u>very</u> unlikely to see such an archer win a whole tournament where many such matches must be won in sequence.
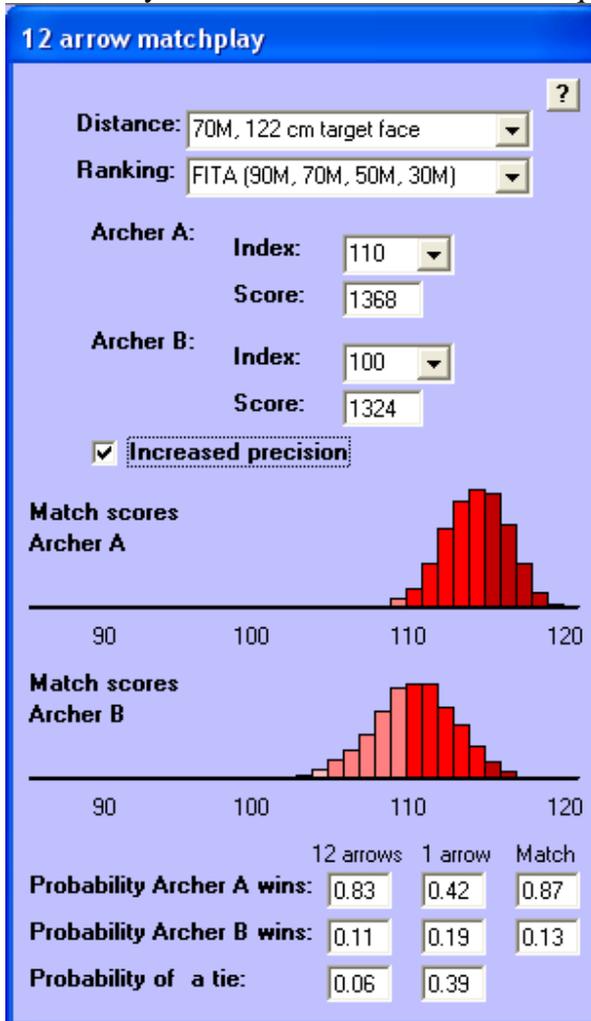

Figure 3: Probability of winning a 12 arrow matchplay

The number of arrows matters a lot

As the number of arrows in a match is increased the probability that the more capable archer will win also increases.

The following figure shows the distribution of likely scores for a 36 arrow match at 70 Metres. Here the index for the more capable archer has been retained at 110, but that for the less capable archer raised to 105. Even with that marked increase in capability for the lesser archer the more capable archer has only the same likelihood of winning as previously.

That is: a longer event (more arrows) will provide a greater probability of the more capable archer winning a particular match. This can also be seen by examining the

probabilities in both cases for the 1 arrow shoot-off, where the less capable archer has a very good chance indeed of winning.
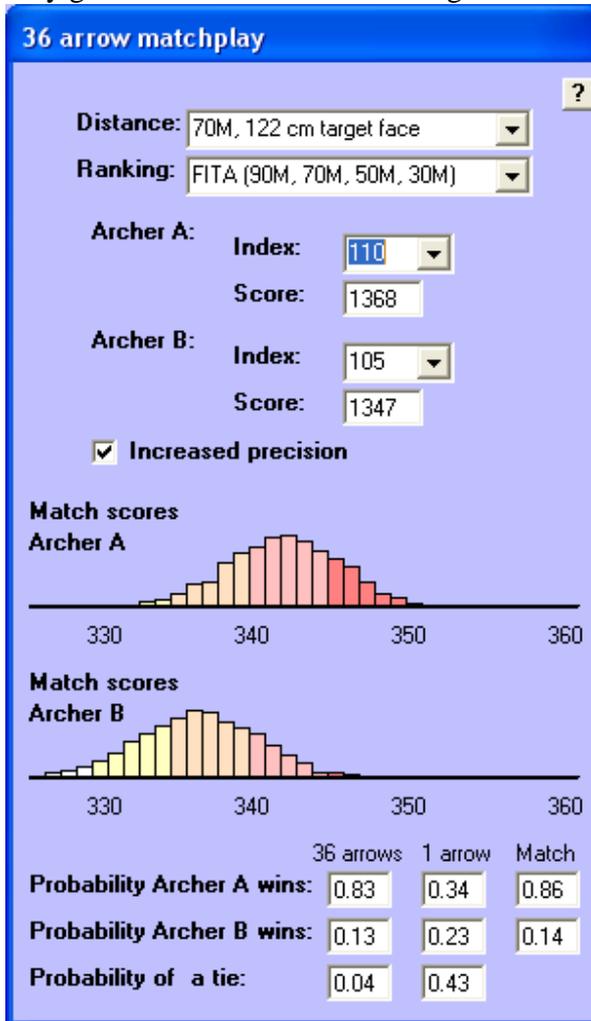

Figure 4: Probability of winning a 36 arrow matchplay

If we go back to our '110 index' and '100 index' archers, it can be seen that our lesser archer has just about no chance of upsetting our more capable archer over the greater number of arrows, even though over a 12 arrow match his chances were quite good.
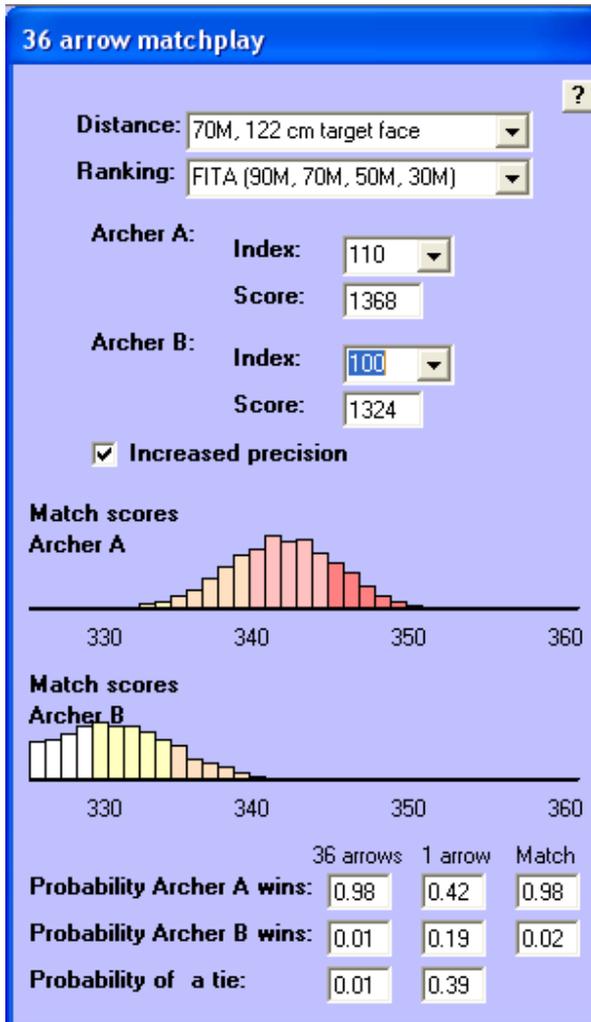
Figure 5: Probability of winning a 36 arrow matchplay

What do we expect to see in a major matchplay tournament?

In a major tournament using matchplay, given the above statistics, we should expect the following:

- Quite frequently we should see a lowly ranked archer beat a highly ranked archer.
- Those lowly ranked archers who do manage to win against a top archer will just about never win more than one or two matches, and will virtually never win a tournament. Nevertheless they are extremely dangerous for the top archers.
- Almost always one of the top ranked archers will win the tournament, but given the statistics it could be any of that top group.

### Do the results from major tournaments match up with these expectations?

It is quite easy to find instances such as the 64th ranked archer beating the 1st ranked archer, so the anticipated upsets do occur.

The results from the ranking rounds and the final placing can be studied using correlation. For World Target Championships this correlation is quite strong, showing that those archers who obtain a high ranking are likely to obtain a high final place. The following show these calculations for WAC2003 (New York).

