

## Exercise 2-5 Solution file from Kelton/Sadowski/Zupick, *Simulation With Arena*, 6th edition, McGraw-Hill, 2015

There are now two “spots” in the server rather than one, shown in the table as two underlined spaces for In Service Arrival Times. Departure records are still placed on the event calendar, but we need to indicate in parentheses after the Arrival Times of entities in service their entity number to match them up with the correct departure records. Table 2-2 becomes:

Just-Finished Event			Variables		Attributes		Statistical Accumulators									Event Calendar		
Entity No.	Time $t$	Event Type	$Q(t)$	$B(t)$	Arrival Times: (In Queue)   In Service		$P$	$N$	$\Sigma WQ$	$WQ^*$	$\Sigma TS$	$TS^*$	$\int Q$	$Q^*$	$\int B$	[Entity   Time,   Type]		
–	0.00	Init	0	0	()	–	0	0	0.00	0.00	0.00	0.00	0.00	0	0.00	[1,   0.00,   Arr] [–,   20.00,   End]		
1	0.00	Arr	0	1	()	<u>0.00 (1)</u> –	0	1	0.00	0.00	0.00	0.00	0.00	0	0.00	[2,   1.73,   Arr] [1,   2.90,   Dep] [–,   20.00,   End]		
2	1.73	Arr	0	2	()	<u>0.00 (1)</u> <u>1.73 (2)</u>	0	2	0.00	0.00	0.00	0.00	0.00	0	1.73	[1,   2.90,   Dep] [3,   3.08,   Arr] [2,   3.49,   Dep] [–,   20.00,   End]		
1	2.90	Dep	0	1	()	– <u>1.73 (2)</u>	1	2	0.00	0.00	2.90	2.90	0.00	0	4.07	[3,   3.08,   Arr] [2,   3.49,   Dep] [–,   20.00,   End]		
3	3.08	Arr	0	2	()	<u>3.08 (3)</u> <u>1.73 (2)</u>	1	3	0.00	0.00	2.90	2.90	0.00	0	4.25	[2,   3.49,   Dep] [4,   3.79,   Arr] [3,   6.47,   Dep] [–,   20.00,   End]		
2	3.49	Dep	0	1	()	<u>3.08 (3)</u> –	2	3	0.00	0.00	4.66	2.90	0.00	0	5.07	[4,   3.79,   Arr] [3,   6.47,   Dep] [–,   20.00,   End]		
4	3.79	Arr	0	2	()	<u>3.08 (3)</u> <u>3.79 (4)</u>	2	4	0.00	0.00	4.66	2.90	0.00	0	5.37	[5,   4.41,   Arr] [3,   6.47,   Dep] [4,   8.31,   Dep] [–,   20.00,   End]		
5	4.41	Arr	1	2	(4.41)	<u>3.08 (3)</u> <u>3.79 (4)</u>	2	4	0.00	0.00	4.66	2.90	0.00	1	6.61	[3,   6.47,   Dep] [4,   8.31,   Dep] [6,   18.69,   Arr] [–,   20.00,   End]		
3	6.47	Dep	0	2	()	<u>4.41 (5)</u> <u>3.79 (4)</u>	3	5	2.06	2.06	8.05	3.39	2.06	1	10.73	[4,   8.31,   Dep] [5,   10.93,   Dep] [6,   18.69,   Arr] [–,   20.00,   End]		
4	8.31	Dep	0	1	()	<u>4.41 (5)</u> –	4	5	2.06	2.06	12.57	4.52	2.06	1	14.41	[5,   10.93,   Dep] [6,   18.69,   Arr] [–,   20.00,   End]		
5	10.93	Dep	0	0	()	– –	5	5	2.06	2.06	19.09	6.52	2.06	1	17.03	[6,   18.69,   Arr] [–,   20.00,   End]		
6	18.69	Arr	0	1	()	<u>18.69 (6)</u> –	5	6	2.06	2.06	19.09	6.52	2.06	1	17.03	[7,   19.39,   Arr] [–,   20.00,   End] [6,   23.05,   Dep]		
7	19.39	Arr	0	2	()	<u>18.69 (6)</u> <u>19.39 (7)</u>	5	7	2.06	2.06	19.09	6.52	2.06	1	17.73	[–,   20.00,   End] [7,   21.46,   Dep] [6,   23.05,   Dep] [8,   34.91,   Arr]		
–	20.00	End	0	2	()	<u>18.69 (6)</u> <u>19.39 (7)</u>	5	7	2.06	2.06	19.09	6.52	2.06	1	18.95	[7,   21.46,   Dep] [6,   23.05,   Dep] [8,   34.91,   Arr]		

Here are the summary results:

Performance Measure	Value	Result from Table 2-3	Change
Total production	5 parts	5 parts	No change
Average waiting time in queue	0.29 minute per part (7 parts)	2.53 minutes per part (6 parts)	Decreased
Maximum waiting time in queue	2.06 minutes	8.16 minutes	Decreased
Average total time in system	3.82 minutes per part (5 parts)	6.44 minutes per part (5 parts)	Decreased
Maximum total time in system	6.52 minutes	12.62 minutes	Decreased
Time-average number of parts in queue	0.10 part	0.79 part	Decreased
Maximum number of parts in queue	1 part	3 parts	Decreased
Drill-press utilization	0.47 [= $18.95/(2 \times 20)$ ] (dimensionless proportion)	0.92 (dimensionless proportion)	Decreased

Congestion is considerably relieved on all measures; the average total time in system is reduced the least since parts must still endure their (same) processing times no matter how little time they have to wait in queue.