

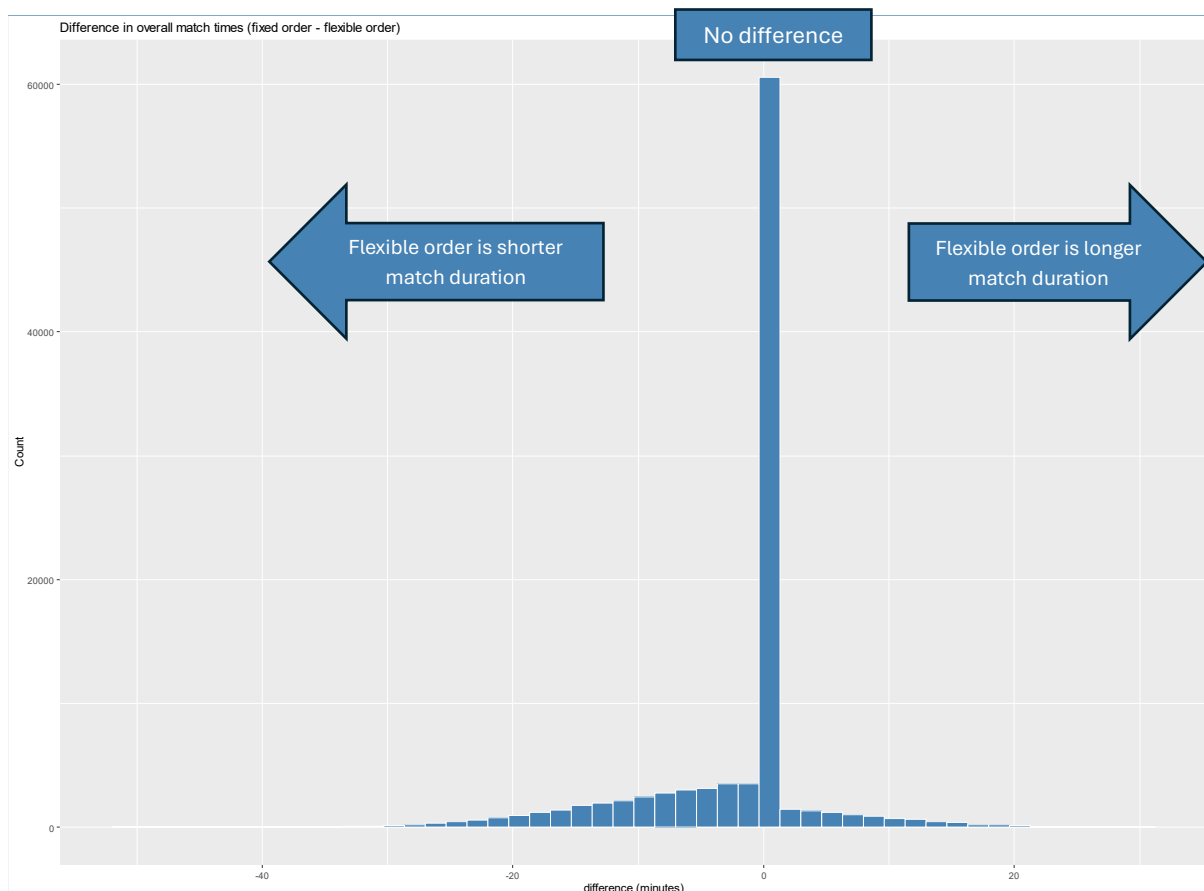
# HARPENDEN RACQUETEERS BADMINTON CLUB

## Analysis of match duration dependency on playing order (Mens 6 and Mixed 6)

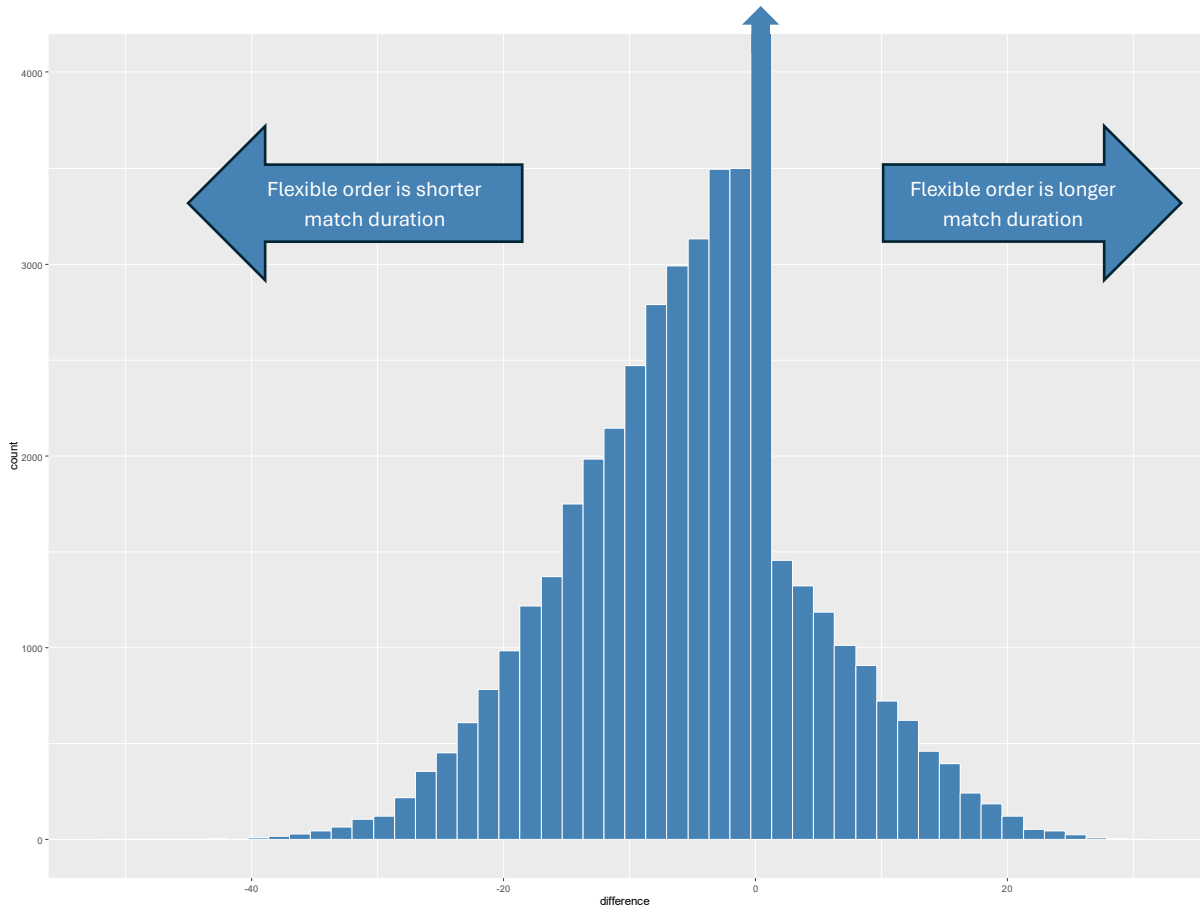
Many badminton leagues suggest a playing order for each rubber when matches comprise three pairs from each team. The question is whether it is better to stick to that order even if a court is free and another pair is available to play ('strict order'), or whether it is better to start a new rubber as soon as any pair is free ('flexible order'). To answer this question 100,000 matches were simulated assuming that only two courts are available for play and each rubber in those matches lasted a random length of time.

For the majority of matches (58% of the time) it makes no difference. Of the other 42%, the majority of matches would be shorter if a flexible order is adopted (32% are shorter, and 10% are longer).

