The Swiss System; Buchholtz Number Ranking; SPORT software

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Introduction

The Petanque Federation Australia (PFA) has adopted the Swiss System as the standard competition format to be used in qualifying rounds of all championship events which includes State and National Championships. Several clubs in Victoria are also using the Swiss System for their tournaments or their tournament qualifying rounds.

At the end of the Swiss System rounds in a tournament, teams may be ranked according to several criteria; two of which are the team's Buchholtz Number (BHN) and Fine Buchholtz Number (fBHN). These numbers are a reflection of the quality of the opponents that the team has played. The Buchholtz Number is the sum of all the wins of a team's opponents and the Fine Buchholtz Number is the sum of all the opponent's BHN's.

To assist in tournament management and scoring, PFA recommends the SPORT software by Ottmar Kraemer-Fuhrmann (www.sport-software.com). This software has been used in recent National and State Championships and offers many different tournament formats: Swiss System, Round-robin system, Single and Double Elimination, Poules and Mêlée. Ranking criteria, including the Buchholtz Number, are a feature of the SPORT software.

This paper will attempt to explain the Swiss System and Buchholtz Number ranking with examples from a petanque tournament scored using the SPORT software shown in the Appendix.

In the following sections 'player' can be replaced with 'team' and 'opponent' can be taken to mean opposing player or opposing team.

The Swiss System

The Swiss System (also known as the Swiss Ladder System) is a tournament system that allows participants to play a limited number of rounds against opponents of similar strength. The system was introduced in 1895 by Dr. J. Muller in a chess tournament in Zurich, hence the name 'Swiss System'. The principles of the system are (van Diepen & Partsch 1990):

1. In every round, each player is paired with an opponent with an equal score (or as nearly equal as possible);
2. Two players are paired at most once;
3. After a predetermined number of rounds the players are ranked according to a set of criteria. The leading player wins; or the ranking is the basis of subsequent elimination series.

So, in **round 1**, some random pairing is made. In **round 2** all the winners play each other and all the losers play each other, but if there is an odd number of winners one of them will play a loser. In **round 3**, there will be three groups: those 2-0 scores (2 wins, no losses); those with 1-1 scores; and those with 0-2 scores. Players within each score group play each other and if there is an odd number of players in a score group then one is selected to play another of an adjoining score group. This arrangement continues for following rounds.

The Swiss System Pairing Algorithm

Variations of the Swiss System exist that accommodate particular circumstances. For instance round 1 pairings may be according to some seeding rules rather than random allocation. Or pairing of players from the same club may be discouraged.

These variations are often concerning the pairing algorithm of the Swiss System. This algorithm may be a set of written instructions; for example the **Swiss Pairing Rules** of the Wellington Petanque Association (http://www.petanque.org.nz/resources/Swiss_Pairings.htm); or embedded in software computer code.

A number of technical papers have been written on Swiss System pairing algorithms, e.g. van Diepen & Partsch 1990, and Kujansuu et al. 1995. And there are Internet blogs devoted to the topic, e.g. Swiss Tournament Scheduling: Leaguevine's New Algorithm on **The Leaguevine Blog** (https://www.leaguevine.com/blog/18/swiss-tournament-scheduling-leaguevines-new-algorithm/). These are mainly concerned with the Swiss System in chess tournaments.

The SPORT software manual (SPORT 6.22) describes the Swiss Ladder System in Sec. 2.5 and the pairing algorithm is set out in sub-sections **Drawing mode - first round** and **- further rounds.** It is summarized below:

- Pairing in round 1 can be random or players (some or all) can be seeded and paired accordingly. Seeding prevents top players competing against each other in round 1.
- When the number of entries is odd a player receives a bye. In the first round an unseeded player is selected at random for the bye; or if all players are seeded, the player with the lowest seeding receives the bye. In subsequent rounds one of the players with the lowest score is selected at random for the bye.
- No player receives more than one bye in the tournament.
- No player plays the same player twice.
- In rounds 2, 3, etc. players with the same number of wins form a score group. Pairings are allocated randomly from score groups. If the number of players in a score group is odd, then the player with the lowest number of exceptions is moved to the next lower group. An exception is recorded for a player if they receive a bye or are moved to a lower score group.
- Special pairings are made for seeded players that have not lost a single game, or have to play against an opponent of a higher group. In these cases the pairings follow the same method as an elimination system. This ensures that high seeded winning players meet in the later rounds of a tournament.

The Number of Rounds in a Swiss System Tournament

Consider a tournament with 32 players. After round 1 there will be 16 players with 1-0 scores; after round 2 there will be 8 players with 2-0 scores; after round 3 there will be 4 players with 3-0 scores and after round 4 there will only be 2 players with 4-0 scores. These two players will meet in the fifth round and a clear winner of the tournament determined.

We can write this sequence as

Round	1	2	3	4	5
Players	32	16	8	4	2
Scores	0-0	1-0	2-0	3-0	4-0

and if *n* is the number of rounds $2^n = 2^5 = 2\times2\times2\times2\times2 = 32$. So five rounds will determine a clear winner from 32 players. This sequence, where the number of winners is halved at the conclusion of each unique round, is the reverse order of the **powers of 2** sequence

2, 4, 8, 16, 32, 64, 128, …

where $x_1 = 2^1 = 2,\ x_2 = 2^2 = 4,\ x_3 = 2^3 = 8, \ldots, x_7 = 2^7 = 128, \ldots$ and in general $x_n = 2^n$. The position order of the number in the sequence corresponds with the number of rounds required for an elimination system; e.g. 32 is in position 5 = 5 rounds for elimination. For those who follow tennis, the Grand Slam tournaments have 7 rounds (the final is the 7th round) and 128 players in the Men's and Women's draw. Of course this regular halving of winners leading to a last round with only two players having won all their games <u>will only apply if the number of entrants is</u> $8, 16, 32, 64, 128, \ldots$.

In general, the minimum number of rounds needed for a unique winner from *n* entrants in an elimination system is: $Rounds\ =\ \text{CEIL}\left(\log_2(n)\right)$, where CEIL() is the ceiling function and $\log_2()$ is the binary logarithm (logarithm to the base 2). The ceiling function rounds a fractional number to the next highest integer and binary logarithms can be evaluated from natural logarithms $\ln(n) \equiv \log_e(n)$ using the rule: $\log_2(n) = \dfrac{\ln(n)}{\ln(2)}$

Consider a tournament of $n = 24$ players. The number of rounds required for an elimination system is:

$$Rounds = \text{CEIL}\left(\log_2(24)\right) = \text{CEIL}(4.5850) = 5 \quad \text{where} \quad \log_2(24) = \frac{\ln(24)}{\ln(2)} = 4.5850\ .$$

Now consider the $n = 24$ players in a 5-round Swiss System tournament.

After round 1 there will be 12 players with 1-0 scores; after round 2 there will be 6 players with 2-0 scores and after round 3 there will be 3 players with 3-0 scores. One of these three will drop down into the next lower 2-1 score group for pairing and could win in the next round.

So after round 4 there could be 2 players with 4-0 scores. These two players would meet in round 5 to decide a clear winner.

This sequence can be shown as

Round	1	2	3	4	5
Players	24	12	6	3	2
Scores	0-0	1-0	2-0	3-0	4-0

But it could happen that with 24 entrants and 3 players with 3-0 scores after round 3; that the player moved into the lower 2-1 score group for pairing, loses in the next round. This leads to only one player with a 4-0 score in round 5. This sequence could be shown as

Round	1	2	3	4	5
Players	24	12	6	3	1
Scores	0-0	1-0	2-0	3-0	4-0

In this case, the single player *A* with a 4-0 score will be paired with a player *B* with a 3-1 score in round 5. If *B* wins then both players will finish the tournament with equal 4-1 scores. A tiebreak method will be required to determine the winner and to order all players with identical scores. This outcome may apply to any tournament where the number of entrants is not one of the sequence $\ldots, 8, 16, 32, 64, 128, \ldots$ with the corresponding minimal number of rounds $\ldots, 3, 4, 5, 6, 7, \ldots$. A tournament with 24 entrants is shown in the Appendix.

The SPORT software manual has the following table

Number of entrants	Minimal Rounds	Suggested Rounds
9-16	4	6
17-32	5	7
33-64	6	8
etc.		

and makes the points:

- The pairing method assures that matches from about the third round on are between players of nearly equal level.
- The minimum number of rounds is the same number of rounds to be played in an elimination system, and that in practice, two additional rounds have been shown to be sufficient to establish a clear winner.
- Experience has shown that it is better to play shorter games with a higher number of rounds.

Swiss System Tie-break and Ranking using the Buchholtz Number (BHN)

The Buchholtz system is a ranking or scoring system, first used by Bruno Buchholtz in a Swiss System chess tournament in 1932 (Hooper & Whyld 1992). Originally developed as an auxiliary scoring method it is now used as a tie-breaking method in chess and other sports.

The principle of the system is that when two players have equal scores (number of wins) at the end of the defined number of rounds a tie break is required to determine the winner or top ranked player. The scores of both player's opponents (in all rounds) are added giving each their Buchholtz Number (BHN).

The player having the larger BHN wins (or is ranked higher) based on the assumption they have played against better performing players.

As an example consider two players *A* and *B* with equal scores of 4 at the end of a 4-round Swiss System petanque tournament. A tie break is required and each player's BHN is calculated.

Rank	Player	Score	BHN	fBHN	Games	Points
1	**A**	4	10	35	4:0	43:19
2	**B**	4	8	38	4:0	50:25
3	S	3	11	35	3:1	39:27
4	R	3	10	34	3:1	30:20
5	Y	3	9	33	3:1	42:32
:	:	:	:	:	:	:
8	X	2	11	31	2:2	35:34
:	:	:	:	:	:	:
11	Z	2	9	32	2:2	28:33
:	:	:	:	:	:	:
13	Q	2	8	32	2:2	34:34
:	:	:	:	:	:	:
16	P	2	6	33	2:2	31:37
:	:	:	:	:	:	:
18	W	1	9	29	1:3	31:46

[This table is an extract of the tournament data shown in the Appendix]

A player's BHN can only be calculated at the conclusion of a round, say round *n*. And its calculation requires knowing that player's opponents in round *n* and previous rounds $(n-1), (n-2), \ldots, 2, 1$ and their cumulative scores in round *n*. A player's Buchholtz Number is usually determined by computer software.

As an example consider two players *A* and *B* with equal scores of 4 at the end of a 4-round Swiss System petanque tournament. A tie break is required and each player's BHN is calculated.

> *A* played against *P, Q, R,* and *S* in rounds 1, 2, 3, and 4 respectively; and
> *B* played against *W, X, Y* and *Z* in the same rounds.

For player *A* adding the scores of *P, Q, R* and *S* gives *A's* Buchholtz Number as $BHN_A = 2+2+3+3=10$

For player *B* adding the scores of *W, X, Y* and *Z* gives *B's* Buchholtz Number as $BHN_B = 1+2+3+2=8$

Tie-break and Ranking using the Fine Buchholtz Number (fBHN)

Occasionally players may have identical scores and Buchholtz Numbers and in such cases a refinement known as the Fine Buchholtz Number (fBHN) can be used as a tie break.

A player's fBHN is the sum of the Buchholtz Numbers of all of the player's opponents.

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Appendix: Caulfield Mixed Triples – 22-Mar-2015

On Sun-22-Mar-2015 the Caulfield Park Petanque Club (Balaclava Rd, Caulfield North, VIC 3161, Australia) held a Mixed Triples tournament.

The format was 4 qualifying rounds Swiss System (timed games); top 8 teams into the Principale (elimination finals series); remaining teams into a 3-round Swiss System Consolante.

Scoring and Tournament Management with SPORT software.

The 24 entered teams (including three teams from New Zealand) are shown in the table below

Team	Name 1	Name 2	Name 3
A	SewHee, Kenny	Vencatasamy, Frederic	Langlois, Muriel
B	Grancourt, Sylvio	Grancourt, Danielle	Lablache, Tony
C	Edouard, Sebastien	Min Kuan, Lim	Masson, Denis
D	Mayor, Santiago	Lucette, Christian	Mayor, Pierette
E	Bradburn, Claire (NZ)	Bradburn, Brian (NZ)	Frost, Neville (NZ)
F	Hamon, Patrick	Willet, Rob	Karambolas, Gina
G	Langlois, Stephane	Marie, Eileen	Ramond, Guillaume
H	Parley, Jean (NZ)	Peachey, Bill (NZ)	Bunce, Colin (NZ)
J	Beaufort, Corinne	Leveque, Lucas	Anthian, Christiane
K	Deramond, Adeline	Langlois, Jacques	Langlois, Juliette
L	Maddern, Kerrie	Shaw, Geoff	Conway, Terry
M	Barker, Michael	Barker, Raeta	Liew, Maria
N	Ward, Kevin	Yeomans, Dianne	Kinghorn, Lindsay
P	Brown, Sandra	Buffet, Antoine	Ritman, Trish
Q	Finette, Gerard	Darbinian, Anastasea	Bernhard, Luc
R	Kinghorn, Bridie	Masson, Brooke	Masson, Christopher
S	Lacase, Julie	Lacase, Michel	Ally, Peter
T	Bommarito, Bernard	Darbinian, Sasha	Buckley, Colin
U	McRae, Helen	Wales, Gloria	Smith, Roger
V	Lubin, Pierrot	Masson, Annick	Leconte, Eric
W	Hebblethwaite, Rick	Hebblethwaite, Aileen	Dufroux, Jean Claude
X	Bunce, Marilyn (NZ)	Frost, Stephany (NZ)	Parley, Charles (NZ)
Y	Bahler, Guy	Barter, Terry	Beaufort, Benjamin
Z	Lebrasse, Medgee	Lousteau, Michel	Masson, Eddy

Note: Letters I and O not used

The results of the 4 qualifying rounds are shown below (winning teams **BOLD**). Round 1 pairings were random. Team Letter subscripts, e.g. $T_{(3)}$ indicate the team's score at the conclusion of the previous round. The subscript values relate to the score groups used for pairings.

ROUND 1

Match	Home	Guest	Scores
1	**Y**	L	13:5
2	W	**B**	7:13
3	K	**D**	9:13
4	N	**Z**	6:13
5	G	**R**	4:7
6	E	**S**	9:11
7	J	**C**	2:13
8	P	**A**	0:13
9	M	**F**	2:13
10	U	**T**	7:10
11	H	**Q**	6:12
12	V	**X**	6:13

ROUND 2

Match	Home	Guest	Scores
13	$Z_{(1)}$	**$Y_{(1)}$**	6:9
14	$X_{(1)}$	**$B_{(1)}$**	8:13
15	$Q_{(1)}$	**$A_{(1)}$**	8:12
16	**$R_{(1)}$**	$D_{(1)}$	9:4
17	$T_{(1)}$	**$F_{(1)}$**	4:13
18	$C_{(1)}$	**$S_{(1)}$**	6:10
19	$L_{(0)}$	**$E_{(0)}$**	0:13
20	$J_{(0)}$	**$W_{(0)}$**	10:11
21	**$H_{(0)}$**	$U_{(0)}$	13:6
22	**$V_{(0)}$**	$G_{(0)}$	13:7
23	**$P_{(0)}$**	$M_{(0)}$	10:8
24	$N_{(0)}$	**$K_{(0)}$**	10:12

ROUND 3

Match	Home	Guest	Scores
25	**$S_{(2)}$**	$F_{(2)}$	12:2
26	**$A_{(2)}$**	$R_{(2)}$	8:5
27	$Y_{(2)}$	**$B_{(2)}$**	9:11
28	$Q_{(1)}$	**$Z_{(1)}$**	5:8
29	**$V_{(1)}$**	$T_{(1)}$	12:5
30	**$K_{(1)}$**	$H_{(1)}$	6:4
31	**$C_{(1)}$**	$X_{(1)}$	13:1
32	$P_{(1)}$	**$E_{(1)}$**	9:12
33	$W_{(1)}$	**$D_{(1)}$**	8:10
34	**$U_{(0)}$**	$J_{(0)}$	13:10
35	$M_{(0)}$	**$G_{(0)}$**	4:13
36	**$L_{(0)}$**	$N_{(0)}$	13:3

ROUND 4

Match	Home	Guest	Scores
37	$S_{(3)}$	**$A_{(3)}$**	6:10
38	**$B_{(3)}$**	$Z_{(2)}$	13:1
39	**$C_{(2)}$**	$E_{(2)}$	10:4
40	$F_{(2)}$	**$R_{(2)}$**	4:9
41	$D_{(2)}$	**$Y_{(2)}$**	10:11
42	$K_{(2)}$	**$V_{(2)}$**	9:12
43	**$X_{(1)}$**	$H_{(1)}$	13:2
44	**$Q_{(1)}$**	$U_{(1)}$	9:8
45	**$T_{(1)}$**	$W_{(1)}$	13:5
46	$L_{(1)}$	**$G_{(1)}$**	4:10
47	**$P_{(1)}$**	$N_{(0)}$	12:4
48	**$J_{(0)}$**	$M_{(0)}$	13:4

After round 1 there are 12 winning teams (shown in BOLD) and these make up the 1:0 score group used for pairing in round 2. In round 2 there are two score groups, see matches 13-18 and 19-24.

After round 2 there are three score groups: 6 teams with 2:0 scores; 12 teams with 1:1 scores and 6 teams with 0:2 scores. These teams are paired in matches 25-27, 28-33 and 34-36 in round 3.

After round 3 there are four score groups: 3 teams with 3:0 scores; 9 teams with 2:1 scores; 9 teams with 1:2 scores and 3 teams with 0:3 scores. Because of the odd numbers in the score groups there are some 'unequal pairings' – see matches 38 and 47 in round 4. All other matches in round 4 are pairings of teams with the same score.

At the conclusion of the four qualifying rounds teams were ranked according to:

- Score
- Buchholtz Number (BHN) [see teams *A* and *B* ranked 1 and 2]
- Fine Buchholtz Number (fBHN) [see teams *C* and *V* ranked 6 and 7]
- Points Difference, delta = points For − points Against [see teams *E* and *Z* ranked 10 and 11]

Final Ranking Qualification

Rank	Team	Score	BHN	fBHN	Games	Points
1	A	4	10	35	4:0	43:19
2	B	4	8	38	4:0	50:25
3	S	3	11	35	3:1	39:27
4	R	3	10	34	3:1	30:20
5	Y	3	9	33	3:1	42:32
6	C	3	8	36	3:1	42:17
7	V	3	8	31	3:1	43:34
8	X	2	11	31	2:2	35:34
9	D	2	9	34	2:2	37:37
10	E	2	9	32	2:2	38:30
11	Z	2	9	32	2:2	28:33
12	F	2	8	35	2:2	32:27
13	Q	2	8	32	2:2	34:34
14	G	2	7	32	2:2	34:28
15	T	2	7	31	2:2	32:37
16	P	2	6	33	2:2	31:37
17	K	2	6	31	2:2	36:39
18	W	1	9	29	1:3	31:46
19	L	1	7	32	1:3	22:39
20	H	1	7	31	1:3	25:37
21	U	1	6	27	1:3	34:42
22	J	1	5	30	1:3	35:41
23	N	0	7	28	0:4	23:50
24	M	0	7	26	0:4	18:49

The top eight teams progressed to an elimination finals series. The remaining 16 teams played in a three-round Swiss System tournament.

All teams played 7 games for the day.