The horizontal axis is the archer's place in the 144 arrow ranking round. The vertical axis is the archer's corresponding place following the matchplay. If the two places matched the points would all lie on the diagonal black line. Those archers who lose the 1st round match fall above the horizontal yellow line, for the second match it is above the blue line and for the 3rd match it is above the purple line.

WAC03 Men's Compound
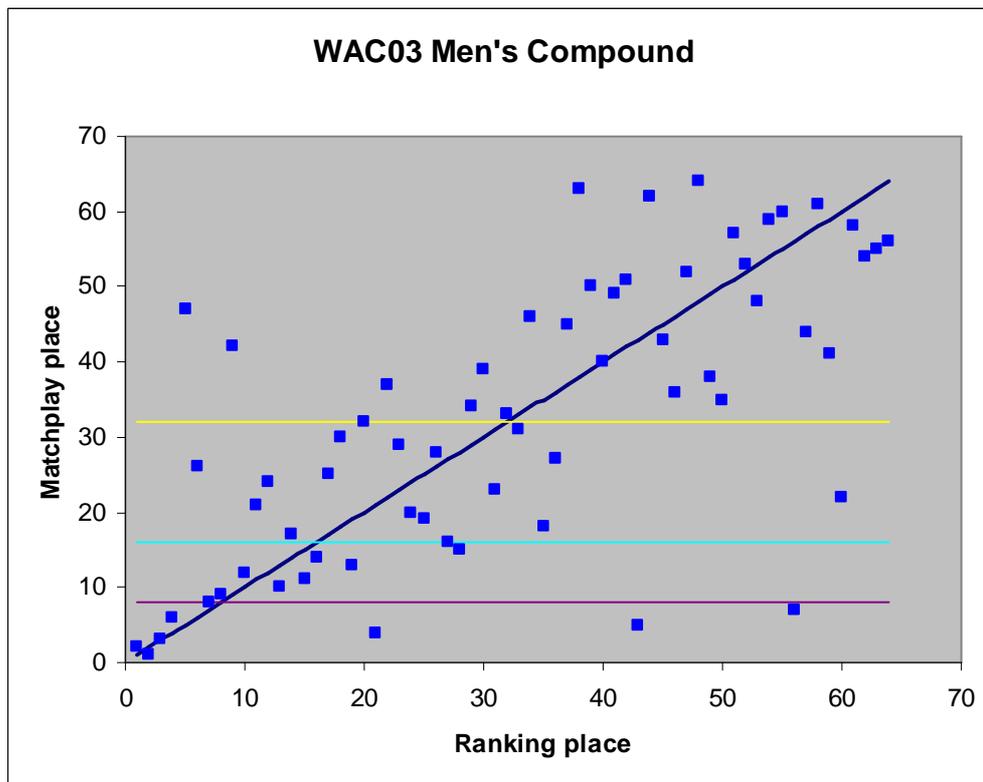
In the Men's Compound event the 57th placed archer in the ranking round had a very low score at 90 Metres but much higher scores at the other distances. Consequently his ranking place is not a good indicator of his ability and this data point is an anomaly.

WAC03 Womens Compound

WAC03 Men's Recurve

WAC03 Womens Recurve
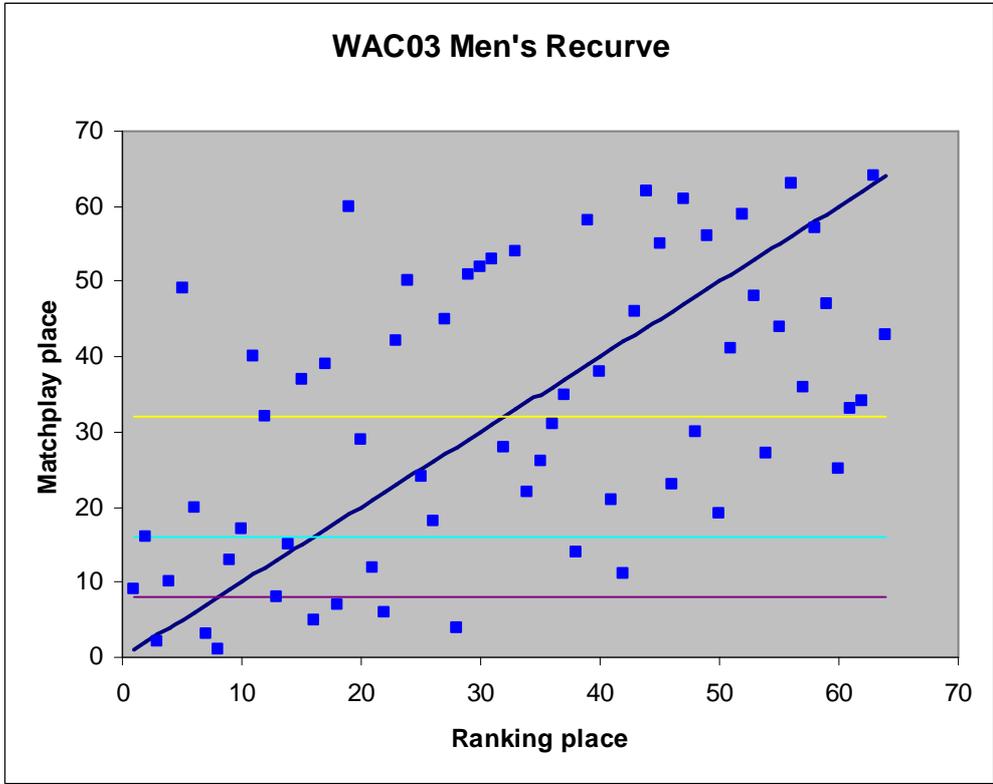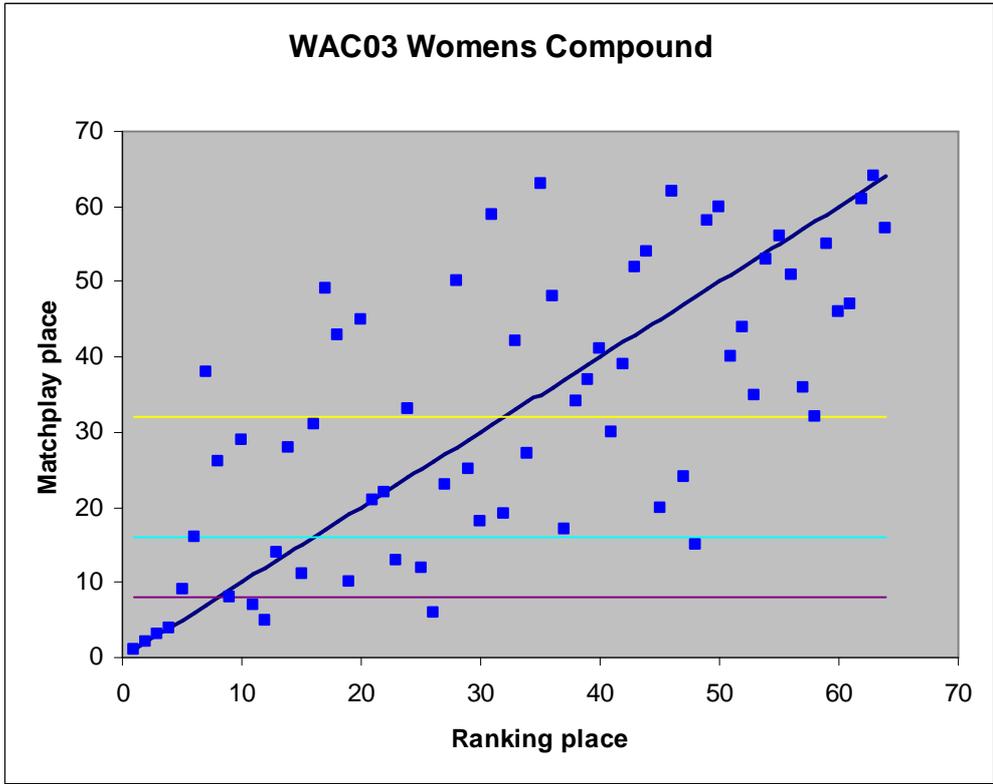