Exercise 2-1

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

Define $S(t)$ = the total number of parts in the system (in queue plus in service) at time t, let $\int S$ denote the area under $S(t)$ up to the event time at a row in the table, and S^* be the maximum value of $S(t)$ observed up to the event time in the row. Table 2-2 is then augmented as follows (the new cells are shaded):

Just-Finished Event			Variables			Attributes		Statistical Accumulators										Event Calendar		
Entity No.	Time t	Event Type	$Q(t)$	$B(t)$	$S(t)$	Arrival Times: (In Queue)	In Service	P	N	ΣWQ	WQ^*	ΣTS	TS^*	$\int Q$	Q^*	$\int B$	$\int S$	S^*	[Entity No.,	Time,	Type]
–	0.00	Init	0	0	0	()	–	0	0	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	0	[1,	0.00,	Arr]
																			[–,	20.00,	End]
1	0.00	Arr	0	1	1	()	0.00	0	1	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00	1	[2,	1.73,	Arr]
																			[1,	2.90,	Dep]
																			[–,	20.00,	End]
2	1.73	Arr	1	1	2	(1.73)	0.00	0	1	0.00	0.00	0.00	0.00	0.00	1	1.73	1.73	2	[1,	2.90,	Dep]
																			[3,	3.08,	Arr]
																			[–,	20.00,	End]
1	2.90	Dep	0	1	1	()	1.73	1	2	1.17	1.17	2.90	2.90	1.17	1	2.90	4.07	2	[3,	3.08,	Arr]
																			[2,	4.66,	Dep]
																			[–,	20.00,	End]
3	3.08	Arr	1	1	2	(3.08)	1.73	1	2	1.17	1.17	2.90	2.90	1.17	1	3.08	4.25	2	[4,	3.79,	Arr]
																			[2,	4.66,	Dep]
																			[–,	20.00,	End]
4	3.79	Arr	2	1	3	(3.79, 3.08)	1.73	1	2	1.17	1.17	2.90	2.90	1.88	2	3.79	5.67	3	[5,	4.41,	Arr]
																			[2,	4.66,	Dep]
																			[–,	20.00,	End]
5	4.41	Arr	3	1	4	(4.41, 3.79, 3.08)	1.73	1	2	1.17	1.17	2.90	2.90	3.12	3	4.41	7.53	4	[2,	4.66,	Dep]
																			[6,	18.69,	Arr]
																			[–,	20.00,	End]
2	4.66	Dep	2	1	3	(4.41, 3.79)	3.08	2	3	2.75	1.58	5.83	2.93	3.87	3	4.66	8.53	4	[3,	8.05,	Dep]
																			[6,	18.69,	Arr]
																			[–,	20.00,	End]
3	8.05	Dep	1	1	2	(4.41)	3.79	3	4	7.01	4.26	10.80	4.97	10.65	3	8.05	18.79	4	[4,	12.57,	Dep]
																			[6,	18.69,	Arr]
																			[–,	20.00,	End]
4	12.57	Dep	0	1	1	()	4.41	4	5	15.17	8.16	19.58	8.78	15.17	3	12.57	27.74	4	[5,	17.03,	Dep]
																			[6,	18.69,	Arr]
																			[–,	20.00,	End]
5	17.03	Dep	0	0	0	()	–	5	5	15.17	8.16	32.20	12.62	15.17	3	17.03	32.20	4	[6,	18.69,	Arr]
																			[–,	20.00,	End]
6	18.69	Arr	0	1	1	()	18.69	5	6	15.17	8.16	32.20	12.62	15.17	3	17.03	32.20	4	[7,	19.39,	Arr]
																			[–,	20.00,	End]
																			[6,	23.05,	Dep]
7	19.39	Arr	1	1	2	(19.39)	18.69	5	6	15.17	8.16	32.20	12.62	15.17	3	17.73	32.90	4	[–,	20.00,	End]
																			[6,	23.05,	Dep]
																			[8,	34.91,	Arr]
–	20.00	End	1	1	2	(19.39)	18.69	5	6	15.17	8.16	32.20	12.62	15.78	3	18.34	34.12	4	[6,	23.05,	Dep]
																			[8,	34.91,	Arr]

The time-average number in system is 34.12/20 = 1.706 and the maximum number in system is 4. Here's a crude plot of $S(t)$: