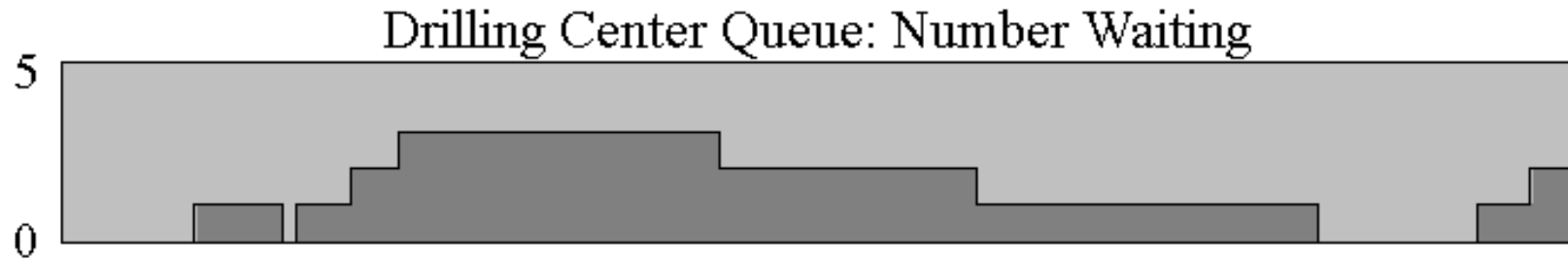


Exercise 2-8 Solution file from Kelton/Sadowski/Zupick, *Simulation With Arena*, 6th edition, McGraw-Hill, 2015

Introduce a new event type (Down) and schedule it on initialization to happen at time 4; the extra event record is shaded in the table below. This does nothing to the state variables or statistical accumulators until time 4 rolls around and the Down event is executed. At that time, the time of departure of the part in service (entity no. 2) is changed from its prior value (4.66) to that plus the 4-minute downtime, or $4.66 + 4 = 8.66$ (new event time shaded in the event calendar at that time). We also schedule an event for the drill press to come back up (Up) at time $4 + 4 = 8$ (event record shaded). In this particular realization, having such an “Up” event might not be deemed necessary, but in general it could be in the case that the Down event happened when the machine happened to be idle, in which case we’d need to define it as busy at that time (blocking arrivals during the downtime from entering service), and when it comes back up execute logic to release the first part in queue (if any) to begin service. The calculations in the table below are similar to what’s in Section 2.4.3 so we leave it to you to recreate this table and check your work. Here’s a crude plot of the number-in-queue curve:



The final output performance measures are:

- Total production = 4
- Average waiting time in queue = $27.17/5 = 5.43$ minutes per part (5 parts)
- Maximum waiting time in queue = 12.16 minutes
- Average total time in system = $31.58/4 = 7.90$ minutes per part (4 parts)
- Maximum total time in system = 12.78 minutes
- Time-average number of parts in queue = $29.09/20 = 1.45$ parts
- Maximum number of parts in queue = 3 parts
- Drill-press utilization = $20.00/20 = 1.00$

Comparing these results to those in Table 2-3, we see that the downtime had the effect of reducing production and increasing congestion ... OK, maybe not surprising, but it would have been hard to quantify this without the simulation. A legitimate question (that we hope you’re asking yourself) is whether the observed differences are statistically significant ... stay tuned (Exercise 6-18).

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	ΣWQ	WQ^*	ΣTS	TS^*	$\downarrow Q$	Q^*	$\downarrow B$		[Entity No., 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]		
																	[–, 4.00, Down]		
																	[–, 20.00, End]		
1	0.00	Arr	0	1	() 0.00		0	1	0.00	0.00	0.00	0.00	0.00	0	0.00		[2, 1.73, Arr]		
																	[1, 2.90, Dep]		
																	[–, 4.00, Down]		
																	[–, 20.00, End]		
2	1.73	Arr	1	1	(1.73) 0.00		0	1	0.00	0.00	0.00	0.00	0.00	1	1.73		[1, 2.90, Dep]		
																	[3, 3.08, Arr]		
																	[–, 4.00, Down]		
																	[–, 20.00, End]		

1	2.90	Dep	0	1	()	1.73	1	2	1.17	1.17	2.90	2.90	1.17	1	2.90	[3, 3.08, Arr] [-, 4.00, Down] [2, 4.66, Dep] [-, 20.00, End]
3	3.08	Arr	1	1	(3.08)	1.73	1	2	1.17	1.17	2.90	2.90	1.17	1	3.08	[4, 3.79, Arr] [-, 4.00, Down] [2, 4.66, Dep] [-, 20.00, End]
4	3.79	Arr	2	1	(3.79, 3.08)	1.73	1	2	1.17	1.17	2.90	2.90	1.88	2	3.79	[-, 4.00, Down] [5, 4.41, Arr] [2, 4.66, Dep] [-, 20.00, End]
-	4.00	Down	2	1	(3.79, 3.08)	1.73	1	2	1.17	1.17	2.90	2.90	2.30	2	4.00	[5, 4.41, Arr] [2, 8.66, Dep] [-, 8.00, Up] [-, 20.00, End]
5	4.41	Arr	3	1	(4.41, 3.79, 3.08)	1.73	1	2	1.17	1.17	2.90	2.90	3.12	3	4.41	[-, 8.00, Up] [2, 8.66, Dep] [6, 18.69, Arr] [-, 20.00, End]
-	8.00	Up	3	1	(4.41, 3.79, 3.08)	1.73	1	2	1.17	1.17	2.90	2.90	13.89	3	7.00	[2, 8.66, Dep] [6, 18.69, Arr] [-, 20.00, End]
2	8.66	Dep	2	1	(4.41, 3.79)	3.08	2	3	6.75	5.58	9.83	6.93	15.87	3	8.66	[3, 12.05, Dep] [6, 18.69, Arr] [-, 20.00, End]
3	12.05	Dep	1	1	(4.41)	3.79	3	4	15.01	8.26	18.80	8.97	22.65	3	12.05	[4, 16.57, Dep] [6, 18.69, Arr] [-, 20.00, End]
4	16.57	Dep	0	1	()	4.41	4	5	27.17	12.16	31.58	12.78	27.17	3	16.57	[6, 18.69, Arr] [-, 20.00, End] [5, 21.03, Dep]
6	18.69	Arr	1	1	(18.69)	4.41	4	5	27.17	12.16	31.58	12.78	27.17	3	18.69	[7, 19.39, Arr] [-, 20.00, End] [5, 21.03, Dep]
7	19.39	Arr	2	1	(19.39, 18.69)	4.41	4	5	27.17	12.16	31.58	12.78	27.87	3	19.39	[-, 20.00, End] [5, 21.03, Dep] [8, 34.91, Arr]
-	20.00	End	2	1	(19.39, 18.69)	4.41	4	5	27.17	12.16	31.58	12.78	29.09	3	20.00	[5, 21.03, Dep] [8, 34.91, Arr]