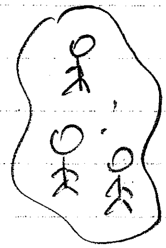
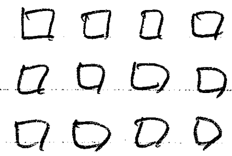
Ex. Prob. 17-6.32, p. 821 (Dolomite Corp)

12 semi-automatic machines needing servicing
s operators (human)



how to use them?, operators



12 machs

Alt.	Rule
1	Each op → her machines ; Several M/M/1/·/n queues
2	Pool op's → idle takes next machine: One M/M/s/·/12
3	Combine all as single crew → work together ; One M/M/1/·/12

(# machs assigned; ↑ crew)

Alt	"Runn." Time	Mean	λ	Serv. Time	Mean	μ
1	exp	150 min →	0.4/hr	exp	15 min	4/hr
2	"	"	"	"	15 min	4/hr
3	"	"	"	"	15/c min	4c/hr

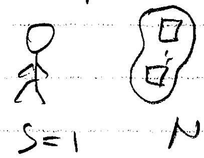
↑ crew size

Constraint: Running at least 89% time

N: # in assigned pop'n

L/N: % not running , 1 - L/N: % running

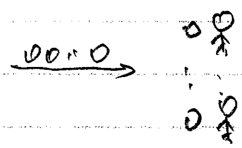
a) Alt. 1 ; S=1, N: # assigned to an operator

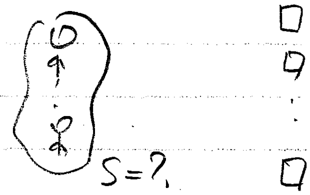


N	λ	Tot. Arr. rate	μ	L	1-L/N	$\bar{\lambda}$	$\bar{\lambda}/(S\mu)$
1	.4	.4	4	.09	.91	.36	.09
2	.4	.8	4	.19	.90	.72	.18
3	.4	1.2	4	.32	.893	1.07	.267
4	.4	1.6	4	.46	.883	1.41	.35

util. rate

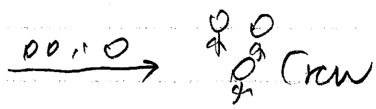
b) Alt. 2 ; N=12 , S=?





S	λ	Tot. Arr. rate	μ	L	1-L/N	$\bar{\lambda}$	$\bar{\lambda}/(S\mu)$
1	.4	4.8	4	3.19	.733	3.52	.88
2	.4	4.8	4	1.33	.888	4.26	.53
3	.4	4.8	4	1.13	.906	4.35	.36
4	.4	4.8	4	1.09	.908	4.36	.27

c) Alt. 3   S=1, N=?, C=? (Crew size)



C	λ	$1/\mu$	μ	L	1-L/N	$\bar{\lambda}$	$\bar{\lambda}/\mu$
1	.4	15 min	4/hr	3.19	.733	3.52	.88
2	.4	15/2	8	1.03	.914	4.38	.54
3	.4	15/3	12				
4	.4	15/4	16				

17.43)))

17.6-32.

(a) Alternative 1:

	Data	
λ =	0.4	(exponential parameter)
μ=	4	(mean service rate)
s =	1	(# servers)
N=	3	(size of population)

	Results
L=	0.3206442
L_q =	0.0527086
W =	0.2991803
W_q =	0.0491803

Three machines are the maximum that can be assigned to an operator while still achieving the required production rate. The average number of machines not running is $L = 0.32$, so $1 - (0.32/3) = 89.\cancel{7}3\%$ of the machines are running on the average. The utilization of servers is $(\overline{\lambda}/s\mu) = 1.072/(1 \cdot 4) = 0.268$.

(b) Alternative 2:

	Data	
λ =	0.4	(exponential parameter)
μ=	4	(mean service rate)
s =	3	(# servers)
N=	12	(size of population)

	Results
L=	1.1246521
L_q =	0.0371173
W =	0.2585324
W_q =	0.0085324

Three operators are needed to achieve the required production rate. The average number of machines not running is $L = 1.125$, so $1 - (1.125/12) = 90.6\%$ of the machines are running on the average. The utilization of servers is $(\overline{\lambda}/s\mu) = 4.350/(3 \cdot 4) = 0.363$.

(c) Alternative 3:

	Data	
λ =	0.4	(exponential parameter)
μ=	8	(mean service rate)
s =	1	(# servers)
N=	12	(size of population)

	Results
L=	1.0357708
L_q =	0.4875593
W =	0.2361705
W_q =	0.1111705

Two operators are needed to achieve the required production rate. The average number of machines not running is $L = 1.035$, so $1 - (1.035/12) = 91.4\%$ of the machines are running on the average. The utilization of servers is $(\overline{\lambda}/s\mu) = 4.386/(1 \cdot 8) = 0.548$.