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 $/ S$ 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 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{array}{\|c\|} \hline \text { Entity } \\ \text { No. } \\ \hline \end{array}$ | Time $t$ | Event Type | $Q(t)$ | $B(t)$ | $S(t)$ | Arrival Times: <br> (In Queue) In Service | $P$ | $N$ | IWQ | WQ* | ETS | TS* | $\int Q$ | Q* | fB | [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 | $\begin{aligned} & \hline[1, \\ & {[-,} \end{aligned}$ | $\begin{array}{r} \hline 0.00, \\ 20.00, \end{array}$ | Arr] End |
| 1 | 0.00 | Arr | 0 | 1 | 1 | () $\underline{0.00}$ | 0 | 1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 1 | $\begin{aligned} & {[2,} \\ & {[1,} \\ & {[-,} \end{aligned}$ | $\begin{array}{r} 1.73, \\ 2.90, \\ 20.00, \end{array}$ | $\begin{array}{\|c\|} \hline \text { Arr) } \\ \text { Dep } 1 \\ \text { End } \\ \hline \end{array}$ |
| 2 | 1.73 | Arr | 1 | 1 | 2 | (1.73) $\quad \underline{0.00}$ | 0 | 1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1 | 1.73 | 1.73 | 2 | $\begin{aligned} & {[1,} \\ & {[3,} \\ & {[-,} \\ & \hline \end{aligned}$ | $\begin{array}{r} 2.90, \\ 3.08, \\ 20.00, \\ \hline \end{array}$ | $\begin{array}{\|} \hline \text { Dep } \\ \text { Arr) } \\ \text { End } \\ \hline \end{array}$ |
| 1 | 2.90 | Dep | 0 | 1 | 1 | () $\underline{1.73}$ | 1 | 2 | 1.17 | 1.17 | 2.90 | 2.90 | 1.17 | 1 | 2.90 | 4.07 | 2 | $\begin{aligned} & {[3,} \\ & {[2,} \\ & {[-,} \end{aligned}$ | $\begin{array}{r} 3.08, \\ 4.66 \\ 20.00, \\ \hline \end{array}$ | $\begin{gathered} \hline \text { Arr] } \\ \text { Dep } \\ \text { End] } \\ \hline \end{gathered}$ |
| 3 | 3.08 | Arr | 1 | 1 | 2 | (3.08) $\quad 1.73$ | 1 | 2 | 1.17 | 1.17 | 2.90 | 2.90 | 1.17 | 1 | 3.08 | 4.25 | 2 | $\begin{aligned} & {[4,} \\ & {[2,} \\ & {[-,} \end{aligned}$ | $\begin{array}{r} 3.79, \\ 4.66, \\ 20.00 \\ \hline \end{array}$ | $\begin{array}{r} \text { Arr] } \\ \text { Dep] } \\ \text { End } \end{array}$ |
| 4 | 3.79 | Arr | 2 | 1 | 3 | $(3.79,3.08) \quad \underline{1.73}$ | 1 | 2 | 1.17 | 1.17 | 2.90 | 2.90 | 1.88 | 2 | 3.79 | 5.67 | 3 | [5, <br> [2, <br> [-, | $\begin{gathered} 4.41, \\ 4.66, \\ 20.00, \end{gathered}$ | $\begin{array}{\|c\|} \hline \text { Arr) } \\ \text { Dep } \\ \text { End } \\ \hline \end{array}$ |
| 5 | 4.41 | Arr | 3 | 1 | 4 | $(4.41,3.79,3.08) \quad \underline{1.73}$ | 1 | 2 | 1.17 | 1.17 | 2.90 | 2.90 | 3.12 | 3 | 4.41 | 7.53 | 4 | $\begin{aligned} & {[2,} \\ & {[6,} \\ & {[-,} \end{aligned}$ | $\begin{array}{r} \hline 4.66, \\ 18.69, \\ 20.00, \\ \hline \end{array}$ | $\begin{gathered} \hline \text { Dep } \\ \text { Arr] } \\ \text { End] } \end{gathered}$ |
| 2 | 4.66 | Dep | 2 | 1 | 3 | $(4.41,3.79) \quad \underline{3.08}$ | 2 | 3 | 2.75 | 1.58 | 5.83 | 2.93 | 3.87 | 3 | 4.66 | 8.53 | 4 | $\begin{aligned} & \hline[3, \\ & {[6,} \\ & {[-,} \\ & \hline \end{aligned}$ | $\begin{array}{r} 8.05, \\ 18.69, \\ 20.00, \\ \hline \end{array}$ | $\begin{array}{r} \hline \text { Dep } \\ \text { Arr] } \\ \text { End } \end{array}$ |
| 3 | 8.05 | Dep | 1 | 1 | 2 | (4.41) $\quad \underline{3.79}$ | 3 | 4 | 7.01 | 4.26 | 10.80 | 4.97 | 10.65 | 3 | 8.05 | 18.79 | 4 | $\begin{aligned} & {[4,} \\ & {[6,} \\ & {[-,} \\ & \hline \end{aligned}$ | $\begin{aligned} & 12.57, \\ & 18.69, \\ & 20.00, \end{aligned}$ | $\begin{array}{\|r} \hline \text { Dep } \\ \text { Arr) } \\ \text { End } \\ \hline \end{array}$ |
| 4 | 12.57 | Dep | 0 | 1 | 1 | () $\quad \underline{4.41}$ | 4 | 5 | 15.17 | 8.16 | 19.58 | 8.78 | 15.17 | 3 | 12.57 | 27.74 | 4 | $\begin{aligned} & {[5,} \\ & {[6,} \\ & {[-,} \\ & \hline \end{aligned}$ | $\begin{aligned} & 17.03, \\ & 18.69, \\ & 20.00, \\ & \hline \end{aligned}$ | $\begin{array}{r} \hline \text { Dep } \\ \text { Arr] } \\ \text { End } \end{array}$ |
| 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 | $\begin{aligned} & {[6,} \\ & {[-,} \\ & \hline \end{aligned}$ | $\begin{aligned} & 18.69, \\ & 20.00, \end{aligned}$ | Arr] End |
| 6 | 18.69 | Arr | 0 | 1 | 1 | () $\quad 18.69$ | 5 | 6 | 15.17 | 8.16 | 32.20 | 12.62 | 15.17 | 3 | 17.03 | 32.20 | 4 | $\begin{aligned} & \hline[7, \\ & {[-,} \\ & {[6,} \\ & \hline \end{aligned}$ | $\begin{aligned} & \hline 19.39, \\ & 20.00, \\ & 23.05, \end{aligned}$ | $\begin{gathered} \text { Arr] } \\ \text { End] } \\ \text { Dep] } \end{gathered}$ |
| 7 | 19.39 | Arr | 1 | 1 | 2 | (19.39) $\quad \underline{18.69}$ | 5 | 6 | 15.17 | 8.16 | 32.20 | 12.62 | 15.17 | 3 | 17.73 | 32.90 | 4 | $\begin{aligned} & \hline-, \\ & {[6,} \\ & {[8,} \\ & \hline \end{aligned}$ | $\begin{aligned} & 20.00, \\ & 23.05, \\ & 34.91, \end{aligned}$ | $\begin{array}{\|c\|} \hline \text { End } \\ \text { Dep } 1 \\ \text { Arr] } \end{array}$ |
| - | 20.00 | End | 1 | 1 | 2 | (19.39) $\quad \underline{18.69}$ | 5 | 6 | 15.17 | 8.16 | 32.20 | 12.62 | 15.78 | 3 | 18.34 | 34.12 | 4 | $\begin{aligned} & {[6,} \\ & {[8,} \end{aligned}$ | $\begin{aligned} & 23.05, \\ & 34.91, \end{aligned}$ | $\begin{array}{r} \hline \text { Dep } \\ \text { Arrr } \end{array}$ |

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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 $S(t)$ :
Drilling Center Queue: Number in System