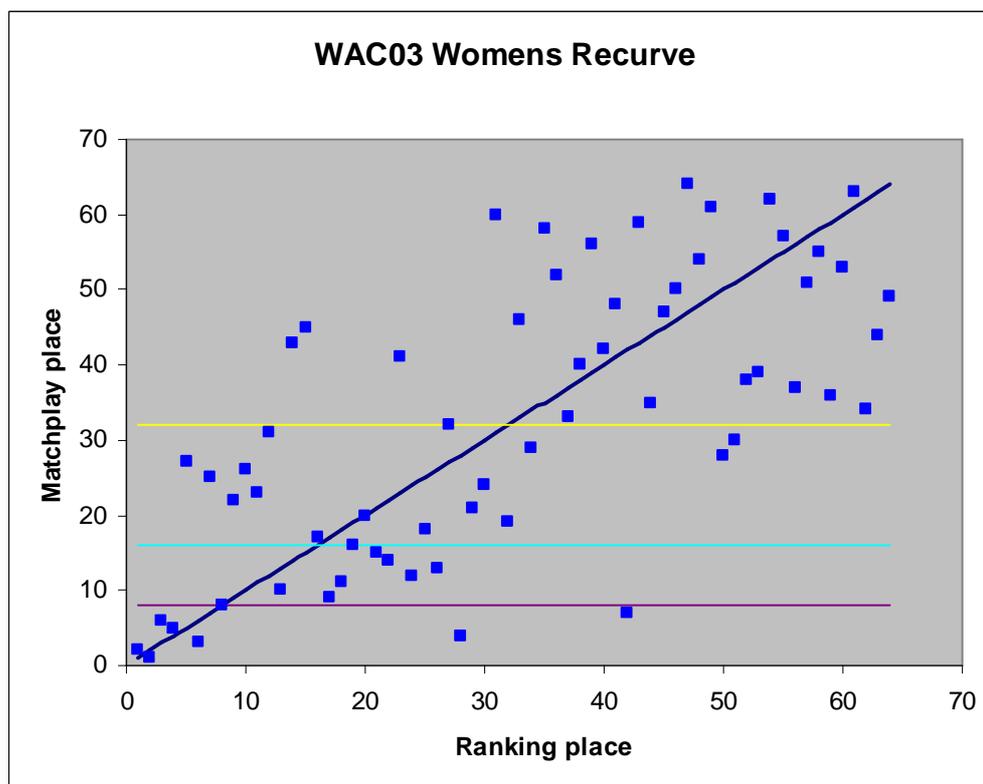
The correlation between the ranking round and matchplay placing are:

Category	Correlation	Comment
Men's Compound	0.69	Strongly correlated
Women's Compound	0.69	Strongly correlated
Men's Recurve	0.52	Moderately correlated
Women's Recurve	0.70	Strongly correlated

Several points are worth comment:

- The ranking event place is very strong indicator of the likely matchplay placing.
- There are the expected prominent casualties where a lowly ranked archer does beat a highly ranked archer.
- Archers ranking lower than 32nd have virtually no chance of getting past the 2nd round of matchplay.
- Very few archers ranked lower than 16th manage to get past the 3rd round of matchplay.
- Archers ranking in the top 16 have a good chance of finishing in the top 16 after the matchplay. That is, being able to rank in at 16th place or better is very important indeed as the winner is very likely to be from within that group.

As noted, ranking in the top 16 is important. For WAC2003 the number of archers from that group who were in the top 16 after the matchplay were as follows:

Category	Top 16 ranked in the top 16 overall
Men's Compound	10
Women's Compound	11
Men's Recurve	9
Women's Recurve	7

This shows that for the compound categories, significantly greater than 50% of the archers in the top 16 places after the matchplay were from those who finished in the top 16 places in the ranking round. For the recurve categories it was 50%.

Note that if a significant proportion of those top archers get to the final rounds of the matchplay their abilities are going to be reasonably similar. This means that in any single match in the later part of the tournament we will have each of the competitors with about an equal chance of success. This means that the last few rounds of matchplay are pretty much a lottery with any of the archers able to win. Therefore getting to the last 16 is a very significant achievement.

Overall, the results are as exactly as we would expect from the statistics.

Do we get '70 Metre specialists' or 'matchplay specialists'?

The possibility of '70 Metre specialists' or 'matchplay specialists' can be studied using the archer ability index and the results from major tournaments. These studies do not show that either of these types of 'specialist' is prominent. The correlations between the FITA index and the 70 Metre range score index for WAC2003 were as follows:

Category	Correlation	Comment
Men's Compound	0.70	Strongly correlated
Women's Compound	0.89	Very strongly correlated
Men's Recurve	0.63	Moderately correlated
Women's Recurve	0.69	Strongly correlated

However, it is apparent that there are archers who do not cope as well with the pressures of matchplay as do others.

Strategy for a major tournament

From considering the probabilities of winning a 12 arrow match, it is strongly apparent that we need the greatest advantage over an opponent as is possible. Even then, the possibility of a loss is quite high.

Hence, it is very important that an archer be placed as high as possible in the ranking round so that at least in the first matchplay round the difference in abilities of the two archers is as great as possible, and hopefully also for the second match too. After that, the

ability of the two archers is likely to be similar and either archer will have a good probability of success in a particular round.

Therefore the ranking round is of <u>vital</u> importance, even though the results are then decided using matchplay.

Selecting teams

Given the above study, it is vitally important team members can obtain as high a score as possible in the ranking round. The ability to do this will be best indicated by their ability to obtain very high scores in rounds consisting of many shots. This leads to the FITA 90 Metre or 70 Metre 144 arrow round scores as being the best indication of an archer's likelihood of doing well in a major tournament, regardless of whether it is decided by such a round or by matchplay. <u>Therefore we want archers who can regularly and consistently achieve world-level scores for the FITA 144 arrow round</u>.

It is strongly apparent that those archers ranking in the top 16 are likely to make up a majority of those finishing in the top 16 after the matchplay. Consequently it is important to consider the FITA 90 Metre and FITA 70 Metre scores necessary to achieve this.

For the most recent World Target Championships the required scores to rank 16th have been as follows:

Category	WAC2003	WAC2005	WAC2007
Men's Compound	1372	1359	1373
Women's Compound	1364	1347	1370
Men's Recurve	1320	1317	1327
Women's Recurve	1317	1319	1332

Note that for WAC2003 the conditions were good, for WAC2005 is was quite windy, and for WAC2007 the men had windy conditions.

This leads to the conclusion that score objectives for team members need to be of the order of:

Category	Objectives
Men's Compound	>1370
Women's Compound	>1370
Men's Recurve	>1320
Women's Recurve	>1320

It seems essential that the prospective team members can obtain these score levels regularly and in conditions that are not perfect.

Nevertheless, it is also important that the archers have demonstrated an ability to perform well in matchplay. However, the results of matchplay should be given a lesser weighting

because of the way the statistics work. This is perhaps best assessed subjectively, however it is strongly apparent that those archers who do achieve the above scores are well used to the pressures of matchplay, it is those who rank lower down the list who usually have the greater challenges with the pressures of major events.

In summary

- The best indicator of likely performance is the full 144 arrow FITA round rather than performance in matchplay. It is best to base archer selection on the full FITA round, not on matchplay.
- It is <u>essential</u> that archers are able to finish in the top 16 archers in the ranking round. Those archers will have the greatest likelihood of winning the competition.
- The lower ranked archers are a significant and unavoidable risk to the top archers in the early rounds of the matchplay but are virtually certain to be eliminated soon after.
- Archers need to regularly exceed 1370 (compound) and 1320 (recurve) for them to have a serious chance of success (and to do so even when it is a little windy).
- The results from actual competition do match what is expected from a statistical analysis (very well, in fact).

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