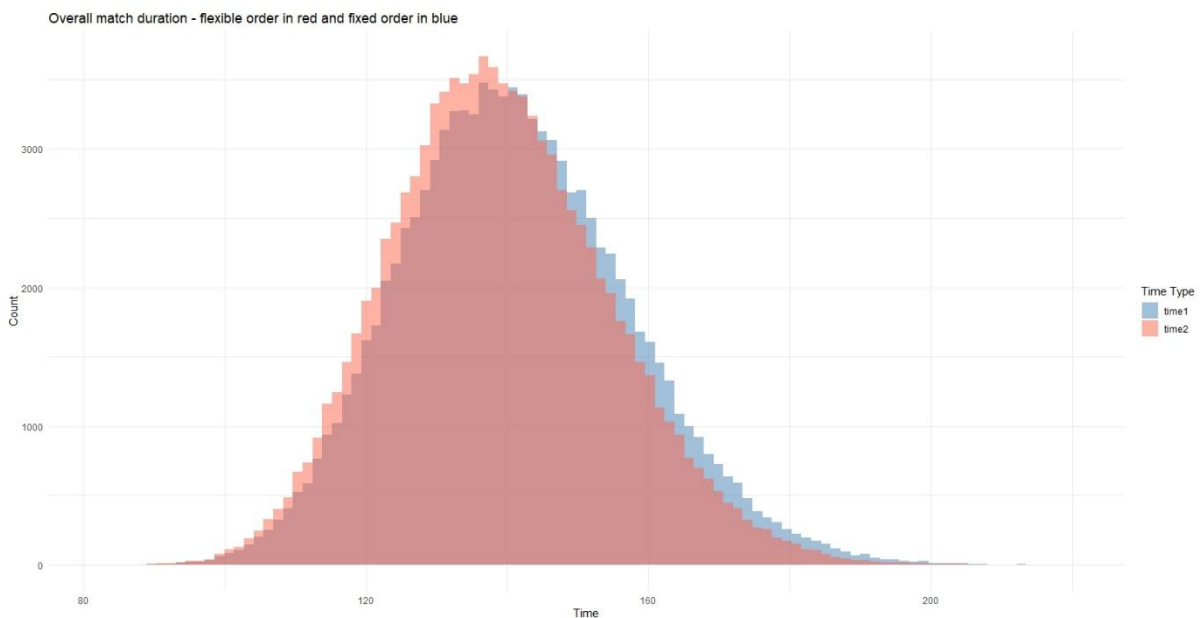
The difference in overall match lengths was compared when (1) playing pairs in strict order or (2) in a flexible order. Graphically the results were:



Zooming in on the bottom of this chart we can see that when it makes a difference, then playing a flexible order would save around 9 minutes overall.



For context the overall match duration of all 100,000 simulated matches showed the following distribution:



The average match duration was 2 hours 19 minutes where a flexible order was used and 2 hours 21 minutes where a fixed order was used.

## Details of the methodology

### Order of play

It is assumed that the scoresheet suggests the following order of play:

Order	Home	Away
1	Pair 1	Pair 1
2	Pair 2	Pair 2
3	Pair 3	Pair 3
4	Pair 2	Pair 1
5	Pair 3	Pair 2
6	Pair 1	Pair 3
7	Pair 3	Pair 1
8	Pair 1	Pair 2
9	Pair 2	Pair 3

PLAYING ORDER		
1	8	6
4	2	9
7	5	3

### Program

An algorithm was constructed (in R) to simulate 100,000 matches. For each match, random times for each rubber were generated and then used to simulate pairs playing their rubbers for those times. As each pair comes off court the algorithm would test to see if the next pair were available to start playing. For each set of rubber times, the next pair was: either selected based on the strict order above (and if both pairs required were not available then the court remained empty until the other game finished); or if any available pairs who had not played their rubber were available then they would go on court.

The annexes show example runs of the algorithm where in each case the duration of each rubber is the same, but (1) the overall match duration was the same even though the playing orders were different, (2) the overall match duration was longer when playing in a flexible order, and (3) the overall match duration was shorter when playing in a flexible order.

The code for the algorithm is available here:

[Playing order simulation.txt](#)

<https://1drv.ms/t/c/b2c9590716d4f627/IQDCYIARVOtFRrz7czZGck98Aa5dEZuVtLv9ClnW9O0tvkk?e=4L6QKj>

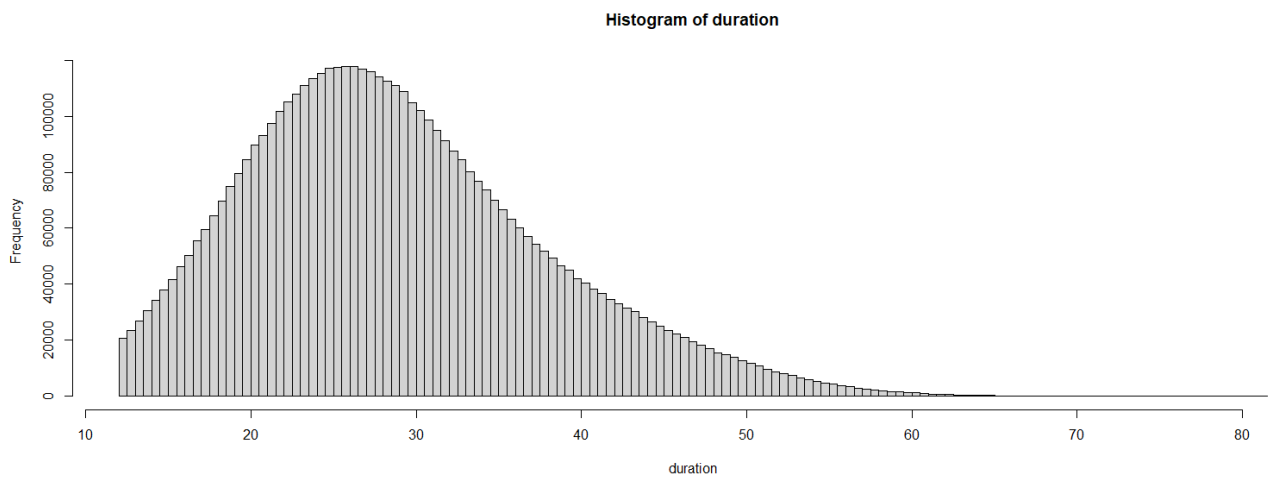
The annex shows an example of the playing times and sequence of play on both bases.

## Probability distribution for the duration of each rubber

The probability distribution for the random times for each rubber was generated assuming:

- the first two games have an average duration of 25 minutes (+/- 7 minutes) and follows a normal distribution (with a standard deviation of 7 minutes) but with a minimum playing time of 12 minutes
- one quarter of rubbers go to three games
- where a third game is played, then it has an average duration of 13 minutes (+/- 5 minutes) and follows a normal distribution but with a minimum playing time of 5 minutes

On this basis the average rubber duration was 29 minutes (+/- 9 minutes) and the distribution is slightly tail-heavy.



# Annex 1 – example of playing order: same overall time

## Playing in strict order

	cum.time	A1	A2	A3	B1	B2	B3	Playing1	Playing2	Time1	Time2
1	0.00000	rest	rest	rest	rest	rest	rest	0	0	0.00000	0.00000
2	0.00000	play	rest	rest	play	rest	rest	1	0	33.51560	0.00000
3	0.00000	play	play	rest	play	play	rest	1	2	33.51560	22.62195
4	22.62195	play	rest	rest	play	rest	rest	1	0	10.89366	0.00000
5	22.62195	play	rest	play	play	rest	play	1	3	10.89366	22.88691
6	33.51560	rest	rest	play	rest	rest	play	0	3	0.00000	11.99325
7	33.51560	rest	play	play	play	rest	play	4	3	36.34999	11.99325
8	45.50885	rest	play	rest	play	rest	rest	4	0	24.35674	0.00000
9	45.50885	rest	play	play	play	play	rest	4	5	24.35674	30.62547
10	69.86559	rest	rest	play	rest	play	rest	0	5	0.00000	6.26873
11	69.86559	play	rest	play	rest	play	play	6	5	33.41991	6.26873
12	76.13432	play	rest	rest	rest	rest	play	6	0	27.15118	0.00000
13	76.13432	play	rest	play	play	rest	play	6	7	27.15118	17.49490
14	93.62922	play	rest	rest	rest	rest	play	6	0	9.65628	0.00000
15	103.28550	rest	rest	rest	rest	rest	rest	0	0	0.00000	0.00000
16	103.28550	play	rest	rest	rest	play	rest	8	0	35.41828	0.00000
17	103.28550	play	play	rest	rest	play	play	8	9	35.41828	12.70655
18	115.99206	play	rest	rest	rest	play	rest	8	0	22.71173	0.00000
19	138.70378	rest	rest	rest	rest	rest	rest	0	0	0.00000	0.00000

Random time for rubber 1

Random time for rubber 2

## Playing in a flexible order

	cum.time	A1	A2	A3	B1	B2	B3	Playing1	Playing2	Time1	Time2
1	0.00000	rest	rest	rest	rest	rest	rest	0	0	0.00000	0.00000
2	0.00000	play	rest	rest	play	rest	rest	1	0	33.51560	0.00000
3	0.00000	play	play	rest	play	play	rest	1	2	33.51560	22.62195
4	22.62195	play	rest	rest	play	rest	rest	1	0	10.89366	0.00000
5	22.62195	play	rest	play	play	rest	play	1	3	10.89366	22.88691
6	33.51560	rest	rest	play	rest	rest	play	0	3	0.00000	11.99325
7	33.51560	rest	play	play	play	rest	play	4	3	36.34999	11.99325
8	45.50885	rest	play	rest	play	rest	rest	4	0	24.35674	0.00000
9	45.50885	rest	play	play	play	play	rest	4	5	24.35674	30.62547
10	69.86559	rest	rest	play	rest	play	rest	0	5	0.00000	6.26873
11	69.86559	play	rest	play	rest	play	play	6	5	33.41991	6.26873
12	76.13432	play	rest	rest	rest	rest	play	6	0	27.15118	0.00000
13	76.13432	play	rest	play	play	rest	play	6	7	27.15118	17.49490
14	93.62922	play	rest	rest	rest	rest	play	6	0	9.65628	0.00000
15	103.28550	rest	rest	rest	rest	rest	rest	0	0	0.00000	0.00000
16	103.28550	play	rest	rest	rest	play	rest	8	0	35.41828	0.00000
17	103.28550	play	play	rest	rest	play	play	8	9	35.41828	12.70655
18	115.99206	play	rest	rest	rest	play	rest	8	0	22.71173	0.00000
19	138.70378	rest	rest	rest	rest	rest	rest	0	0	0.00000	0.00000

