An astronomer's cricket puzzle

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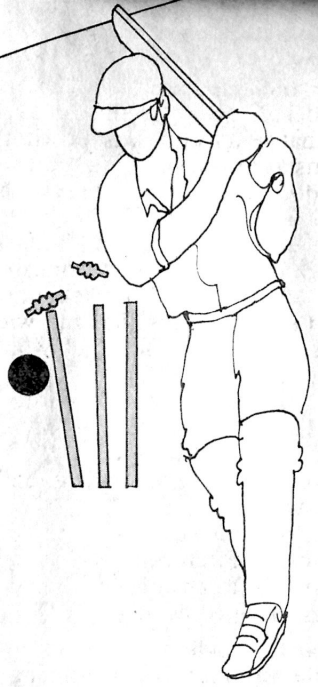


THE FAMOUS Cambridge astronomer, Sir Arthur Eddington, was also a cricket enthusiast. The following puzzle set by him for Caliban's column in *The New Statesman* combines the subtleties of the game with the brilliance of deductive logic. The problem describes a scoresheet extract of a cricket match between two hypothetical counties, Eastershire and Westershire.

Eastershire—Second Innings

A.A. Atkins	6
Bodkins	8
D.D. Dawkins	6
Hawkins	6
Jenkins (J.)	5
Larkins	4
Meakins	7
Hon. P.P. Perkins	11
Capt. S.S. Simkins	6
Tomkins	0
Wilkins	1
Extras	0
Total	60

Bowling Analysis:

	Overs	Mdns	Runs	Wkts
Pitchwell	12.1	2	14	8
Speedwell	6	0	15	1
Tosswell	7	5	31	1

Further information : The batsmen scored entirely in singles and fours. There were no catches, no-balls or runouts. Speedwell and Tosswell each had only one spell of bowling. Pitchwell bowled the first over, Mr Atkins facing the opening ball. Speedwell was the other opening bowler.

Given only this much information it is possible to deduce the answers to the following questions: (a) Which bowler took which wickets? (b) Who remained not out? (c) What was the score at the fall of each wicket? Further, it is possible to construct a table giving the runs scored and the wickets taken in each over!

It seems incredible that so much could be deduced from so little. Partly this is due to the somewhat artificial nature of the conditions given under 'Further Information'. Nevertheless the logical simplicity of the answer is most impressive. I give the solution below. (Those who are interested in cricket and in mathematical puzzles and who want to arrive at the solution independently may skip the steps of reasoning described here.)

Who bowled which overs?

There were 26 overs in all, the last (bowled by Pitchwell) being incomplete. We are also told that Pitchwell bowled the first over. This is possible only if he changed ends. And he cannot have changed ends more than once since the other two bowlers had uninterrupted spells. Keeping in mind that Speedwell opened from the other end, we get the following distribution of overs among the three bowlers :

Pitchwell : 1, 3, 5, 9, 11, 14, 16, 18, 20, 22, 24, 26.

Speedwell : 2, 4, 6, 8, 10, 12

Tosswell : 13, 15, 17, 19, 21, 23, 25.

Who scored off Tosswell?

Tosswell's bowling analysis reads: 7—5—31—1. Thus, the 31 runs were scored in only 2 overs, that is, in 12 balls at the most. Suppose there are X fours and Y singles in the 31. Then,

$$X+Y \leqq 12$$
$$4X+Y=31$$

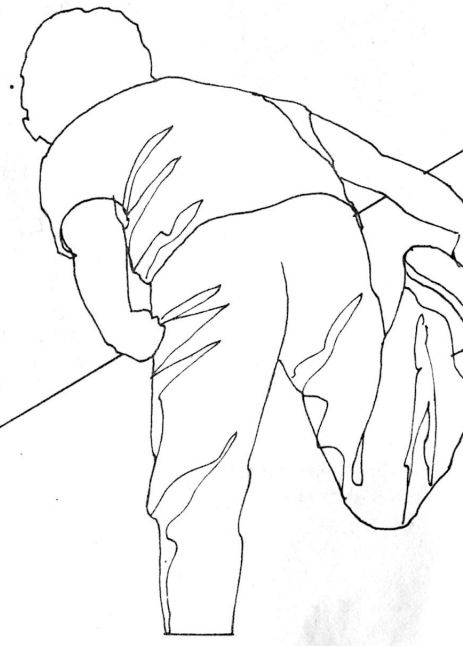
These relations have a unique solution: $X=7$, $Y=3$. (This can be easily verified by trial and error!)

In a typical over a bowler may bowl to up to two batsmen if no wicket falls in the over. If one wicket falls a new batsman may be involved (unless the wicket falls in the last ball of the over). We are told that Tosswell took one wicket. If this wicket fell in one of the two non-maidens, then he must have bowled to at most five batsmen, two in the over with no wicket and three in the over with one wicket. So the seven fours in these two overs were scored by at the most five batsmen. But notice that only two batsmen scored eight or more (Bodkins, 8 and Perkins, 11). So five batsmen *were* involved in these two overs, Bodkins and Perkins each scoring two fours and three others scoring one four each. If fewer than five batsmen had been involved we would have arrived at the impossible conclusion that at least three batsmen scored eight or more.

The first four wickets fall

Since Bodkins scored all his runs in Tosswell's over, he scored nothing in the first 12 overs: Tosswell came on the scene only in the 13th over, as seen earlier. So all the runs until the 13th over were scored by batsmen other than Bodkins. Thus when the first wicket fell (to Pitchwell), the score was six, this being the total number of runs scored by Atkins. The next wicket fell when Dawkins was out, the total being 12. The third wicket fell when Hawkins was bowled by Pitchwell at the total score of 18. We can continue arguing like this until the 13th over. Thus *provided* we are sure that the next man out, Jenkins, went before the 13th over, we can state the fall of wickets sequence as follows:

Wicket	1	2	3	4...	
Total	6	12	18	23...	



When did Jenkins fall?

To decide when Jenkins was out, note that Pitchwell was bowling to Bodkins at times when the total score was odd, because only under these circumstances would Bodkins be at the receiving end from Pitchwell. Since Bodkins did not get out in the first 12 overs the fall of wicket at 23, an odd score, means that the wicket cannot have fallen to Pitchwell. So this wicket must have fallen to Speedwell and so it fell before the 13th over. This was the one and only wicket which fell to Speedwell. Thus we have part of the score card reading as follows:

Atkins, b. Pitchwell	6
Dawkins, b. Pitchwell	6
Hawkins, b. Pitchwell	6
Jenkins, b. Speedwell	5

Speedwell's spell

While Bodkins is not scoring, no over can include more than one single. Now Speedwell bowled six overs, none of which was a maiden, with 15 runs scored off them. How can we distribute 15 runs over six overs so that no over contains more than one single? There is only one solution; there are three overs, each with one four and three overs each with one single. We call the former *f-overs* and the latter *s-overs*.

After an f-over by Speedwell, Pitchwell finds himself bowling to Bodkins. Since Bodkins does not score at all, this must be a maiden over. But Pitchwell bowled only two maidens. So the third f-over by Speedwell was his last over after which Tosswell came to bowl.

The 12th over of the match was bowled by Speedwell and as we saw, four runs were scored in this over. We now show that the wicket of Jenkins fell after these four runs were scored. For suppose the wicket fell *before* the four runs were made. At that time the score was 23. Of the 23 runs, at the most 11 were scored off Speedwell, leaving the balance of at least 12 runs off Pitchwell. But Pitchwell's bowling analysis tells us that he gave away, *in all*, 14 runs. Thus, in his last overs, none of which was a maiden, he is supposed to have conceded at the most two runs. This is impossible. Hence, the wicket of Jenkins fell after the four runs were scored off Speedwell.

Distributing the fours and singles

At the beginning of the 13th over, Bodkins, still without score, faces Tosswell while Larkins (also with zero score) is at the other end. Pitchwell's bowling analysis so far is: 6—2—8—3. Pitchwell gives away six more runs in the remaining six overs. As none of these is a maiden, each over has one run in it. Earlier we saw that Tosswell conceded three singles. Thus, in all, there are nine singles scored in the remaining part of the match. Who scored these? Meakins, with a score of seven must have scored at least three; Perkins with a score of 11 also scored at least three singles, Simkins at least two and Wilkins one single. So the nine singles are all accounted for and the scoring strokes of the players after Jenkins got out are:

Bodkins: 4, 4; Larkins: 4; Meakins: 4, 1,1,1; Perkins: 4,4,1,1,1; Simkins: 4,1,1; Wilins: 1. The order of fours and singles is still to be decided.

Was Tosswell's first over a maiden? If it were, then Pitchwell bowled his over to Larkins. But Larkins scored his four runs with a boundary. So he did not score at all in this over by Pitchwell, because Pitchwell conceded only one run in each of his overs. But if Larkins did not score at all, this over was a maiden: which also contradicts the fact that Pitchwell bowled no more maidens after his first six overs. So we arrive at the conclusion that Tosswell's first over was not a maiden.

It can be easily established that the sequence of runs and wickets in this over must be – 4, 4, wicket, 4, 1, 4. First Bodkins scores his eight runs and gets out. Then Meakins scores five of his seven runs and crosses over and Larkins scores his four runs off the last ball. (Other combinations of fours and ones don't work.)

Thus, in the 14th over, Meakins faces Pitchwell while Larkins is at the other end. Neither of them survive until Tosswell's second non-maiden over, because in that over the batsmen concerned score boundaries, while Meakins has only two runs to score and Larkins, zero. So we have to fill up with maidens from Tosswell while Meakins slowly takes his score to seven and gets out in the 22nd over bowled by Pitchwell. In the 23rd over Tosswell concedes 14 runs. It is easy to trace the rest of the innings from there onwards.

The answer

a) Speedwell took the wicket of Jenkins. Tosswell took the wicket of Bodkins.

b) Wilkins was not out. The rest of the wickets fell to Pitchwell.

c) The wickets fell at: 6, 12, 18, 23, 31, 41, 44, 59, 59, 60.

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Table of Runs and Wickets in each Over

(W: Wicket M: Maiden)

Over	Bowler	Runs/Wickets	Over	Bowler	Runs/Wickets
1	Pitchwell	4, 1	13	Tosswell	4, 4, W, 4, 1, 4
2	Speedwell	1	14	Pitchwell	1
3	Pitchwell	W, 1	15	Tosswell	M
4	Speedwell	4	16	Pitchwell	W, 1
5	Pitchwell	M	17	Tosswell	M
6	Speedwell	1	18	Pitchwell	1
7	Pitchwell	W, 1	19	Tosswell	M
8	Speedwell	4	20	Pitchwell	1
9	Pitchwell	M	21	Tosswell	M
10	Speedwell	1	22	Pitchwell	W, 1
11	Pitchwell	W, 1	23	Tosswell	1, 4, 4, 1, 4
12	Speedwell	4, W	24	Pitchwell	W, W, 1
			25	Tosswell	M
			26	Pitchwell	W

There are slight variations on the sequences given in the above Table but they do not affect the overall answer to this astronomical cricket puzzle.

