

**Football and Mathematics**  
**Premier League and World Cup**

**Gordon Burt**

**MΣ<sup>2</sup>Π**

**Mathematical Social Science Publishing**

Football and Mathematics. Premier League and World Cup.

By Gordon Burt

This book first published 2018

Published by MΣ<sup>2</sup>Π, Mathematical Social Science Publishing, 28 Severn Drive,  
Newport Pagnell, MK16 9DQ, Bucks, UK.

ISBN           0-9544671-1-6

Copyright © 2018 by Gordon Burt

All rights for this book reserved. No part of this book may be reproduced, stored in a retrievable system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the copyright owner.

## Contents

List of Figures and Tables	iv
Acknowledgements	vi
1 Introduction and Overview	1
2 The Premier League and Mathematics	20
3 The 2018 World Cup and Mathematics	73
Bibliography	116
Author Index	119
Subject Index	120
<b>2 The Premier League and Mathematics</b>	<b>20</b>
2.1 Introduction and overview	20
2.2 The Fink Tank: from ordinary language to mathematical science	21
2.3 The basic ideas	24
2.4 Success in aggregate: the league table	27
2.5 Strength and success in individual games	38
2.6 Owners and managers	49
2.7 Success over time	50
2.8 Success and survival ... promotion, relegation and return	58
2.9 The 2018-9 season	62
2.10 Beyond Premier League football	68
2.11 All-play-all competition: a mathematical theory	70
<b>3 The 2018 World Cup and Mathematics</b>	<b>73</b>
3.1 Introduction	73
3.2 Who will win the World Cup?	74
3.3 The activity structure ... the stages of the tournament	77
3.4 England: fluctuating performances, 1950-2014	78
3.5 Qualifying: does 2014 predict 2018?	79
3.6 Pre-tournament predictions	80
3.7 The group stage	88
3.8 The group stage: strength and success	98
3.9 The knockout stage and winning the cup	104
3.10 The 32 teams; the results ... the group stage ... the knockout stage	114

## List of Figures and Tables

### Figures

<b>Figure 2.1</b> The grouped frequency distribution of success, Premier League 2017-8, points scored	29
<b>Figure 2.2</b> The cumulative distribution of success, points scored, Premier League 2017-8	30
<b>Figure 2.3</b> Unitised constant-sum points equals goal proportion, UCSP=GP	36
<b>Figure 2.4</b> Wins and Wins & Draws: UW and UWD as functions of GP	38
<b>Figure 2.5</b> Percentage wins as a function of strength difference; percentage wins & draws similarly	41
<b>Figure 2.5A</b> Relating relative strength to unitised constant-sum points	41
<b>Figure 2.6</b> Away points as a function of Home points, (constant-sum points)	43
<b>Figure 2.7</b> Percentage wins as a function of strength difference; Home and Away	45
<b>Figure 2.8</b> Percentage wins & draws as a function of strength difference; Home and Away	45
<b>Figure 2.9</b> Points scored per game and percentage long passes	47
<b>Figure 2.10</b> Success: points gained in 2011-2 and in 2012-3	51
<b>Figure 2.11</b> Success: the points gained in the two halves of the season, 2012-2013	52
<b>Figure 2.12</b> Evolution through the first half of the season of the correlation with previous season	54
<b>Figure 2.13</b> Survival for the original twenty teams in the 2011-2 season, 2011-2018	57
<b>Figure 2.14</b> Strength and survival: the number of seasons survived relates to the number of points scored in the 2011-2 season	59
<b>Figure 2.15</b> The mean points scored over the six seasons 2011-7 as a predictor of the points scored in 2017-8	60
<b>Figure 2.16</b> Strength (index B2) and success (points after the first four games success)	66
<b>Figure 2.17</b> Germany's Bundesliga, 2016-7 and 2017-8, points gained	69
<b>Figure 3.1</b> England's performance, 1950-2014. (0: not qualifying; 7 winner)	78
<b>Figure 3.2</b> The relationship between FIFA rankings and betting odds	81
<b>Figure 3.3</b> The relationship between FIFA rankings and betting-based probabilities	82
<b>Figure 3.4</b> The relationship between the two probability estimates, betp and Finkp	83
<b>Figure 3.5</b> Points and relative strength in the groups: unitised points as a function of unitised relative strength	101
<b>Figure 3.6</b> Result percentages depend on FIFA rating advantage	103
<b>Figure 3.7</b> The possibility tree for the semi-finals and the final	110

### Tables

<b>Table 1.1 [3.3]</b> The final results of the group stage	14
<b>Table 2.1</b> Related events, cause and consequence	25
<b>Table 2.2</b> Success: the ordering of teams by points, Premier League in 2017-8	28

<b>Table 2.3</b> Measures of success for <i>an individual game</i> : their defining relationships	31
<b>Table 2.4</b> <i>Aggregate</i> measures of success: games, process, goals, results, points and place	31
<b>Table 2.5</b> The complete league table, Premier League 2017-8	32
<b>Table 2.6</b> The correlations between variables, Premier League 2017-8	34
<b>Table 2.7</b> How the result of each game depends on strength (points) advantage	40
<b>Table 2.8</b> How the result of each game depends on strength (points) deficit	40
<b>Table 2.9</b> Home and Away: how the result of each game depends on strength (points) advantage	44
<b>Table 2.10</b> Home and Away: how the result of each game depends on strength (points) deficit	44
<b>Table 2.11</b> Teams are passing more	48
<b>Table 2.12</b> Correlations between points scored in each pair of seasons	51
<b>Table 2.13</b> Comparison of results in the two halves of 2012-2013	53
<b>Table 2.14</b> Overall statistics: points gained $x$ ; and standardised points $u$	57
<b>Table 2.15</b> Strength (B1): mean number of points over seven seasons, 2011-2018. Also Finkelstein's probabilities for: being in the top four in the Premier league; NOT being relegated; and automatic promotion from Championship	63
<b>Table 2.16</b> Correlations between PF position, actual position and Index X position; ordering and points	67
<b>Table 3.1</b> World Cup hosts and winners, 1930-2014 and 2018-2022	76
<b>Table 3.2</b> The teams which qualified in 2014 and in 2018	79
<b>Table 3.3</b> How the stage reached in 2014 relates to the chances of qualifying in 2018	80
<b>Table 3.4</b> Previous world cup winners: number and percentage of wins	80
<b>Table 3.5</b> FIFA rankings, the betting-based probabilities, the Finkelstein probabilities, the times cup won and the stage reached in 2014	83
<b>Table 3.6</b> The average strength of each group; median FIFA ranking	87
<b>Table 3.7</b> The final results of the group stage	98
<b>Table 3.8</b> The correlations between the success variables	98
<b>Table 3.9</b> The probabilities of the teams progressing through the knockout stage and winning the cup – given that they have qualified for the knockout stage	106
<b>Table 3.10</b> The proportion of previous winners and the proportion of European teams	113

## Acknowledgements

Thank you, Neil and Carsten, for your interest in my earlier reports on the Premier League and the World Cup. Thank you, Callum, for saying I should make it a book. And thank you, Robert, for your work and enthusiasm in your role as Football Book Officer.

The direct inspiration for this book has been the weekly column in *The Times* on football statistics, entitled *The Fink Tank*. It is written by Daniel Finkelstein and supported by a team of mathematicians. Football statistics are of value because they provide the facts as opposed to the vagueness, the opinions, the exaggerations and the prejudices which are sometimes present when people talk about football. Sometimes ‘football statistics’ consist of an undisciplined jumble of facts. Although each fact is interesting in its own right and good for a pub quiz, the collection of facts do not come together to form a powerful coherent body of knowledge. This is where *The Fink Tank* scores: applying mathematical science, it provides a coherent body of knowledge about football. This book does not match the sophistication of the work of the *Fink Tank* team but it does aim to articulate what seem to me to be the basic ideas in a coherent body of knowledge about football success.

And now back to the family ...

Just think, Robert, two years ago you and I sat in the Open University refectory studying the Premier League table and practising our primary school mathematics. And think too of all the matches between Arsenal and Dunfermline Athletic on the back lawn at Walnut Lodge!

Callum, here is an extract from my 2011 Christmas newsletter:

“Yesterday saw me in the lee of a tree, battered by a gale and torrential rain, my large umbrella up, Antarctic hat, my brand new hurdie-warmers and six layers on my upper half, peering with fading eyesight into the gloom at one of the green blurs which was possibly Callum playing football.”

Kaia, can you imagine? Your Mum and Dad taking you to football training in Raleigh when you were only two years old! Kaia, Rosa and Rory: what a shock result it was when England beat Brazil 17-2. Out in the Wokingham sun a young England side (combined ages, thirteen years) ... Brazil, down to one man, seventy-three years old. Rosa, FIFA still maintain that the rules forbid you picking the ball up and running with it and throwing it into the goal.

A Glasgow Granny shouts at the telly: “don’t pass it back to the goalie, pass it forward!” Another Glaswegian, Alex “ahcumfigovin” Ferguson<sup>1</sup>, had a similar approach. Using words that are scarcely known to people like myself who come from Edinburgh, he encouraged – and raged at – Carrick to pass the ball forward.<sup>2</sup>

---

<sup>1</sup> McLeod, Keith. “All we ever did in Govan was play football and fight ... it was a great upbringing, says Alex Ferguson.” *Daily Record*, May 9, 2013. Accessed 21 November 2018.  
<https://www.dailyrecord.co.uk/news/scottish-news/alex-ferguson-says-govan-upbringing-1877559>.

<sup>2</sup> Whaling, James. “Michael Carrick reveals what the Sir Alex Ferguson hairdryer treatment was REALLY like.” *Daily Mirror*, October 10, 2018. Accessed 28 November 2018.  
<https://www.mirror.co.uk/sport/football/news/michael-carrick-reveals-what-sir-13393035>.