Playing order is the same in both cases as there is no alternative rubber to be put on whilst waiting 9 minutes for rubber 6 to finish

Same overall match length

## Annex 2 – example of playing order: flexible order is longer

### Playing in strict order

	cum.time	A1	A2	A3	B1	B2	B3	Playing1	Playing2	Time1	Time2
1	0.00000	rest	rest	rest	rest	rest	rest	0	0	0.000000	0.000000
2	0.00000	play	rest	rest	play	rest	rest	1	0	30.614081	0.000000
3	0.00000	play	play	rest	play	play	rest	1	2	30.614081	24.143499
4	24.14350	play	rest	rest	play	rest	rest	1	0	6.470581	0.000000
5	24.14350	play	rest	play	play	rest	play	1	3	6.470581	35.433605
6	30.61408	rest	rest	play	rest	rest	play	0	3	0.000000	28.963024
7	30.61408	rest	play	play	play	rest	play	4	3	19.358017	28.963024
8	49.97210	rest	rest	play	rest	rest	play	0	3	0.000000	9.605007
9	59.57710	rest	rest	rest	rest	rest	rest	0	0	0.000000	0.000000
10	59.57710	rest	rest	play	rest	play	rest	5	0	32.646870	0.000000
11	59.57710	play	rest	play	rest	play	play	5	6	32.646870	61.400614
12	92.22397	play	rest	rest	rest	rest	play	0	6	0.000000	28.753745
13	92.22397	play	rest	play	play	rest	play	7	6	28.587973	28.753745
14	120.81195	play	rest	rest	rest	rest	play	0	6	0.000000	0.165772
15	120.97772	rest	rest	rest	rest	rest	rest	0	0	0.000000	0.000000
16	120.97772	play	rest	rest	rest	play	rest	8	0	38.628461	0.000000
17	120.97772	play	play	rest	rest	play	play	8	9	38.628461	16.683311
18	137.66103	play	rest	rest	rest	play	rest	8	0	21.945150	0.000000
19	159.60618	rest	rest	rest	rest	rest	rest	0	0	0.000000	0.000000

Rubbers 5 and 7 get played whilst the long rubber 6 is on court

### Playing in a flexible order

	cum.time	A1	A2	A3	B1	B2	B3	Playing1	Playing2	Time1	Time2
1	0.00000	rest	rest	rest	rest	rest	rest	0	0	0.000000	0.000000
2	0.00000	play	rest	rest	play	rest	rest	1	0	30.6140805	0.000000
3	0.00000	play	play	rest	play	play	rest	1	2	30.6140805	24.143499
4	24.14350	play	rest	rest	play	rest	rest	1	0	6.4705813	0.000000
5	24.14350	play	rest	play	play	rest	play	1	3	6.4705813	35.433605
6	30.61408	rest	rest	play	rest	rest	play	0	3	0.0000000	28.963024
7	30.61408	rest	play	play	play	rest	play	4	3	19.3580168	28.963024
8	49.97210	rest	rest	play	rest	rest	play	0	3	0.0000000	9.605007
9	49.97210	play	rest	play	rest	play	play	8	3	38.6284613	9.605007
10	59.57710	play	rest	rest	rest	play	rest	8	0	29.0234543	0.000000
11	59.57710	play	rest	play	play	play	rest	8	7	29.0234543	28.587973
12	88.16508	play	rest	rest	rest	play	rest	8	0	0.4354817	0.000000
13	88.16508	play	play	rest	rest	play	play	8	9	0.4354817	16.683311
14	88.60056	rest	play	rest	rest	rest	play	0	9	0.0000000	16.247829
15	88.60056	rest	play	play	rest	play	play	5	9	32.6468697	16.247829
16	104.84839	rest	rest	play	rest	play	rest	5	0	16.3990403	0.000000
17	104.84839	play	rest	play	rest	play	play	5	6	16.3990403	61.400614
18	121.24743	play	rest	rest	rest	rest	play	0	6	0.0000000	45.001574
19	166.24900	rest	rest	rest	rest	rest	rest	0	0	0.0000000	0.000000

The flexible playing order means that the overall match takes longer

Rubber 6 gets played last but is particularly long

### Annex 3 – example of playing order: flexible order is shorter

▲	cum.time	A1	A2	A3	B1	B2	B3	Playing1	Playing2	Time1	Time2
1	0.00000	rest	rest	rest	rest	rest	rest	0	0	0.000000	0.000000
2	0.00000	play	rest	rest	play	rest	rest	1	0	19.001711	0.000000
3	0.00000	play	play	rest	play	play	rest	1	2	19.001711	17.292937
4	17.29294	play	rest	rest	play	rest	rest	1	0	1.708774	0.000000
5	17.29294	play	rest	play	play	rest	play	1	3	1.708774	47.144459
6	19.00171	rest	rest	play	rest	rest	play	0	3	0.000000	45.435685
7	19.00171	rest	play	play	play	rest	play	4	3	44.098627	45.435685
8	63.10034	rest	rest	play	rest	rest	play	0	3	0.000000	1.337058
9	64.43740	rest	rest	rest	rest	rest	rest	0	0	0.000000	0.000000
10	64.43740	rest	rest	play	rest	play	rest	5	0	33.650667	0.000000
11	64.43740	play	rest	play	rest	play	play	5	6	33.650667	19.731913
12	84.16931	rest	rest	play	rest	play	rest	5	0	13.918754	0.000000
13	98.08806	rest	rest	rest	rest	rest	rest	0	0	0.000000	0.000000
14	98.08806	rest	rest	play	play	rest	rest	7	0	49.051758	0.000000
15	98.08806	play	rest	play	play	play	rest	7	8	49.051758	38.632429
16	136.72049	rest	rest	play	play	rest	rest	7	0	10.419330	0.000000
17	136.72049	rest	play	play	play	rest	play	7	9	10.419330	23.878812
18	147.13982	rest	play	rest	rest	rest	play	0	9	0.000000	13.459482
19	160.59930	rest	rest	rest	rest	rest	rest	0	0	0.000000	0.000000

Need to wait 1 minute before rubber 5 can be put on court

Need to wait 13 minutes before rubber 7 can be put on court

▲	cum.time	A1	A2	A3	B1	B2	B3	Playing1	Playing2	Time1	Time2
1	0.00000	rest	rest	rest	rest	rest	rest	0	0	0.000000	0.000000
2	0.00000	play	rest	rest	play	rest	rest	1	0	19.001711	0.000000
3	0.00000	play	play	rest	play	play	rest	1	2	19.001711	17.292937
4	17.29294	play	rest	rest	play	rest	rest	1	0	1.708774	0.000000
5	17.29294	play	rest	play	play	rest	play	1	3	1.708774	47.144459
6	19.00171	rest	rest	play	rest	rest	play	0	3	0.000000	45.435685
7	19.00171	rest	play	play	play	rest	play	4	3	44.098627	45.435685
8	63.10034	rest	rest	play	rest	rest	play	0	3	0.000000	1.337058
9	63.10034	play	rest	play	rest	play	play	8	3	38.632429	1.337058
10	64.43740	play	rest	rest	rest	play	rest	8	0	37.295370	0.000000
11	64.43740	play	rest	play	play	play	rest	8	7	37.295370	49.051758
12	101.73277	rest	rest	play	play	rest	rest	0	7	0.000000	11.756388
13	101.73277	play	rest	play	play	rest	play	6	7	19.731913	11.756388
14	113.48915	play	rest	rest	rest	rest	play	6	0	7.975525	0.000000
15	113.48915	play	rest	play	rest	play	play	6	5	7.975525	33.650667
16	121.46468	rest	rest	play	rest	play	rest	0	5	0.000000	25.675141
17	121.46468	rest	play	play	rest	play	play	9	5	23.878812	25.675141
18	145.34349	rest	rest	play	rest	play	rest	0	5	0.000000	1.796330
19	147.13982	rest	rest	rest	rest	rest	rest	0	0	0.000000	0.000000

The flexible playing order means that the overall match takes less time